D2.1 Pilot Specification and planning

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Executive summary

This deliverable illustrates the planning for the EUreka3D-XR demonstration prototypes, also called XR scenarios or pilots, which take place in three different settings and locations - Girona (Catalonia, Spain), Bibracte (France), and Paphos (Cyprus) - and that use the EUreka3D-XR open tools developed for enabling CHIs to reuse cultural collections to create XR experiences dedicated to end-users:

- the Girona pilot (led by CRDI) is about using archival materials to reconstruct in 3D the medieval walls of the city of Girona as they were before the demolition happened in the 20th century; and to reuse such reconstruction for an AR walking tour using a mobile device;
- the Bibracte pilot (led by BIBRACTE) is about visiting the archaeological site of the Celtic city of Bibracte and being able to understand the process of excavations, the reconstructed aspect of buildings and the artefacts that were retrieved by archaeologists in different zones of the site, by following a map available on a mobile app;
- the Paphos pilot (led by CUT) is about visiting a monastery in a cave in the surroundings of Paphos, and being able to virtually meet avatars of the monks who lived there, ask them predefined questions and hear their stories, with headset.

The three pilots basically deliver user experiences of extended reality, thus meaning that the experience should be accessed by users on location, with mobile devices or virtual glasses and headset. However, the XR scenario for each pilot will also be made available in different formats that allow for online fruition, e.g., with illustrative videos, as a virtual reality experience via browser, or by enabling remote access to 3D objects on a map.

In general terms, the planned work will unfold for the three pilots according to the schedule sketched out in the Grant Agreement, that is composed of two main phases:

Table 1: General planning for the three Pilots

Phase 1: M1-12	- Requirements for the scenario and tools - Content selection, storyboard of user experience, expected narrative - First assessment of the expected scenario and tool usage - Prototypes v. 0.1 (beta version), by M12 - Girona presentation event, by M12
Phase 2: M13-18	- Iterative development, improvements to prototype, testing - Aggregation of content to Europeana, by M15 - Iterative assessment of the expected scenario and tool usage - Prototypes v. 1.0, by M18 - Cyprus presentation event, by M18 - Lessons learnt collected and shared in case studies and the project's booklet

The content produced and used in each pilot scenario will be published in the Europeana collections website, and documentation of the XR experiences will be made available openly to the stakeholders of the common European data space for cultural heritage, also providing access to the tools.

The story of the development of the pilots, their contents and their tools will be presented as case studies and included in the final publication, distributed as online resource and on print.

More details about the tools and their technical aspects are described in the *D3.1 Technical Specifications*, which was produced in parallel with this deliverable.

Initial considerations about the expected impact of the three pilot scenarios are provided in the document, stemming from internal reflections of the consortium and from the early feedback received from the experts of EUreka3D-XR Advisory Board who received a presentation of the pilot scenarios and tools in July 2025. Besides local activities and project's presentations to take place in the course of the following months, three events are the major occasions for demonstrating and showcasing the pilots: a capacity building event organised in Brussels on 26 September 2025; the Girona demonstration event, planned on 28-29 January 2026; and the final conference in Cyprus, which is set in the last week of May 2026 in conjunction with the events celebrating the Cyprus Presidency of the EU.

The document is composed of the following chapters:

1. Introduction
2. Pilots production schedule and planning
3. Virtual Visualisation of the middle-ages walls of the city of Girona
4. The AR narrative of the hidden side of the Bibracte archaeological site
5. A new life for the Englystra of St. Neophytos
6. Preliminary reflections on expected impact of the pilot scenarios
7. Conclusions

1. Introduction

EUreka3D-XR is investigating the transformation of 2D and 3D digital cultural assets into XR scenarios, to support innovative reuse of those assets in services and products that appeal to end-users. The project is therefore addressing the needs of cultural heritage institutions (CHIs) in reusing their digital collections, thus leveraging the investment made in 2D and 3D digitisation, and in delivering innovative storytelling to their target communities. In this light, EUreka3D-XR is developing open-source digital tools, including online services and mobile apps.

Such tools are tested, improved and used in three real-life settings, that are called alternatively pilots, use cases or scenarios. The three scenarios offer experiences of extended reality (XR) to users, and are set in three locations: Girona (CAT), Bibracte (FR), and Paphos (CY), respectively led by partners CRDI, Bibracte and CUT.

Fig. 1 Three pilot XR scenarios for demonstration developed in EUreka3D-XR

Scope of the three pilot scenarios is to demonstrate the use of the EUreka3D-XR tools by different types of CHIs and with different collections and approaches, and thus inspire other CHIs to try the tools with their own content, for creating their XR experiences that engage audiences in their own context.

Both the tools and scenarios will be published and showcased in various formats in the common European data space for cultural heritage, the EUreka3D Data Hub and on europeana.eu. This report provides the specifications of the end product for each pilot scenario, including production schedule and planning.

1.1 Target Audience and Stakeholder Communities addressed with the demonstration scenarios

According to the project's Grant Agreement, the pilots are demonstrators for the successful use of the EUreka3D-XR tools. In this light, the main target audience for the scenarios are fellow CHIs and cultural professionals who are inspired by the pilot to try the tools in their own context. They are the main stakeholders whose feedback and evaluation should be collected and taken into account since the early stages of the project, to support an iterative development of the scenarios and tools which meet the needs of potential CHI users. They are also the main stakeholders for the expected impact of the project, which aims at supporting CHIs and cultural curators in their digital transition, by making it easier to reuse 3D and other digital cultural collections, also accessing and using the common European data space for cultural heritage.

As part of this primary target audience, cultural professionals engaged with the evaluation of the scenarios are both the staff of each pilot leader, who are actively involved in the use of the tools and in the scenario production, and work in close collaboration with the technical partners in the project and with the other consortium partners; and non-partner cultural professionals, who are not directly involved in the development and who will provide the external point of view regarding the effectiveness of the tools and the appeal of the demonstration scenario.

Examples of the evaluation by this target audience are the meeting held on 8 July 2025 with the experts of EUreka3D-XR Advisory Board, feedback collection from the Brussels capacity building event on 26 September 2025, and the upcoming focus group in October 2025.

In addition, the scenarios themselves indeed reuse 3D and other digital cultural collections in XR experiences that deliver cultural narratives, and these narratives are targeted to end users, such as site visitors, tourists, educators, schools, local citizens and so on. These end users are also stakeholders for the scenarios, however the challenge of the project's timeline, where the final prototype of the scenarios will be completed towards the end of the project, makes it more difficult to collect feedback from these end users. An effort will be made however to engage such end users in the evaluation of the prototypes, via dedicated local focus groups, surveys and interviews.

Examples of the evaluation by these stakeholder communities are the various activities planned by the pilot leaders in the second half of the project, such as evaluation with teachers and schools in Cyprus via surveys (CUT), evaluation with end users, visitors of the archaeological site and students (BIBRACTE), public presentation to Girona citizens collecting their feedback (CRDI).

In the following chapters 3, 4 and 5, specific subgroups belonging to these target groups and communities are indicated for each scenario. In this light, rather than covering the entire spectrum of possible target audiences, each pilot acts as a case study and focuses on relevant subgroups or geographic areas. Specific actions with these target audiences and stakeholders are indicated for each pilot.

1.2 Tools used in the demonstration scenarios

In EUreka3D-XR, five tools are being developed to enable use and reuse of 3D and other types of digital cultural content in creative outputs that enhance the visitor's experience of collections, heritage sites, and cultural visits.

The tools are tailored to CHIs who want to experiment with their own collections and other publicly available cultural contents, and easily create end-products that appeal to their target audiences. Detailed description of the tools and their technical requirements are provided in *D3.1 Technical Requirements.*
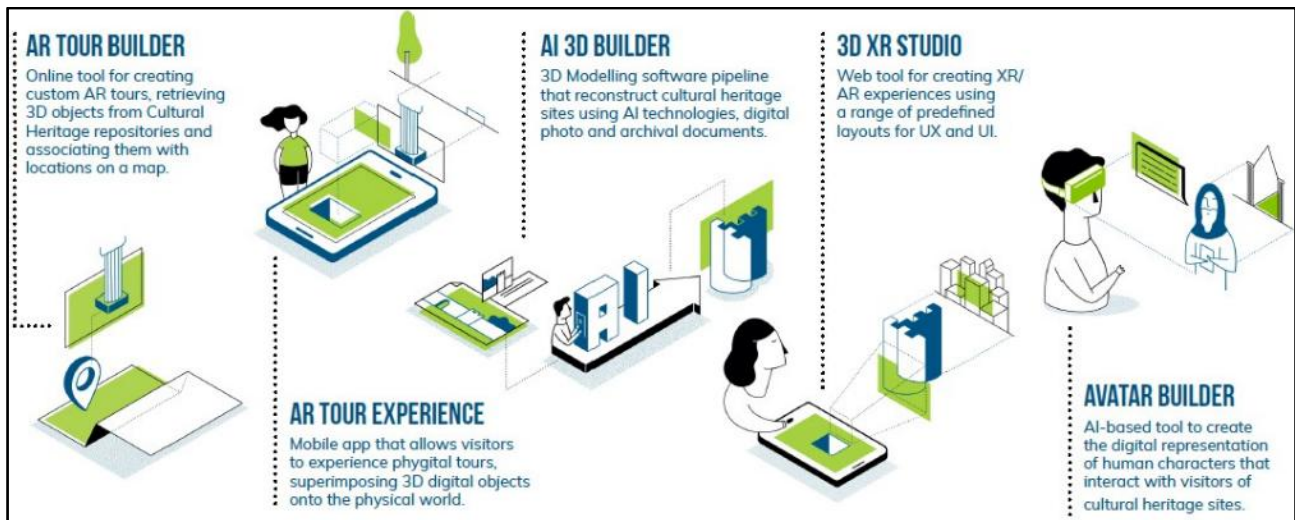
Fig. 2 The five tools developed in EUreka3D-XR

The five tools are used in three different real-life settings, thus creating three demonstration scenarios, by transforming cultural contents such as 2D, 3D, video, texts, maps, stories from EUreka3D-XR content providers into compelling narratives that engage visitors in three locations: the city of Girona, the archaeological site of Bibracte, and the monastery of Saint Neophytos in Paphos.

Each scenario uses of one or more of the five tools, in particular:

- CRDI uses the AI 3D Builder and the 3D XR Studio by Swing:It, to reconstruct 3D models and then produce the virtual visualisation of the medieval walls of the city of Girona;
- BIBRACTE uses the AR Tour Builder and its complementary AR Tour Experience by NTUA, to produce the XR narrative of Bibracte archaeological site;
- CUT uses the Avatar Builder by MIRALab, to produce the creation of a new life of Saint Neophytos Englystra in Cyprus in virtual space.

In addition to the work of pilots' partners, the tools will be tested in the consortium independently from the three showcase scenarios, for evaluation and iterative development scopes. To this purpose, focus groups are organised in the project to collect additional feedback on the tools and the scenarios by relevant stakeholders. A presentation meeting to showcase the pilot scenarios and tools to the members of EUreka3D-XR Advisory board was organised in July 2025 and a dedicated focus group is planned in October 2025, and more evaluation actions will take place both at project level and locally by the pilots as long as the development progresses and the prototypes are taking shape.

The tools and the three pilot XR scenarios will be delivered to the common European data space for cultural heritage, to enrich the corpus of open access digital cultural resources and collections online, and to inspire others in experimenting new technologies. The integration of all project outcomes in the data space has already been planned and agreed with Europeana as the operator of the data space: content used in the scenario will be published in europeana.eu, the access to the tools will be granted to any data space users via the data space website and editorials, and the XR experiences of the three scenarios will be showcased

in demonstration videos, editorials and other inspiring materials. Details on the integration are provided in the *D1.2 Integration Report*.

The work done for the development of the scenarios also serves the effort on capacity building of EUreka3D-XR project by feeding learning resources, case studies and demonstration about the use of the tools to other cultural institutions in search for innovation in their workflows on 3D and digital transformation.

1.3 Role of this deliverable in the project

This deliverable is complemented by the *D3.1 Technical Specifications*, and in fact the two documents were produced in parallel. Coordination meetings took place regularly since the beginning of the project, so that the tools developers and technology providers (Swing:It, NTUA, MIRALab, EGI and imec) would be enabled and facilitated in discussing with the partner CHIs and content providers (CRDI, BIBRACTE and CUT), not only to collect specifications of the desired functionalities of the tools, but also for sharing common requirements, technical challenges and desiderata, including the developments needed in the EUreka3D Data Hub as the backending cloud to access and store 3D models used in the pilot applications. These coordination meetings were organised by Photoconsortium (WP2 leader) and imec (WP3 leader).

This deliverable at M6 also corresponds to milestone 4 "Definition of Pilots specification", and illustrates for each pilot scenario the following aspects:

- information about the content of the scenario, its target audience, the narrative and storytelling which will unfold in the pilot application, to be realised using the selected EUreka3D-XR tools;
- the planning for the technical development of the pilot application according to the project's milestones;
- the planning for evaluation actions to collect stakeholders' feedback on the application and its use, and for communication and dissemination at local level;
- additional information about the cultural objects or collections from each pilot, which will be aggregated as new contents in Europeana; about the expected future developments of the pilot; and about other EUreka3D tools tested in the pilot besides those which were actually used to create the specific XR scenario.

Besides being a comprehensive planning for each pilot scenario, the work illustrated in this document serves to feed various other deliverables foreseen in the project, such as the *Pilot Prototypes V0.1 and V1.1* (D2.2, D2.3, D2.4 due M12, and D2.5, D2.6 and D2.7 due M18), the *D4.3 Sustainability Plan* due M12; the *D2.8 Publication of content in Europeana* due M15 and the *D4.2 Impact assessment report* at M18.

Additionally, the results of the pilot scenarios will feed content for the capacity building action as planned in *D5.1 Capacity Building Implementation Plan* and for the communication and dissemination action as planned in *D4.1 Dissemination and exploitation plan.*

The lessons learnt, challenges encountered, and overall journey by each content partner in the realisation of the pilot XR scenario will be collected in case studies and openly published as learning resources to inspire others.

2. Pilots production schedule and planning

According to the general plan indicated in the Grant Agreement, the three pilot scenarios have a common general schedule with three major deliverables and milestones:

- the pilot specification and planning at M6, this document
- the pilot prototype V0.1 at M12, coupled with a demonstration event that is set on 28-29 January in Girona
- the pilot prototype V1.0 at M18, which delivers the final, working application for each pilot.

This general schedule basically creates two phases for the pilots' production schedule and planning:

- the first phase comprising requirements collections for the scenario and tools; content selection, storyboard of user experience, expected narrative; and first assessments of the expected scenario and tool usage to bring to the delivery of prototypes v. 0.1 (beta version) and presentation event by January 2026;
- the second phase comprising iterative development, improvements to prototype, testing and evaluation with internal and external stakeholders for iterative assessment of the expected scenario and tool usage leading to the delivery of prototypes v. 1.0, by July 2026. In parallel to these development and assessment activities, in the second phase of the production schedule other activities take place: the work for enabling aggregation of content to Europeana takes place, with datasets ready for publication by April 2026, and collection of lessons learnt as case studies for the project's booklet.

In the timeline foreseen in the Grant Agreement, the final conference in Cyprus in conjunction with the EU Presidency and Euromed 2026 conference, set by M18, should have been a perfect occasion to showcase the final pilot applications to a wide international audience, celebrating the successful completion of the project. However, in order to match with the timing of the Cyprus Presidency events that are set in the final week of May, the final conference of EUreka3D-XR is moved to M16, in a day TBC in the week 24-31 May. While the earlier date of the final conference does not have a specific impact on the planning of the prototypes development, which can be significantly showcased at the final conference in the very last stages of their development, it would be necessary to accelerate the pace of analysing and collecting the lessons learnt in the pilots' journey, which is an essential element of the project's final publication, i.e. the final booklet. In this light, planning work for the content collection and retroplanning for the booklet production has already been initiated.

The details of the activities for pilots' production schedule and planning are provided in the next paragraphs, that include both common activities that take place for the three pilots (indicated with "ALL") and the specific pilot-related activities happening for each of the three pilots (indicated with "NAME OF PARTNER").

2.1 Phase 1

[M1] February 2025

- ALL: First presentation of the expected scenario at the launch event of the project, in Pisa and online, held on 27 February 2025.
- ALL: Participation in the development of requirements.

[M2] March 2025

- BIBRACTE: Composition of the internal working group on the main scenario, definition of the guiding thread ("Showing the invisible") and requirements for the Points of Interest (a 3D model at a minimum and additional content to highlight all the potential of the tool).

[M4] May 2025

- CRDI: Dossier with all technical information about walls to be followed by Swing:It in order to have a realistic virtual visualisation of the walls; internal evaluation of AI 3D Builder first visualisation results.
- CUT: Digitisation for site monitoring: Photogrammetry of the Englystra; Laser scan of the Englystra; Dissemination recording, Collation of initial imagery.
- BIBRACTE: First identification of Points of Interest (POI) on site and their associated content.
- ALL: Presentation of the outline of the scenario in the video of International Museum Day (18/5/2025).
- ALL: Presentation of the Scenarios at the conference in Florence (29/5/2025).

[M5] June 2025

- BIBRACTE: Continued identification of POIs and associated content: sharing with NTUA a first set of 7 POIs with their content for testing in September; preliminary consideration of a second scenario to illustrate the possibility of creating several tours on the same site.
- CUT: Detailed storytelling and definition of the speeches for the avatar of Saint Neophytos; testing the formats of the Avatar Builder and their visualisation possibilities in EUreka3D Data Hub.

[M6] July 2025

- ALL: Mock-up of scenarios made available for plenary meeting and presentation to EUreka3D-XR Advisory Board (7-8/7/2025), collecting feedback.
- ALL: Detailed planning for pilot scenarios, with specification of the end product, and schedule of activities.
- CRDI: Drone photoshooting of the existing walls, including professionals from Swing:It visiting Girona and participating in the drone photoshooting (14-15/7/2025).
- BIBRACTE: Final selection of POIs for the main scenario and identification of their contents.

[M8] September 2025

- ALL: First demonstration of scenarios at the EUreka3D-XR capacity building event 'Reimagining cultural heritage in 3D and XR' in Brussels, 26/9/2025, with evaluation from participants.
- BIBRACTE: On-site test with NTUA of 7 POIs (16-18/9/2025), User Experience Storyboard.
- CUT: The Saint Day of Saint Neophytos, on 28/9/2025. CUT is minded to mark the day with a collaborative event with the monastic community - subject to the availability of the monks and access to the monastery. On the same occasion, a special liturgy celebrating the Memorial of the discovery of Saint Neophytos holy relics in 1750 takes place and will be recorded in audio/video for use in the pilot's documentation.

[M9] October 2025

- ALL: Evaluation of the toolbox, including consortium partners and Advisory Board members (internal focus group, exact date TBC).

[M10] November 2025

- BIBRACTE: Production of the main scenario in the AR Tour Builder.

[M11] December 2025

- ALL: Assessment and testing of the expected scenario and use of the tools in preparation of the demonstration event in Girona .

[M12] January 2026

- ALL: Hybrid demonstration event in Girona, 29/1/2026 (morning): EUreka3D-XR toolbox and showcase scenarios demonstrations (for the three pilots.
- CRDI: On-site session 29/1/2026 (afternoon), evaluation with archivists and records managers (specific for the Girona pilot): workshop on the use of archival documents to create 3D/XR experiences, also testing the AI 3D Builder tool.
- CUT: The second Saint Day of Saint Neophytos, 24/01/2026. CUT is minded to mark the day with a collaborative event with the monastic community - subject to the availability of the monks and access to the monastery.

2.2 Phase 2

[M13-18] February - July 2026

- ALL: Iterative development and prototype improvements.
- ALL: Iterative evaluation of expected scenarios and use of the tool.

[M14] March 2026

- BIBRACTE: Evaluation with culture, tourism, education and ICC professionals.

[M15] April 2026

- ALL: Digital assets ready to be aggregated into Europeana.
- BIBRACTE: Production of the second scenario in the AR Tour Builder.

[M16] May 2026

- ALL: Lessons learned collected and shared (project booklet).

- ALL: Demonstration of the scenarios at the Cyprus Conference, in the week 24-31 May 2026 (exact date TBC).
- CUT: Evaluation with onsite visitors at the Monastery, during selected open days, with interviews and written questionnaires.

[M17] June 2026

- CUT: Evaluation with teachers and schools, via surveys.
- BIBRACTE: Evaluation with end users, visitors of the site and students.

[M18] July 2026

- ALL: Final prototype V1.1 completed.
- CRDI: Public presentation in Girona with the aim of introducing the on-site experience to citizens and collect feedback.

3 Virtual visualisation of the medieval walls of the city of Girona

Fig 3. The medieval walls of the city of Girona

3.1 The Pilot scenario, specifications of the end product

This scenario is about the virtual reconstruction of the western side of the walls of Girona city. The walls were partly demolished at the beginning of the 20th century because of the new urban setting of the city, and so archaeological restoration was not possible anymore. In the EUreka3D-XR project, 3D modelling and XR let us go back to history and recover what was destroyed at that time. Based on cartography, engravings, photography, films and textual records, we will be able to visualise the walls again with a very realistic approach.

Using the tool that partner project Swing:It is developing, an advanced AI-powered software pipeline to generate 3D models from 2D image collections, it will be possible to create very realistic 3D models of the demolished walls. Besides, using the other tool also developed by Swing:It, a web-based and also a mobile application, it will be possible to have an XR experience on site.
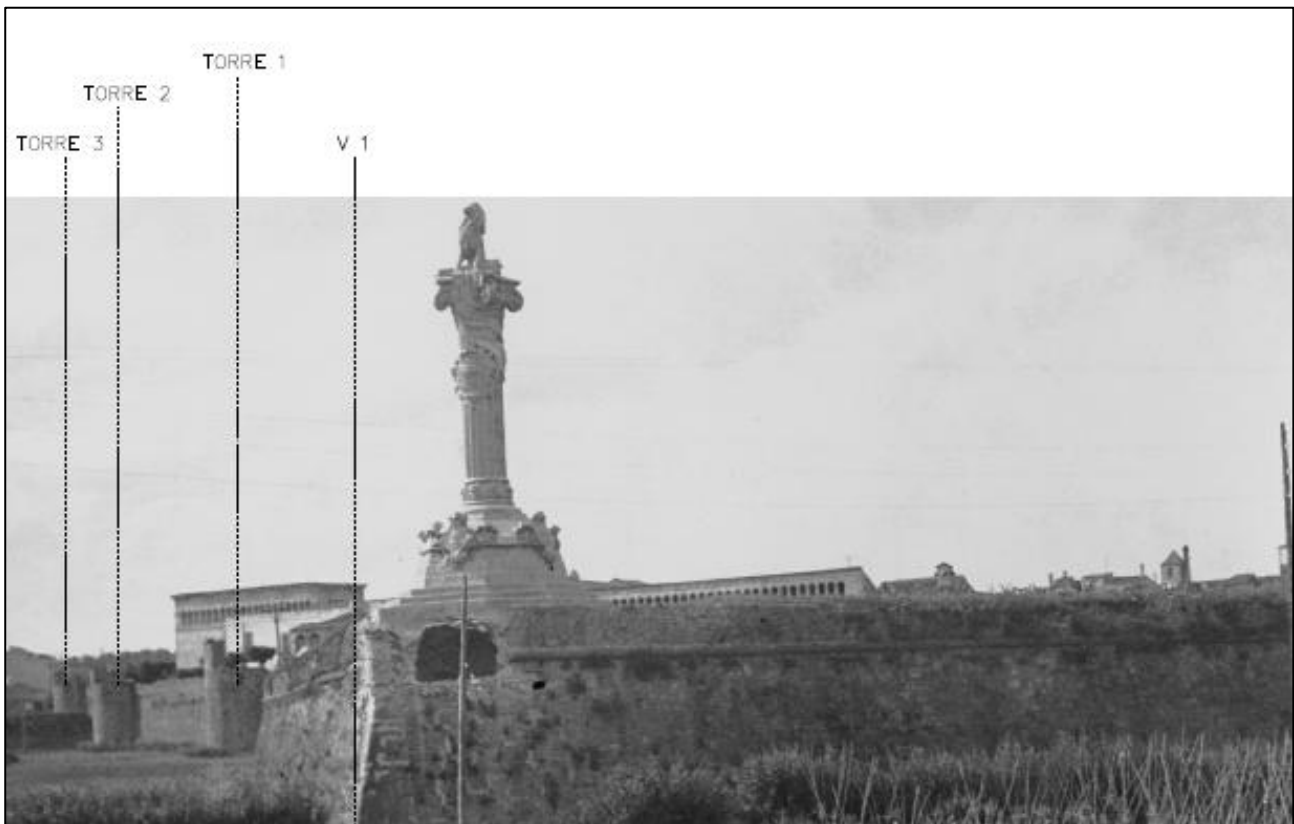
Fig. 4 Heritage photograph of the section of the wall adjacent to the bastion, with the three towers.

3.1.1 Target audiences / stakeholders

The Girona pilot utilises two tools, both provided by partner Swing:It: the AI 3D Builder and the 3D XR Studio. They are combined for the Girona pilot, but they are not directly connected, being each a standalone solution, and have different audiences as well. The pilot as a demonstrator is targeting mainly archivists and records managers who may want to use the AI 3D Builder to generate 3D models from 2D contents. Additionally, the use of 3D contents in AR tours aims at engaging on one side curators and CHI staff who create the AR/XR tours, and city visitors and other local stakeholders who access the Girona walls application.

That creates different target audiences the pilot takes into account, the details for the various categories are provided in the subsections below:

A. Target audience for the use of the AI 3D Builder

- **Archivists and other professionals in record management**: As primary custodians of historical records, archivists are the main target for this tool. Archives, museums and libraries hold the 2D sources (cartography, engravings, photographs, films, textual records) that are transformed into 3D models. The pipeline is designed to facilitate their work in digital reconstruction, offering an advanced solution to valorise and reuse archival materials in new 3D/XR contexts.

- **Researchers in digital humanities**: Scholars working on digital reconstruction, urban history, or heritage visualisation will benefit from the capacity to generate accurate 3D models from documentary sources.
- **Technical staff at CHIs**: Professionals responsible for digitisation and digital asset management.

and additionally, other stakeholders are:

- Curators, CHI and archive institutions and their management
- CHIs' digitisation departments
- Technology partners and developers in the digital heritage field
- Creative industries professionals
- Cultural tourism professionals

B. Target audience for the use of the 3D XR Studio, to create AR/VR tours

- Curators, CHIs managers, staff and professionals
- Researchers
- Educators
- Creative industries professionals
- Cultural tourism professionals

C. Target audience for the use of the 3D XR Studio, to visit the Girona walls

- **Girona citizens**: Residents are the primary audience for onsite experiences, being directly interested in the virtual recovery of their city's lost heritage.
- **Tourists and cultural visitors**: People visiting Girona, interested in historical and cultural discovery through immersive and interactive experiences.
- **Educators and students**: Local schools and universities using XR onsite or remotely for educational purposes.
- **Cultural events organisers**: Entities planning guided tours, city events, or educational workshops.

and additionally, other stakeholders are:

- Girona municipality and local authorities
- Tourism boards and cultural tourism operators
- Educational institutions
- Community associations promoting local heritage

3.1.2 Content used in the scenario

The scenario starts from a variety of 2D documentation to produce 3D models. The content used in the scenario is therefore extensive, to grant the tool sufficient source materials and information details to generate accurate and scientifically-sound 3D models. A selection of the content will be aggregated and published in Europeana (cfr. sect. 3.4).

The detailed list of content is illustrated below: these are the records and data provided for the virtual 3D reconstruction of the Girona city walls, in the sector designated as a pilot test. CRDI provides these records

to Swing:It in order to have all the scientific information required for the most realistic virtual approach with regards to target users and their devices, and to identify the set of images needed for the textures of the 3D models.

General plan of the section of the wall to be reconstructed: This plan precisely defines the section of the wall to be virtually reconstructed through the creation of 3D models. It includes all the elements to be considered. As informative elements, the document contains:

- The layout of the wall over the current map.
- The layout of the bastion, with four marked vertices serving as reference points for other documents in this dossier.
- At Vertex 1, a sentry box is drawn.
- At Vertex 1, the remains of the bastion still existing are highlighted in bold. Part of this bastion is not visible on the surface and can only be seen by descending into the underground parking area (new photos have been taken, see Annex 2).
- Inside the bastion, the space currently occupied by the municipal market is marked.
- The three gateways in the wall that provided access to the bastion are indicated.
- The layout of the moat that follows the wall and bastion.
- The layout of the parapet walk along the wall is marked. This walkway was narrow up to Tower 2. From there, it became much wider, allowing carts to pass. The widths are specified.
- In front of Tower 2, a powder warehouse is drawn. The structure of this powder warehouse still exists. Therefore, this powder warehouse and Vertex 1 of the bastion are the only existing reference points for an on-site visit.

General plans of the section based on an Orto photography[1]: It is the same plan as the previous one based on an orthophotograph. The orthophotograph provides the information needed to avoid collision while viewing the 3D model on-site.

Plan of the bastion: This plan provides a detailed explanation of all the elements that were part of the bastion. As informative elements, the document contains:

- The layout of the bastion within the corresponding section of the wall.
- Surface area of the bastion: 6,098.58 m².
- Exact measurements of all the faces of the bastion.
- Location of the different elements of the bastion: sentry boxes, embrasures, cannons, banquettes, loopholes, and gateways.
- Position of the powder warehouse, in the central part.

In addition to the plan of the bastion, the document includes a view of the bastion with the sculpture of *the Lion*. It is important to note that the monument of *the Lion* dates from 1909 and is not part of the wall reconstruction, as it belongs to a different historical context. This document also includes a frontal view of

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[1] An orthophoto, orthophotograph, orthoimage or orthoimagery is an aerial photograph or satellite imagery geometrically corrected ("orthorectified") such that the scale is uniform. cfr. https://en.wikipedia.org/wiki/Orthophoto

the bastion and the wall, featuring one of the towers. This view clearly shows the two ground levels: the current level (plaza level) and the historical level (parking level).

Plan of the vestiges of the bastion: This plan explains the current state of the bastion, meaning it includes the elements that are still preserved. As informative elements, the document contains:

- The structure of the bastion's vertex, on which the Lion monument is located. This monument should NOT be considered for the 3D model.
- Remains of the lateral walls. These are only preserved at the underground level, meaning they are only visible when descending into the parking area.
- Indications of the dimensions of the current elevator (4.35 x 2.53 m) that provides access to the parking area.
- Measurements of all elements.
- Indications of the current municipal market, as a reference point.

In addition to the plan of the bastion, the same document includes a view of the bastion, with the heights indicated.

Height of the wall: This graphic provides information on the different heights of the wall, considering both the current level (plaza level) and the historical level. The various heights indicated are:

- Tower section.
- Wall section.
- Wall-walk section.
- Bastion section.
- Moat section.
- Elevations from the 1869 plan.

Current heights: This graphic provides information on the different heights of the preserved vestiges of the wall. It distinguishes between the current plaza level and the historical level (parking level). The data included are:

- Heights of the existing elements.
- Altitudes from the 1869 plan.

Image of the powder warehouse: Image of the preserved vestiges of the powder warehouse. The image was taken from Google Earth. The same document includes the powder warehouse plan with the following information:

- The length measurements of the walls.
- The total surface area of the powder warehouse: 54.27 m².
- The wall with its corresponding width.

Drawing of the powder warehouse: Map of the powder warehouse according to its original structure and in relation to the wall and the tower. As informative elements, the document includes:

- A drawing of the powder warehouse structure indicating the location of the entrance door, which no longer exists.
- The position of the powder warehouse in relation to the tower and the wall.
- The wall-walk ends at the powder warehouse, with a width suitable for cart circulation, and transitions into a narrow pedestrian passage.

Photograph of the bastion: Photograph of the bastion with the image of the sculpture *The lion* in the foreground. Vertex 1 is marked as a reference for the plans. Towers 1, 2, and 3 are also marked.

Photograph of the section of the wall with the three towers: Photograph of the section of the wall adjacent to the bastion. Towers 1, 2, and 3 are marked. It should be noted that Tower 3 is located directly in front of the powder warehouse.

Photograph of the three towers: Photograph of the three towers. Vertex 2 of the bastion is marked. It should be noted that Tower 3 is located directly in front of the powder warehouse.

Photograph: vertex 3 of the bastion: Partial photograph of the bastion. Vertex 3 is marked.

Photograph: general view: Photograph of the general view of the bastion and the section of the wall to be recreated in 3D. The *Lion* sculpture helps to locate Vertex 1 of the wall. The image also marks Vertex 4 and Towers 1 and 2.

Historical plans of the section of the wall and bastion (1869): This is an original plan from 1869, when the wall had not yet been demolished. This plan is used in this dossier as a reference for all the altitudes present in the plans created for this project.

 Images for textures of the medieval walls and bastions: All these images are used to provide the texture of the walls and associated elements. These images are currently allocated in the CRDI cloud. For the new images, CRDI follows the instructions provided by Swing:It.

3.1.3 Narrative and storyboard

Users will be able to watch the 3D models of the walls, towers and bastions on site. The linked records and information to these models will provide them a historical narrative. Audio records will be in Catalan and English. This is the main information of the historical context:

- Girona has been 2,100 years since the foundation of Girona by the Romans (Gnaeus Pompey the Great, in 76 BC).
- The medieval walls of Girona were built in the 15th century.
- The building of towers and bastions (16th- 17th century).
- The walls and all these elements were partly demolished at the beginning of the 20th century.
- The walls of the eastern side were kept, even if they were abandoned for many years.

- It was during the 1980s that the works carried out in different phases aimed to reuse a space for walking and enjoyment, more than carrying out an archaeological restoration.
- It is in the 21st century, in the framework of EUreka3D-XR project that the demolished part of the walls is being virtually reconstructed.

3.1.4 Interaction with end users

The Girona pilot utilises two tools, both provided by Swing:It.

AI 3D Builder is a professional tool for creating 3D models from properly generated collections of 2D materials. The tool is not specifically dedicated to end users such as site visitors, tourists or educators: it is rather targeted to CH curators, archivists, collection managers, etc.

In the pilot the AI 3D Builder is used for recreating the 3D-based virtual visualisation of the Girona walls. Once the 3D model is re-created by the curator, it can be rendered online as any 3D model, and also used in the **3D XR Studio** tool for visualisation onsite via a mobile app and enabling amazing XR experiences for tourists.

For the Girona prototype, the work in progress with the 3D XR Studio includes the creation of a web + mobile application that shows the end user a predefined pathway along the perimeter of part of the former west Girona walls.

The user downloads the mobile app on their smartphone and walks by, following the pathway map on the display. Along the walk the user can access virtual objects in extended reality, by visualising the 3D models in the scene.

As a curator/admin, the mobile and the web apps also allow to build the pathway and define its elements (models, reference points, etc) as well as augmentative contents. He/she is supported with tools for precise selection, rotation, scaling, and repositioning of 3D models.

By positioning their mobile device at every known reference point, the user can experience the model, obtain augmented information and also interact with a mascot, accessing the narrative and all the additional content created by the curators.

3.1.5 Workflow of the curator

A. Workflow for the AI 3D Builder

The AI 3D Builder pipeline is built upon Microsoft Trellis, an advanced AI model for image-to-3D conversion. This offers superior quality and ability to process multiple perspectives simultaneously, and supports local deployment for data security and control.

The curator accesses the tool via a web application that allows for processing 2D image collections, inputting various source photos as well as realistic illustrations and outputting industry-standard GLB files for broad compatibility. The AI handles the 2D-to-3D conversion, starting from images that the curator uploads in the tool. Guidelines are provided to the curator also including good practices for input photos and realistic illustrations as well as for quality of the output. The guidelines also include information about the elements to ensure optimal results across various input conditions (e.g lack of details, missing perspectives, quality

issues). Fine-tuning, also depending on the input conditions, requires a further crucial human refinement stage to improve the output generated by AI.

Once acceptable result is reached, the final GLB file can be normally stored, visualised, used, and also exported to other formats. The final model can be uploaded, for example, via the EUreka3D Data Hub which offers a 3D viewer and a full pipeline to safely store, manage and share 3D models and their associated metadata and paradata, also enabling publication on Europeana as open access data with a PID.

B. Workflow for the 3D XR Studio

The 3D XR Studio is a dual-component system comprising a web application and a mobile one devoted to the creation of XR experiences. The mobile app can also be used by curators for on-site refinement of the XR virtual area and precise 3D models placement.

By checking in the 3D XR Studio via a safe authentication mechanism, fully compatible with the EGI Single-Sing-On check-in adopted in the EUreka3D Data Hub, cultural heritage professionals and curators can easily create, organise, and distribute engaging XR experiences for large audiences. The tool is based on a streamlined approach that is designed to significantly reduce the technical expertise required and allows for rapid prototyping and deployment of immersive content.

In the web application, curators operate as Admins (editors of the XR experience). The tool implements a graphical interface (based on REACT technology) and features that enable Admins to import and select 3D models to position them on a map.

More specifically, Admins can:

- define AR/VR experience areas by inputting coordinates;
- provide a 3D map to visualise existing structures;
- import 3D models, and/or call to the Europeana API to fetch additional 3D models and ingest them in the 3D environment;
- arrange a precise positioning of the models within the virtual environment by defining coordinates, orientation, and scale.

In addition, the 3D XR Studio permits to create a mobile application for AR experiences onsite, which serves end users to follow the map and access the 3D models and narratives. The mobile app also has editing features for Admins, who can:

- Place and manage 3D Objects in real-time in the XR scene (position, scale, etc);
- Set 3D Objects visualisation (add visual occlusions);
- Handle Points (add, delete, move) that create the guided tour.

The Mobile App will handle model subset made available to the specific cultural site through the Web App only.

Fig. 5 Mock-up for the 3D XR Studio: on the left what the curator sees, with tools for managing the models on the scene; on the right what the user sees, with the mascot.

3.2 Evaluation planning, stakeholders feedback collection

The evaluation of the tools developed by Swing:It will be carried out by professionals from CRDI and the Municipal Archive. Other departments from Girona City Council will also be involved, specifically from the Cartography Department and the City History Museum. More feedback by external stakeholders will be collected during project's focus groups with the Advisory Board and with participants in the Brussels capacity building event in September and other project's events, via surveys, interviews and one-to-one reflections and discussions.

Externally, the applications will be tested by Catalan and Spanish institutions participating in the workshop to be held in Girona in January 2026, aimed at introducing these tools to the target users. Hands-on practice

and training with the tools will also include evaluation by the attendees via survey and one-to-one interactions.

A presentation of the application to Girona citizens and other local authorities will be organized towards the end of the project when the application is ready, also collecting initial feedback via surveys or interviews.

3.3 Dissemination planning

The main professional dissemination of this scenario, at local level, will take place during the hybrid demonstration event planned by the project for January 2026. As part of this event, a workshop will be organised for archivists and CHIs from across the country, giving them the opportunity to use the tool for creating 3D models based on photographic collections from their own archives or from other open access documentation available.

Public dissemination will take place through on-site visits for the XR experience. These visits will be organised by CRDI once the project is completed, the tools have been validated, and there is full certainty about their proper functioning. A public presentation will be held in July 2026 in Girona with the aim of introducing the on-site experience to citizens.

In addition to these visits, CRDI also plans to produce a physical model of the reconstructed wall, which will be exhibited in a public space, preferably outdoors. The 3D-printed model is foreseen either during the project or as a post-project action.

3.4 Aggregation of content in Europeana

The 3D models developed within the framework of this project will be stored in the EUreka3D Data Hub. This allows for their visualisation, third-party access to all project documentation, and their publication on Europeana. The publication on Europeana will follow the process established in the EUreka3D Data Hub, which involves filling out a form linked to the 3D object, allowing for the entry of various metadata and paradata that are subsequently transformed into Europeana Data Model (EDM) and published on Europeana.

Provisional 3D models that are expected to be generated, and will be aggregated for publication:

- 3D model of the bastion;

- 3D models of the 3 towers;

- 3D model of a portion of the west walls.

In addition to the 3D models, 2D contents will be aggregated as complementary documentation. The heritage photographs used to support the reconstruction process were aggregated in Europeana since 2015[2]. A collection of around 50 heritage maps of the city of Girona will be also aggregated. The precise number of maps that will be published in Europeana will be determined later. Finally, it is planned to record a video showcasing the complete XR experience. This video will also be published on Europeana.

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[2] The collection in Europeana

3.5 Future developments

The scenario developed in this project is considered a pilot test. The City Council of Girona intends to continue with the 3D reconstruction of the entire wall—both the demolished sections and the parts that were preserved and restored in the 1980s. In this regard, the work on 3D model reconstruction is expected to continue, as it is part of a broader municipal project driven by the EUreka3D-XR initiative. It is important to note that research into the urban history of the city began in the 1990s. The goal is to bring much of the content from these studies into a visual and accessible space for the public.

3.6 Additional tools tested in the scenario

Fig. 6 Heroines of Santa Barbara. Ramon

Within the historical context of the city walls, the **Avatar Builder** application will be used to create a character that delivers the narrative about the city's historical defence based on real figures during the French War (1808–1814). Specifically, it aims to give voice to the regiment of women who fought in defence of the city in the final battle that relied on the walls as its principal line of defence.

This women's regiment fought on the front lines as what is considered the first all-female military unit, known as Santa Bàrbara. The 'Bàrbara' women were identified by a red ribbon tied around their arms. They did not fight merely to combat an enemy. They did all this for far more personal and human reasons: to defend their families and their city. Therefore, this is a war narrative told from a gender-perspective.

At the time of writing, CRDI is finalizing a dossier with information and documentation for creating the avatar. This will be shared with partners MIRALab and Swing:It to evaluate the feasibility for the production of the test avatar.

4 The AR narrative of the hidden side of the Bibracte archaeological site

Fig. 7 Remnants of archaeological buildings in Bibracte site

4.1 The Pilot scenario, specifications of the end product

A Gallic town from the 1st century BC, Bibracte was mainly made up, until the middle of the 1st century BC, of wooden buildings of which only a few vestiges remain: postholes, pits, circulation levels, hearths, etc.

In addition, there are the following realities, common to all archaeological sites:

- Archaeology destroys its object of study because each archaeological layer can only be excavated once before being destroyed when the layer below is excavated in turn.
- At the end of the work, the last excavated layer is either backfilled to protect the remains (which is always the case for the remains of wooden buildings whose structure has disappeared), or it is preserved in situ (which is the case for a small part of the stone remains).
- Even when remains are preserved in situ, this always represents a state of the building, often the most recent, the other phases having been destroyed as the work progressed.

What escapes immediate perception at an archaeological site, as well as at many more recent heritage sites (including ancient city centers), falls into four categories: what has disappeared, what is present but not visible, what is not or no longer perceptible to the senses or the intellect, and finally what remains outside the scope of the in situ experience of visitors, such as the behind-the-scenes processes of the professional processes of archaeology and heritage restoration.

The table below details these different aspects:

Table 2: Hidden aspects in an archaeological site

		ARCHAEOLOGICAL SITE	PATRIMONIAL SITE
ABSENT	**Disappeared**	Past landscapes and ecosystems	
	Destroyed	- Structure, object and decor destroyed by time: perishable materials, inscriptions erased by the seasons... - The same by men (war, vandalism, ploughing, construction, exterior and interior renovation, etc.)	
		Archaeological layers during excavations which destroy their object of study	The same applies to building archaeology and restoration
	Moved	- Reused materials, stolen objects and decorations... - Furniture moved and scattered - Works preserved / exhibited elsewhere to ensure their safety and conservation	
NOT VISIBLE	**Over time**	Remains visible only during excavations	The same applies to building archaeology and restoration
	Covered / Masked	Archaeological layer covered to protect the remains.	Painted sign under plaster, old facade under modern ones,...
	Inaccessible / Hidden	Protection of people and property: excavated and backfilled archaeological structures, dangerous areas (basements, top of a tower), sensitive areas (Lascaux Caves), interior of private property, etc.	
NON PERCEPTIBLE	**To the senses**	Degradation/preservation process of different materials	
		- Significant absences (e.g., burials) - Anomalies you relief - Thin remains (post holes, etc.) - Micro-remains (seeds, pollen, etc.)	Everything that is not visible: see above
	To the intellect = not understandable	- Elevation when only the walls remain - Function of spaces (especially when uses have changed as is often the case in old centers) - Economic and social structures: commercial networks, social organisation… - Global historical phenomena: Romanisation, industrialisation, etc.	
	Forget	Sensitive and symbolic dimensions: gestures and craftsmanship, religious and cultural practices, etc.	
BEHIND THE SCENES		Preparatory phase for excavation operations, excavations themselves most of the time, post-excavation	The same goes for restoration projects.

Local scope of the scenario:

The main challenge of mediating with visitors to the Bibracte archaeological site is therefore to enable them to see and understand these almost invisible remains and realities on the site. Until now, their development has been based mainly on:

- the museographic elements of the permanent exhibition: models, iconography, videos and texts,
- explanatory panels on the archaeological site with the same type of iconography, accompanied by some restitutions on a reduced scale or on a scale of 1,
- the 'La Boussole de Bibracte' geolocated tour application, including iconography and 360° views of hypothetical 3D reconstructions of the elevations of three buildings. However, this tool does not easily allow to better respond to this challenge because the integration of new media (video, audio and more particularly 3D visible in AR) requires new development by the service provider and therefore a cost for Bibracte.

Today, the EUreka3D-XR project offers a more comprehensive and immersive response to this challenge, directly on the archaeological site. Thanks to AR, visitors will be able to view 3D models of terrain and objects linked to their discovery context and enriched with complementary media. This visit will allow them to discover 'the hidden side of Bibracte' by having access to missing elements, not visible in situ or not directly accessible to the senses and intellect (see table above).

This scenario will thus make it possible to:

- Increase site traffic,
- Strengthen the links between the archaeological site and the museum,
- Encourage visitors to the site to come to the museum to discover "in real life" the objects of which they have seen 3D models,
- Better promote research to visitors.

Overall scope of the scenario:

It concerns all heritage sites, from archaeological sites to ancient centres which encounter similar problems. The solutions provided by the Bibracte scenario could in fact be transposed to more recent sites.

In view of this global scope, it is important that the Bibracte scenario:

- explores to the maximum the possibilities of making visible and understanding the different types of invisible realities, as much as current knowledge allows,
- uses all the potential of the tools developed by NTUA in order to highlight them for their future users.

4.1.1 Target audiences / stakeholders

The pilot as a demonstrator is targeting mainly cultural professionals who may want to use the tools, but the AR tour, created with such tools, aims at engaging site visitors and other local stakeholders. So this creates two separated target audiences that the pilot takes into account.

The details for the two categories are provided in the subsections below:

A. Target audience for the use of the AR Tour Builder

The target audiences for this scenario are primarily:
- Heritage institutions managing outdoor sites,
- Public and private operators of archaeological excavations
- Municipalities and tourist offices of towns with an old town centre

and secondarily:
- Schools
- Independent tourist guides
- Cultural and Creative Industries (CCI).

Some of these audiences are already accustomed to using no-code tools to design heritage discovery experiences: Genially for light escape games, and especially PlaysVisit and GuidiGO[3] for geolocated tours. The first need is in fact common to these audiences (with the possible exception of the ICC): to have a no-code and open source tool, therefore free, to easily design geolocated tours that make 3D models and other types of cultural heritage content accessible via a mobile application, thus offering an AR experience to the on-site visitor.

In fact, there is currently no completely free and accessible solution without mastering coding that allows the creation of geolocated tours that can accommodate AR experiences using 3D models. Existing solutions such as GuidiGO or PlayVisit are proprietary platforms that require a paid subscription for 3D and AR, and remain limited to marker-based AR. Development tools such as Unity or Unreal Engine, although open source or with free licenses, require programming skills and are not specifically designed for the creation of geolocated tours for non-developers. In addition, the ARKit and ARCore frameworks, although offering advanced markerless spatial AR functions, also require specific development to combine geolocation and AR using 3D models. Finally, these solutions are not interoperable with open platforms that provide access to cultural heritage items, such as Europeana and the EUreka3D Data Hub.

Thus, the creation of a free, easy-to-use tool specifically designed to meet the needs of heritage sites and other stakeholders constitutes a major challenge in democratising the creation of geolocated tours in AR, while allowing complete autonomy for end users in the design and editing of content. The tools by NTUA developed in the Bibracte scenario can provide solutions to these challenges. These tools can also meet specific needs, possibly absent from Bibracte but for which technical responses can be tested:

- Use of QR codes to more precisely locate 3Ds in AR (not relevant on the archaeological site of Bibracte due to the small number of supports to fix them),
- Setting the trigger radius for POIs, i.e. the distance from which their content is displayed on the mobile application: shorten this distance when POIs are close or in an urban context in areas with heavy vehicle traffic / lengthen it when a POI is not physically accessible (remains under brambles, construction site under excavation, etc.) or temporarily in the event of a visit by a large group.

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[3] For example, of the 151 GuidiGO tours listed in Bourgogne-Franche-Comté (France), 52% were carried out by classes (from CP to Terminale, often in partnership with heritage institutions), 20.5% by tourist offices, 8.5% by heritage institutions (museums and castles) and 10.5% by other stakeholders (mainly independent guides, followed by students and heritage enthusiasts).

- Presentation of underwater remains from the surface. The effect of AR will be a little different, however, since the 3D models will appear on the surface of the water, but it is an interesting solution to allow a wider audience to discover these remains in a less expensive and more secure way. There are two pilot projects, MeDryDive AR App and VISAS (Virtual and Immersive AR for Submersible Archaeological Sites, but whose design tools are not open source.
- Materialisation in situ POIs by physical marking because not everyone knows how to read and use a map in order to signal the POI in addition to the vibration of the phone.

B. Target audience of the AR Tour Experience, to visit the Bibracte site

This refers to all visitors to the archaeological site of Bibracte and more particularly to those who do not visit the Bibracte museum and do not take a guided tour.

This scenario will be able to meet several needs of this audience in its diversity:

- For all visitors: the aim is to alleviate their frustration at the lack of visible remains on the site, while responding to their natural desire to see, understand and explore. The scenario promotes an active approach to discovery: it allows everyone to become an actor in their visit, by revealing "The Hidden Side of Bibracte" through an immersive and interactive experience that stimulates the imagination and enriches understanding of the site.
- For visitors keen on archaeology, or also on other heritage sites: deepen their knowledge, particularly with the possibility of downloading content that can be read later in more detail.
- For teachers and students: this scenario illustrates several aspects of the French school curriculum, in particular "And before France? What traces of an ancient occupation?" (History - CM1/CM2) and "Arts and societies (Antiquity and the Middle Ages): city, architecture, myths and representations" (History of the arts, 5th grade).

4.1.2 Content used in the scenario

The scenario will be structured around 3D content, supplemented by 2D elements, videos, audio files, texts as well as online content. While the majority of 3D content has already been identified (see section 4.1.3), this is not yet the case for a significant portion of the additional content due to the very richness of Bibracte's iconographic, documentary and multimedia collection[4]. The list below shows the types of content that have already been identified. An example of complementary content associated with a POI is detailed in the following section.

- 3D Content
    - 3D 'terrain' models (remains of structures and excavation areas): six to eight
    - 3D models of objects: around fifteen
    - 3D restoration of the missing elevations of certain buildings: one to three
  The majority of this content is already present on the EUreka3D Data Hub, others will be added: PC2 masonry cellar, restitution of elevations (technical and legal feasibility to be verified), potential 3D

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[4] 10^5 photographs, 10^3 2D plans of the site and excavations, 10^3 photogrammetric plans and 3D models of the excavations, 10^2 geophysical surveys and LIDARD, 10^2 3D models of objects, 10^3 PDF text content, 10^2 videos and 10^2 audio files

'terrain' models resulting from the conversion of orthophotos via the AI 3D Builder tool and objects unearthed in 2024 and 2025, the digitisation of which would provide a relevant addition to the scenario.

- Other file types:
    - 2D+: photogrammetric plans, orthophotographs and georeferenced landscape photographs.
    - 2D: photos of excavations, remains, objects, models from the museum; scans of old documents such as 19th century excavation notebooks, etc.
    - PDF: various texts such as mediation content, exhibition catalogs, extracts from excavation reports, etc., relating to the Bibracte site (remains and objects) as well as archaeological methods and knowledge about the past.
    - Video: targeted videos on various archaeological sectors and more thematic videos on certain subjects related to POIs.
    - Audio: in addition to some existing files, recordings of oral presentations of the 3D models will be made, in order to allow their full screen consultation without text overlay or interface change

- Specific online content:
    - Editorial content bringing together various media, for example: https://www.bibracte.fr/dossier/le-vin-bibracte.
    - Quiz on Historiana, for example: http://hi.st/Bnr.
    - Third-party content already online, in particular scientific publications on HAL, Persée, Open Edition, etc.

Methodological note:

The precise selection of content is directly linked to the narrative structuring of the scenario and the identification of points of interest (POI), each of which is built around a main 3D content. Furthermore, the very richness of the collection requires significant work to identify and select the most relevant resources. This work is underway and will be finalised in the fall of 2026, as the overall narrative of the scenario, as well as those specific to each POI, are consolidated.

Thus, this section draws up a typology of the mobilisable contents, while their detailed distribution, in particular the specific associations between main contents and complementary contents, is started in section 4.1.3 Story and storyboard, consistent with the educational intentions and narrative logic of the scenario, and will be completed by the fall.

4.1.3 Narrative and storyboard

Two tour circuits will be offered thanks to the fact that the possibility of several routes is allowed by the editing tool.

Its components, the POIs, will be chosen based on two criteria:
- Their ability to show and understand remains and reality not directly visible on the site,
- The availability of 3D terrain or object models: each POI will have a 3D model as its main content (or a geolocated and oriented landscape photos), as it is the medium with the strongest evocative power

thanks to the possibility of viewing them in AR. In addition, this 3D model will guide the narrative specific to each POI and therefore the selection of additional content.
- The availability of diverse complementary content by engaging to highlight the full potential of the AR Tour Builder & AR Tour Experience tools.

An initial list of POIs under consideration:

- The Rock of the Wivre
  Main content: georeferenced and oriented photograph from 1873-1874
  -> story: The vanished landscapes
- The Côme-Chaudron Workshops
  Main content: 3D object "Helmet reused as a foundry ladle"
  -> narrative: The craftsmanship of metal craftsmen
- PC 14 enclosure
  Main content: 3D terrain "Amphora dump pit"
  -> narrative: The wine trade
- The well at the edge of the PC14 enclosure
  Main content: 3D object "Small turned maple cup"
  -> story: Wood and archaeology
- Public space PC15
  Main content: 3D rendering of the elevation
  -> narrative: Gallic construction and public buildings
- The slope of the Theurot de la Roche
  Main content: 3D terrain "Mine shaft"
  -> narrative: Silver ore and currency
- The Great Gates
  Main content: 3D terrain "The Bibracte defensive system: the Great Gates - 2024"
  -> narrative: The two enclosures and the murus gallicus technique

Other POIs may be added to this list, particularly after testing the AI 3D Builder tool which would allow orthophotos to be converted into 3D models.

Detailed example of the content of the POI "The well at the edge of the PC14 enclosure"
Location: 46.926337, 4.034625
- Main content: 3D object "Turned maple cup" and its audio presentation
  -> story: Wood and archaeology
- Additional content:
- 2D: well being excavated, oak beam, fir shingle and museum showcase on dendrochronology
- PDF: "Worked wood, architectural wood, dendrochronology" (Annual report 2016, Bibracte, 9 pages, FR) and "Dendrology and dendrochronology: wood sciences and their contribution to archaeology"(Bibracte, 1 page, FR)
- video : "Dendrochronology" (2:51 FR and EN)
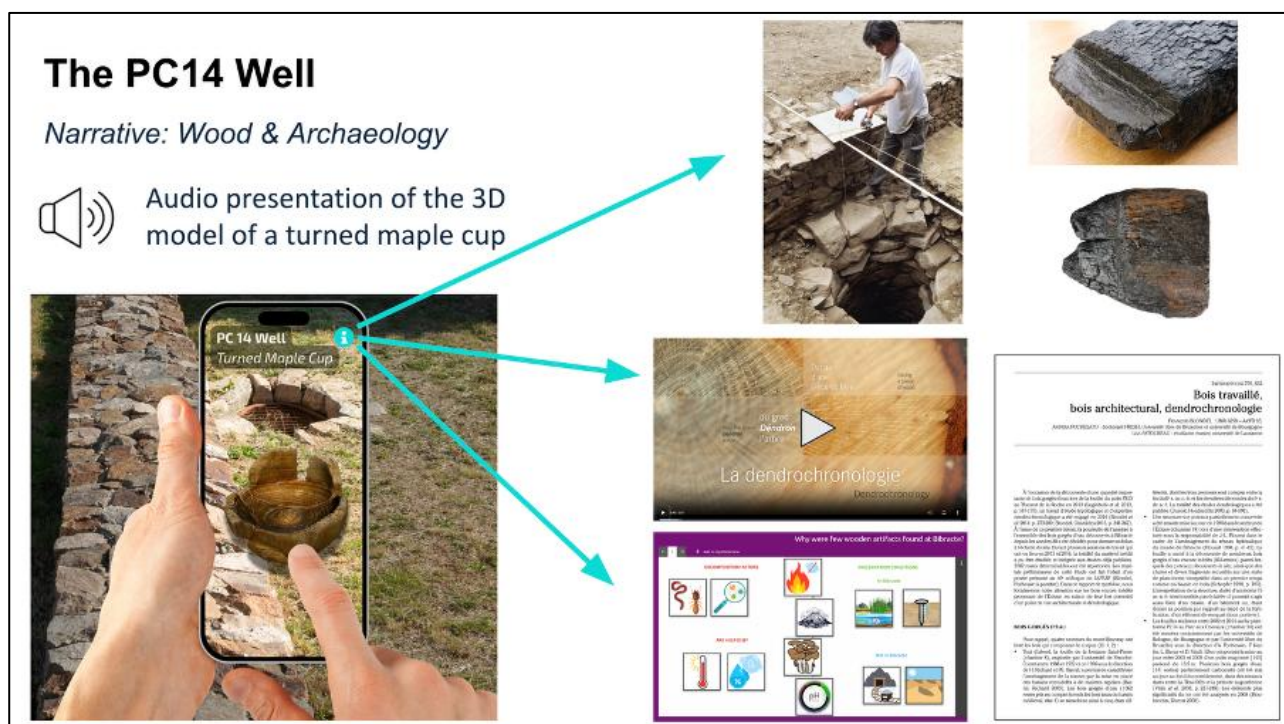- quiz : http://hi.st/Bnr

Fig. 8 Mock-up of the user experience with one Point of Interest

The secondary narrative

In addition to the main narrative, a secondary storytelling is under consideration: it will be much lighter and will not necessarily include 3D models since it is only a question of highlighting this possibility allowed by the tool. It will be a different theme from that of the main scenario and linked to the calendar of International or European Days and events in order to show that it is possible to design light courses to be offered ephemerally on recurring dates. Three themes are currently under consideration before a decision is made in Fall 2025:

- The landscape and natural environment of Mont Beuvray for International Forest Day on March 21, International Mother Earth Day on April 22 and "Rendez-vous aux jardins" (France, first weekend in June).

- Archaeological looting for the International Day Against Illicit Trafficking in Cultural Property on November 14, based on the of OER of the PITCHER project (Preventing Illicit Trafficking of Cultural Heritage: Educational Resources – Erasmus+ 2021-2024), one of which incorporates a 3D model of EUreka3D project.

- The link between archaeology and science for International Mathematics Day on March 14, International Metrology Day on May 20, European Researchers' Night on the last Friday in September, and European Science Week in October.

These two stories will be available in French and English, ensuring their linguistic accessibility to as many people as possible. In addition, the incorporation of digital accessibility features will be considered, such as alternative text, enhanced contrast, and the ability to adjust font size.

Considering audiences with disabilities (particularly those with visual, hearing, cognitive, or motor disabilities), addressing their needs will be part of an ongoing process. The implementation of accessibility features will be considered during the testing phase to identify possible improvements in terms of ergonomics, navigation, and access to content.

4.1.4 Interaction with end users

On site

- Mobile app/physical environment interactions: seeing differently and understanding what is in front of us thanks to the app's content; identifying remains and in situ clues to answer questions (perhaps in the form of interactive quizzes); moving from one POI to another (especially those that are linked)...
- Interactions with the app: interact with the touch interface (buttons, menus) to navigate through the different content available; manipulate and explore 3D models in AR (rotation, zoom, movement in virtual space).
- Social interactions with other visitors: to share their wonder, their discoveries, discuss the content presented and cooperate to answer the quizzes, particularly through educational interactions between students or between parents and children.

Online

All content accessible from the application will be online content, unless the problem of Wi-Fi coverage in the areas concerned by the four French operators requires prior downloading of the content.[5]

4.1.5 Workflow for the curator

The site curator accesses the tool and has a range of functionalities, as described below.

Shape the scenario

The AR Tour Builder tool aims to support the creation of the geolocated tours at Bibracte and be offered as an open tool for future use by any interested stakeholder. The AR Tour Builder provides a map interface which allows users to create and position POIs on certain locations. A POI can be associated with multiple cultural heritage objects of various formats (3D objects, images, text) and includes certain metadata, such as an overview description. A map enriched with POIs constitutes a tour. Multiple tours can be organised under the concept of a 'project', which represents a heritage site, or a geographical area in which one or more tour

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[5] Since several areas of Mont Beuvray are not covered by all four French mobile phone operators, content must be downloaded directly to the application to allow offline use.

circuits are offered. Each project therefore has a map associated with it. A single user can manage several 'projects' if they are responsible for several non-connected sites.

The possibility of offering several tours on the same site is particularly interesting. It allows users to create different circuits according:

- to their themes, particularly interesting for subjects not directly covered in the other tours or allowing you to renew your perspective on the heritage presented (for example audiovisual heritage; Europe; garden, environment and biodiversity; fight against illicit trafficking of cultural goods; science and research),
- the type of public (for example a family and children's circuit),
- the time of year, particularly interesting for recurring events such as certain international and European days or even unofficial days such as April 1st and December 28th in Spain.

This opportunity opens up a rich field of possibilities which invites detailed planning of work over several years.

The AR Tour Experience tool allows curators to test the scenario in situ in order to correct and adapt it, depending on on-site particularities (e.g., network coverage) and the evaluation of the overall experience.

Access/retrieve contents

Access to content is supported via a 'Library' interface (one per project)

- an 'External' tab offers a drop-down menu to select the external source, such as Europeana or the EUreka3D Data Hub.

- a 'Download' tab supports 2-entry areas for creating POIs:
  - Enter a URL
  - Download a file

Once a file is selected/uploaded, a view on the right appears as a small sidebar in with the asset information, such as a file preview, title, description, file name (imported or manually filled information)

Embed the contents in the application

The contents are embedded at the level of each POI.

Once a POI is created, part of the content can be inserted directly via the tool: title, thumbnail and descriptive text. Other content can be added from the Library. e.g., 2D images, 3D models, videos, audios, PDFs and online content.

4.2 Evaluation planning, stakeholders feedback collection

An initial test of the application will take place in September 2025 with NTUA, and will in particular allow:

- to have a first glimpse of how the various types of content are served on-site and particularly of the AR visualisation of 3D models and their anchoring with physical space

- to better identify the content that should be served at different locations, considering also how the network signal works

A further evaluation of both tools will be carried out in November and December 2025, when the contents are implemented in the AR Tour Builder and the application is tested in situ. The AR Tour Builder will be evaluated by staff who are used to using CMS and the AR Tour Experience by the working group "scenario " and those who are in contact with the public (mediation services, including tour guides, communication and tourism).

In addition to the internal evaluation, two evaluation phases are planned with groups do not belonging to Bibracte staff or the EUreka3D-XR consortium:

- The first in February-March 2026 with stakeholders (culture, tourism, education and ICC professionals) located within a 100 km radius of Bibracte. A few professionals from further afield, but specialised in digital technology applied to the cultural, tourism, and educational fields, will also be invited to participate.
- A second in May-June 2026 with end users of the AR Tour application: visitors and students.

An evaluation grid will be created for each tool and will include several criteria, including the quality of 3D anchors and ergonomics for the AR Tour Experience. Each evaluation will result in a report that will be shared with the project members.

4.3 Dissemination planning

Besides the international events organised by the consortium (26 September 2025 in Brussels (Belgium), 29 January 2026 in Girona (Spain), End of May 2026 in Limassol (Cyprus), the promotion of the scenario, coupled with the presentation of the tools will happen during dissemination and capacity building events possibly attended or organized by Bibracte, as illustrated below.

National

- March 25-26, 2026 at SITEM in Paris: submission of the proposal in the Fall
- May-June 2026: Webinar organised for education and culture professionals as part of the Bibracte PREAC

Regional

- May 2026 in Bibracte: workshop during the Digital Spring organised by the Nièvre department (to be confirmed)
- May-June 2026 in Dijon: presentation and workshop for those responsible for heritage sites organised with the Bourgogne Franche Comté Region
- May-June 2026 in Bibracte: presentation and workshop (one day or two half-days) for teachers organised with the Dijon Rectorate.

Local

- May-June 2026: presentation to partners of the Grand Site de France "Bibracte – Morvan des Sommets"

For the presentations happening in France, presentation materials will be produced in French and their design will be coordinated with the relevant stakeholders and co-organisers of these events.

This promotion could, in a second phase, be carried out for residents and visitors when the first tests of the tools have provided us with sufficient information to consider its sustainability (cfr. par. 4.5)

4.4 Aggregation of content in Europeana

The contents of the two scenarios, as well as those used to test the other tools (see below), will be aggregated to Europeana via four separate channels according to their nature and their rights holders:

- **The new 3D models** will be processed according to the same terms as those used for the 3D models of the EUreka3D project: deposit in the *National Conservatory of 3D Data* (CNDD) in France, with enrichment of the metadata and paradata required by this secure backup environment for 3D data. This content will then migrate to the EUreka3D Data Hub before being aggregated in Europeana.

- **The 2D, PDF, video and audio content owned by Bibracte is** already, for the most part, deposited in the Nakala digital repository. This content can be aggregated to Europeana via Photoconsortium's MINT. The metadata will be provided to Photoconsortium either in the source schema from Nakala or if applicable in EDM by creating a dedicated script.

- **Third-party content already online on platforms offering OAI-PMH feeds** (HAL, Open Edition, Persée, etc.) will be aggregated into Europeana via the Photoconsortium MINT. In accordance with good scientific practices, the authors of this content and the managers of the platforms concerned will be informed of their reuse. This will help foster partnerships and avoid any misunderstandings about the uses permitted by open licenses.

- **Third-party content already online on platforms that do not offer OAI-PMH feeds** (for example ResearchGate)**:** since these resources cannot be directly aggregated in Europeana in the absence of explicit rights, three complementary actions will be considered:
  - Semantic link: they will be integrated into the metadata of the deposited content (CNDD and Nakala) in order to enrich the notices by establishing a correspondence with external scientific or documentary resources.
  - Aggregation by the institution holding the rights (university, laboratory, etc.): if relevant, they are invited to consider aggregation of such resources in Europeana, via Photoconsortium.
  - Ad hoc agreements: For particularly relevant resources, specific agreements with rights holders could be explored to allow their aggregation via Photoconsortium MINT.

As these contents will be aggregated individually on the one hand, and some will not be (specific online contents such as quizzes on Historiana or POI presentation texts, entered directly into the AR Tour Builder tool), the creation of a PDF file per POI, grouping together all the associated resources, could be a relevant solution. This file, deposited on Nakala, would allow the thematic coherence of each point of interest to be preserved while offering a form of narrative aggregation faithful to the user experience of the scenario.

4.5 Future developments

The sustainability and future development prospects of the scenario and tools are considered on two levels: the archaeological site on Mount Beuvray itself, and the potential uses of the tools developed beyond this pilot site.

At the Mount Beuvray Archaeological Site

The presence of an existing geolocated tour application, *La Boussole*, whose content is managed by Bibracte via a CMS, is both an asset and a challenge. It enables Bibracte to bring valuable expertise to the development of tools and the scenario design, but also raises the issue of coexistence or eventual replacement. Indeed, offering visitors two separate geolocated mediation apps on the same site would not be viable.

The adoption of the AR Tour Experience app as a long-term solution would therefore imply the abandonment of *La Boussole*, into which Bibracte has made significant investments. Such a decision could only be considered if the tools developed as part of the project meet the site's technical and functional requirements while providing at least an equivalent quality of visitor experience.

Compared to *La Boussole*, the AR Tour Builder and AR Tour Experience tools offer significant technological advantages:

- Direct integration of multimedia content (videos, audio, web resources subject to network coverage);
- Visualization of 3D models in AR.
- Intuitive interface and smooth user experience.

As part of the longer-term exploitation plans, these functionalities will be complemented by a set of additional capabilities, which are considered important for the experience of the site's visitors:

- Ability to display multiple base maps (topographic, Lidar, aerial view);
- Display of specific pictograms for active excavation areas and available site services (museum, restaurant, parking, shuttle), including time-based management (opening days/hours) directly in AR Tour Builder;
- Availability on broadly-used operating systems beyond Android, especially iOS.

Most importantly, a guarantee of long-term corrective and adaptive maintenance, along with accessible technical support, is an indispensable condition for any deployment aimed at the public.

In addition, a strategic consideration must be taken into account: the scenario developed within the project is based on a specific theme (that of the "hidden side" of Bibracte), chosen to showcase the capabilities of exploiting 3D objects for an enhanced experience on-site. As such, the specific tour prepared in the context of the project is not meant to serve as an all-encompassing tour that provides access to all types of information about each archaeological area of Bibracte. As a matter of fact, transposing the full content of *La Boussole*, currently including more than 50 POIs, into the new environment would require careful planning and considerable resources over several months. The preparation and inclusion of all this information into a new tour to be built via the Tour Builder will be considered with a potential launch aligned with the start of the 2027 tourist season.

Beyond Mount Beuvray

One of the major strengths of the AR Tour Builder lies in its ability to support the creation of tour circuits across multiple geographic areas. An initial use case already identified is the archaeological site at the sources of the Yonne River, located very close to Mount Beuvray, in the village of Glux-en-Glenne. More broadly, the tool and its application present strategic potential to promote the entire territory of the Grand Site de France "Bibracte – Morvan des Sommets", which brings together twelve municipalities around Mount Beuvray.

The AR Tour Builder and AR Tour Experience tools could help foster new heritage-based mediation Tours, rooted in this diversity, by involving local stakeholders in participatory projects. It is important to note that the implementation of such projects would fall under a different team than the one responsible for archaeological mediation at the Bibracte site and museum. This distinction would make it possible to conduct both initiatives in parallel, with separate timelines, without creating conflict or delays between the two undertakings.

4.6 Additional tools tested in the scenario

Plans to use the **AI 3D Builder** are considered to transform 'terrain' orthophotos into 3D models to integrate them into the scenario, particularly for the POIs that do not have 3D terrain models in their primary content. The list of POIs and their contents could be significantly altered if this test proves successful.

A small experimental tour in the museum (thus outside the scenario) will use **3D XR Studio** to showcase 3D models of the archaeological areas from which some of the exhibited objects come. This experiment could be conducted as part of the French educational program 'La classe, l'œuvre !', which involves a collaboration between a class and a museum, allowing students to discover a work of art and then present it to the public in some form during the Night of Museums in mid-May.

The archaeological site also houses the remains of a medieval monastery, and a section of the museum is dedicated to this monument with a number of interesting objects, several of which have 3D models. Testing an AR-based discovery of these objects presented by Mixed Reality (MR) monks, created with the **Avatar Builder**, could be included in the 'La classe, l'œuvre !' program, proposed to a high school in Autun that offers computer science courses. Discussions are underway with MIRALab to explore the feasibility of this proposal (possibility of slightly modifying the appearance of an Orthodox monk created for the Cypriot scenario to make him a Franciscan, the actual involvement of students in designing the audio content spoken by the monks and using the methodology for integrating virtual monks into an MR experience spatially localised by students). Additionally, talks are ongoing with a VR game design company for the possibility to loan or rent Meta Quest 3 headsets at a lower cost.

5 A New Life for the Englystra of St. Neophytos

Fig. 9 The exterior of the Englystra

The *Englystra* of St. Neophytos (or hermitage)[6] is a small but significant monument associated with the Monastery of St Neophytos at Talia, Cyprus. The monument consists of three interconnected caves hand cut into a sheer limestone cliff face over a period of some 55 years by the eponymous Saint Neophytos, also known as Neophytos of Cyprus, and Neophytos the Recluse. With a total length of ~12m and depth of ~3m, the caves are highly decorated with 12th century Byzantine frescoes comparable to the UNESCO World Heritage Site listed Painted Churches of the Troodos Mountains. The monument also contains the tomb of the Saint and formally held a relic of the True Cross, making it particularly significant to the faithful.

5.1 The Pilot scenario, specifications of the end product

The site has been designated as a 'monument at risk' for four main factors:

1. Increased ambient moisture content due to climate change affecting the structural stability of the frescoes and pigmentation;
2. The entire monument (and cliff) is subject to erosion and seismic activity and moving;
3. The continuing drought conditions that have occurred in Cyprus over the past few years;
4. The site has a significant number of tourists/pilgrims posing a real threat of damage (accidental or otherwise) to the interior of the caves due to the confined space.

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[6] Location: 34.84677842176924, 32.445137680820025 - Google Map Link : 34° 50' 48.4253" N 32° 26' 42.5011" E

The site has poor accessibility requiring the climbing of steps to access the caves, narrow doors and confined spaces making it particularly inaccessible to those with mobility issues.

The pilot seeks to provide an alternative to the physical experience of visiting the Englystra should it be necessary to close the monument to the public for repairs, conservation, protection or safety and to provide access to those who may not be able to physically access the space due to distance or physical constraints.

The vision of the pilot is to produce a faithful digital representation of the Englystra based on previous and ongoing research to allow the primary stakeholder, the Monastery of Saint Neophytos, to tell the story of the Saint's life and times though a digital 'avatar' of the saint who will appear in 3D and explains his story to the visitor. The stakeholder has also expressed the need to highlight the values expounded by Saint Neophytos in his writings which they consider have important and relevant messages to the present day. Two versions of the scenario are envisioned, one a Mixed Reality (MR) version on site and the other a purely virtual experience able to be distributed to schools.

The MR use case addresses the need to expose the meaning behind and importance of the frescoes. Due to the smallness and configuration of the space, this is not possible with traditional methods such as information signs.

The scenario seeks to inform the visitor about the history of the site, the challenges it faces and how technology is being used to monitor, protect and preserve cultural heritage in a novel approach to the circular economy, drawing on the Saint's meditations on life applied to the modern world and on the practical application of science and technology to the problems of environmental change and sustainable tourism. To summarise, in MR the visitor will see and hear Saint Neophytos telling his story. The visitor will also be able to see the real environment and the people around.

In the second scenario, based on VR, the user can be anywhere. Through his headset, he will be able to see the full virtual Englystra.

5.1.1 Target audiences / stakeholders

While the Avatar Builder and the use case of the Saint Neophytos avatar are of interest to any CHI who wants to explore this form of user engagement and storytelling, the primary stakeholder for the pilot scenario in Cyprus is the Monastery of Saint Neophytos, and the main target audiences that are addressed with the MR experience are:

1) Cultural tourists on site
2) School children aged 14+

The scenario is intended to address the following issues facing those audiences

- Physical access to the Englystra (virtual implementation)
- Heightened engagement with visitors
- Visitor language localisation
- Access to monument information that cannot be displayed on site.

5.1.2 Content used in the scenario

Resources that will be used/are available to the scenario include

- 2150 images of the three main rooms (sequenced for photogrammetry)
- TLS[7] of the three main rooms
- Spherical maps from the TLS
- Historical documentation on the life and times of the Saint: The entire biography/ literature about
- Saint Neophytos will be listed and studied and used in the pilot scenario, also accompanied with a report
- Recording of part of the liturgy of Saint Neophytos: September 28th marks the discovery of Saint Neophytos holy relics in 1750. On that Day there is a unique Memorial festivity at the Monastery and a special liturgy will take place, which will be recorded in audio/video and used in the pilot's documentation.

5.1.3 Narrative and storyboard

The scenario narrative is based on the concept of the visitor being guided around the space (real or virtual) by a digital representation ('avatar') of the Saint himself. During the visit the avatar will explain aspects of the space in which he lived, the life values and Christianity that he taught, the meanings of the frescoes and walk the visitor through time and space. The premise is that the Saint has returned to the world after an absence of some 800 years (his death being around 1214) and can comment on the changes to the monument from the time he was alive. It is hoped by using this concept that the following points can be introduced through speech to the visitor (this is not a definitive list)

- The construction of the Englystra
- The decoration of the Englystra
- How the monastery came to be
- The changes observable since his death highlighting the monument at risk

The encounter with the avatar will start once the visitor enters the space with the Saint stepping out of the frescoes and manifesting in front of the visitor inviting them to listen to his story and follow him throughout the space. The visitor may be able to preselect their language of preference for the avatars dialogue generated from a predefined corpus of material through generative AI.

There is the potential for non-linear/branching narrative though generative AI, however this will need to be carefully considered and sensitive to the stakeholders wishes. By necessity the on-site experience will not be exhaustive but supplemented by the VR implementation which has more scope for interactive narrative through the .

Here the premise of the Saint returning to the present day helps to restrict the potential for inaccurate or inappropriate answers. Simply put, the Saint only 'knows' what has happened up until his death allowing predefined questions to be posed. or even appealing to the visitor to 'find out what has happened' since his passing, providing the opportunity for the interested visitor to explore further.

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[7] Terrestrial Laser Scanning

5.1.4 Interaction with end users

Onsite using the application tool

This interactive experience is designed to support both VR and MR, utilising the same core assets, virtual elements, and user interface across both modes. The character and graphical user interface (GUI) will be reused, ensuring consistency and efficiency in development. The difference between the two experiences lies in the environment: in VR, the user is fully immersed in a virtual world, while in MR, the user remains in their real physical surroundings, with the virtual character integrated into the real environment through the MetaQuest 3 headset.

The paragraph below provides an overview of the scenario within the AR/VR setup, highlighting key elements of user interaction. It outlines how users could engage with the virtual environment.

Scene Setting (VR/AR): Visitors wear the Meta Quest 3 headset inside the actual Englystra cave. As they look around, monastic chants echo faintly in the background.

Saint Neophytos fades into view, he pauses and looks toward the user.

Dialogue Choices (interactive):

UI Elements: Could be a choice of different situations such as

- 'My Life in Seclusion' — Neophytos describes his decision to become a recluse.
- 'Why I Wrote' — He explains his texts and theological motivations.
- 'The Spirit of the Enkleistra' — A guided spiritual reflection on monastic life.

Dynamic Responses (Example: 'My Life in Seclusion')

Audio (Saint Neophytos speaks): *"I came here not to escape the world, but to better hear the voice of God. I carved these walls with my own hands, seeking silence, not absence... a silence filled with divine presence."*

    Saint's Departure (end of the experience): Neophytos stands, fade out.

Final Words (subtitle overlay): *"May your journey be as inward as it is forward."*

Duration of the experience: The experience will last a couple of minutes, a target session length will be set based on physical comfort with headset. To prevent long animated sequences that demand significant computational resources, the experience will be divided into separate modules or scenes. This also offers users greater flexibility to navigate between scenes.

The figure 10 below illustrates how users interact with a 3D animated representation of Saint Neophytos, integrated into the real-world environment of the Englystra through passthrough-enabled MR technology. Developed in Unity for Android-based devices (e.g., Meta Quest 3), the experience supports live interaction and includes an interactive user interface allowing participants to control dialogues and actions within the immersive storytelling scenario.
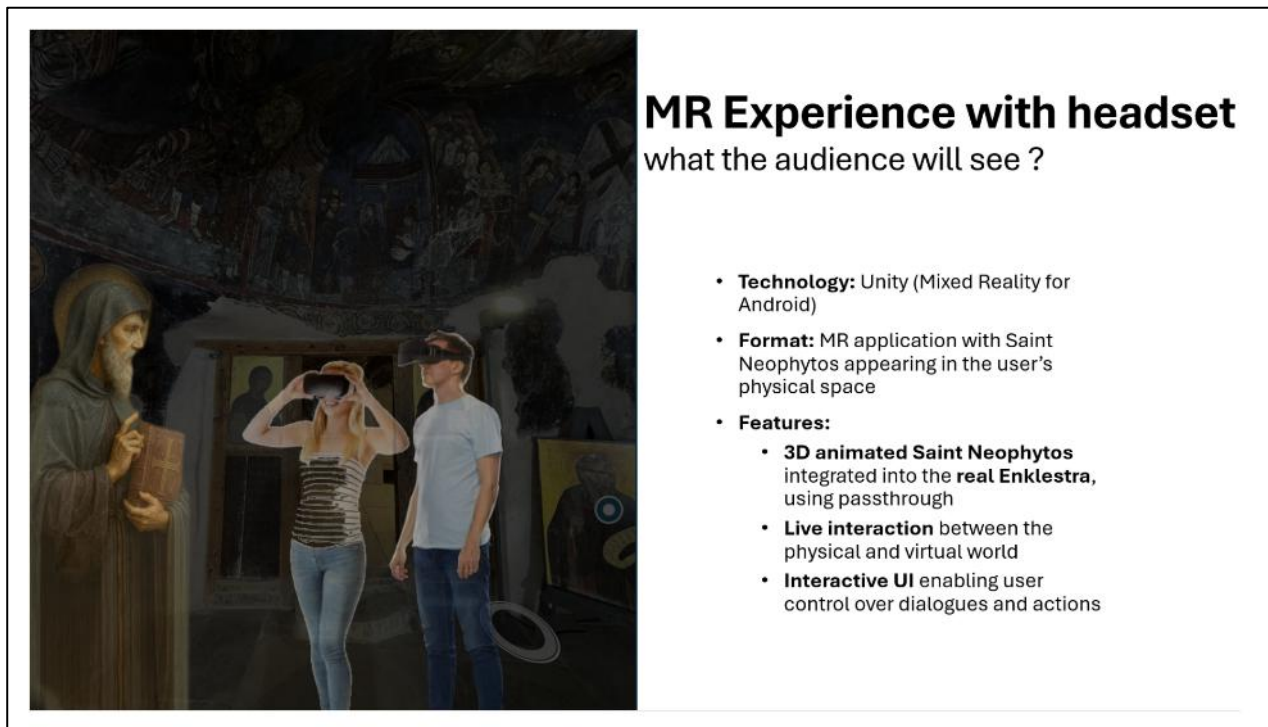
Fig. 10 Mixed Reality (MR) experience with headset featuring Saint Neophytos.

5.1.5 Workflow of the curator

The Avatar Builder Workflow developed within the EUreka3D-XR project provides a structured yet flexible pathway for curators and cultural heritage professionals to create and adapt animated virtual human characters for immersive storytelling. The workflow is specifically designed to be accessible to non-technical users and promotes reusability of assets through clear guidelines, modular datasets, and standardized formats. Curators engage with the process of creating and adapting animated virtual human avatars. Starting with a guide that links to tools, datasets, and examples, the curator customizes the avatar's appearance and behaviour. Once the assets are prepared, they are uploaded to the EUreka3D Data Hub. The system then handles visualization, enabling publication across both web-based platforms and VR/MR environments.

The process (depicted in Figure 11) begins with the curator accessing a set of open-source tools, predefined datasets, and documentation, which will be made available via a dedicated GitHub repository, the EUreka3D Data Hub, and the Data Space for Cultural Heritage. These resources include:

- Predefined rigged 3D character models in GLB and FBX formats,
- Animation clips (e.g., idle, walking, speaking) that can be reused or retargeted,
- Voice tracks generated from historical texts and synchronized with facial and body animation,
- Clear guidelines for adapting characters to different historical contexts or narratives.

Using these materials, the curator can select a base avatar and adapt its appearance, behaviour, and narrative alignment to suit the intended story or cultural context. This may involve replacing textures (e.g., clothing

styles), choosing or reordering existing animation clips, or uploading new voice tracks that correspond to the specific content being presented.

These adaptations can be made without requiring advanced technical skills, thanks to the accompanying step-by-step guide, which explains how to work with the predefined assets using open-source tools such as Blender (for visual editing) and basic file management tools (for organizing assets).

Once the character is customized, the curator can upload the final assets, typically packaged as a .zip file containing the model, animation, and audio, to the EUreka3D Data Hub. From there, the character can be visualized using the web-based 3D viewer, which supports synchronized playback of animated 3D avatars with accompanying audio. This step enables previewing and validating the avatar directly in a browser, and makes the content suitable for publication on Europeana, following the required metadata and licensing standards.

Finally, the curated avatar package can also be exported for deployment in immersive environments, such as MR or VR headsets (e.g., Meta Quest 3). The workflow supports standard export formats like FBX and GLB, ensuring compatibility with widely used engines such as Unity and Unreal, making it easy to integrate the curated avatar into on-site installations, virtual exhibitions, or educational XR experiences.

This workflow empowers curators to actively participate in the creation of engaging, culturally contextualized digital characters, extending their role beyond content selection into interactive narrative design, while still operating within a user-friendly, non-technical environment.
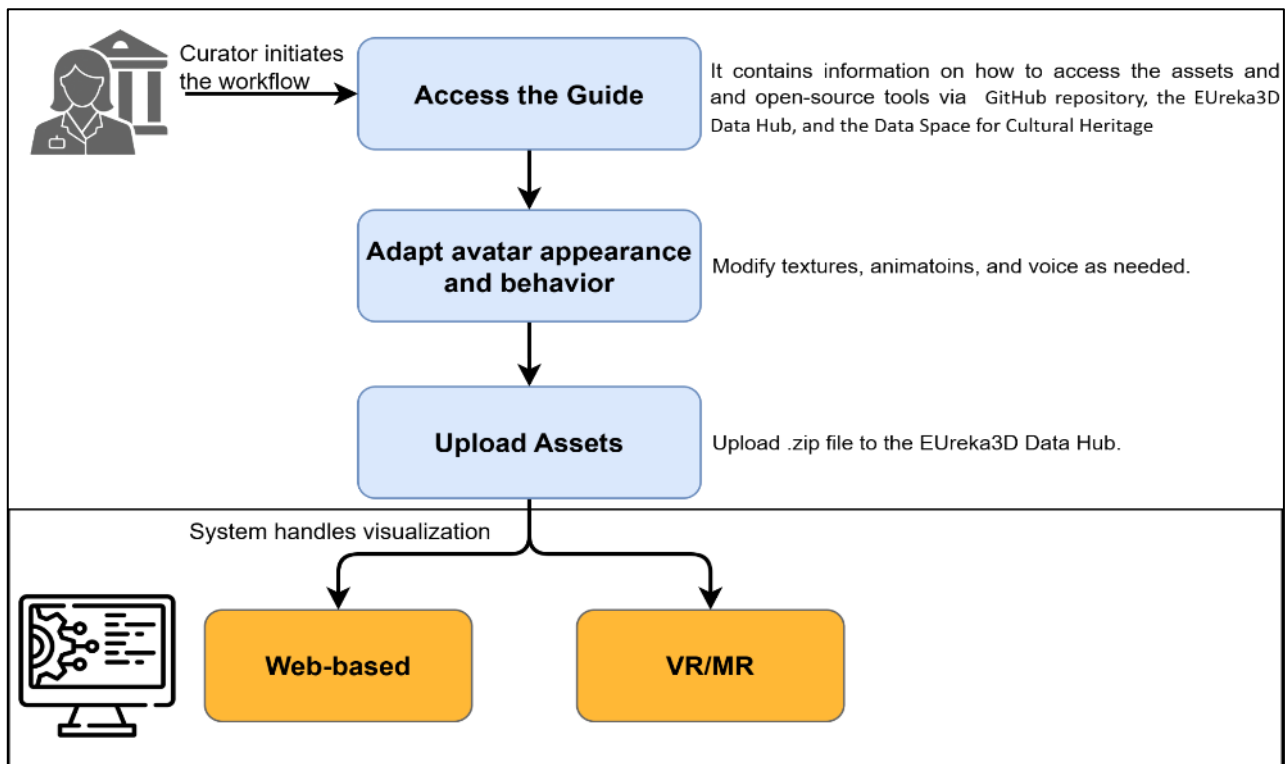

Fig. 11 Workflow of the curator using the Avatar Builder Workflow developed by MIRALab in the EUreka3D-XR project.

5.2 Evaluation planning, stakeholders feedback collection

Internal evaluation will be conducted by CUT following the instructions provided by MIRALab to replicate the development pipeline. Issues, clarifications and refinements to the pipeline will be fed back to MIRALab. CUT and MIRALab will work collaboratively to resolve any issues arising to provide as much clarity and simplification of the process to allow curators to apply the steps in their own XR implementations.

In addition to the internal iterative evaluation and development, also combined with the feedback received from the Advisory Board and in the context of project's events, external feedback from the end users in Cyprus will be undertaken in three phases:

1) From the religious community of Saint Neophytos to ensure that their requirements in terms of expressing the life, times and message of the saint are met and approved.
2) From the onsite MR participants during selected open days. This will be part of the event and conducted through a mixture of interviews and written questionnaires
3) Feedback from deployment in schools will be conducted via questionnaire to be completed by the teacher as students fall into the category of minors. This will include sections on the applicability of the visualisations in supporting the teaching curriculum and observed reaction/engagement with the subject matter by students.

Feedback from the user experience will be analysed to assess the usefulness/impact of the case study as a method for imparting experiential learning though XR not explicitly in regard to the deployment of the tool.

5.3 Dissemination planning

The vision for the dissemination of the scenario is to provide two separate implementations, one a MR version to be used within the Englystra itself, the other a VR experience that can be used off site. A deployment of the virtual reality implementation will also be made at the Monastery to enhance the existing museum offering and provide virtual access to the Englystra for those unable to physically access the site or when the Englystra is not open for public visits.

CUT will work with the stakeholder community's information and publicity infrastructure to ensure that there is a unified message in line with the stakeholders' mission. Agreed publicity and dissemination materials will be distributed by both the stakeholder and by CUT providing an extension to new audiences.

In line with the identified target audience information will be distributed to educators on how to access, set up and use the virtual reality implementation within the classroom environment for teaching. It is an ambition of the case study to extend the educational version to encompass the global Cypriot diaspora reconnecting people of Cypriot origin to one facet of their cultural identity.

As noted in the project's Grant Agreement, the scenario will use generative AI to produce the scenario narrative in multiple languages. Promotional material will be produced as appropriate to the communities being addressed. This will include Greek and English. Information on site is also provided in Russian.

5.4 Aggregation of content in Europeana

All data, metadata and paradata for assets to be aggregated into Europeana will conform to the established protocols, formats and requirements of the EUreka3D Data Hub and those that arise from their development through the EUreka3D-XR project. All assets identified for aggregation (and their component parts) will be uploaded to the EUreka3D Data Hub before the aggregation deadline of M15 (April 2026).

5.5 Future developments

The development of generative AI avatars able to interactively impart knowledge to an audience in their own language will be a significant advance in cultural heritage dissemination into the educational and tourist sector. It is however not without its problems as discussed in *D1.6 Ethics Issues mitigation measures*.

Providing virtual access to heritage sites, especially those in remote areas, offers educators the opportunity to enrich their teaching portfolio and engage pupils on different levels. Logistically and financially planning a school trip to a site is an expensive commitment. Cultural heritage destinations may not be willing (or able) to accommodate large parties of students, monitor their activities or cope with associated disruption to their regular visitor baselines. Moreover, concerns about health and safety and accessibility aspects within sites present challenges that CHIs may not be able to undertake, either financially or because alterations may compromise the nature of the site or monument. In both cases VR has a role to play offering simulacra of the site that can be used to impart the essence of the place but more importantly where lessons can be taught.

The multilingual aspect holds significant potential for nations hosting large migrant communities (whether economic or social). Engaging with the culture of a host nation is one pathway to increase the assimilation process, however language may be a significant barrier to accessing information about the host culture. In the Republic of Cyprus around 20% of the population do not speak Greek as their mother tongue and about 10% of the population are migrants, with a positive net migration profile predominantly with a younger demographic.

5.6 Additional tools tested in the scenario

Due to the size of the Englystra, tools geared to creating AR tours in large areas, such as the ARTour Experience (NTUA) and 3D XR Studio (Swing:It) are not suitable to be tested for use on site. Additionally, tools that require internet connectivity and geolocation are not suitable for use at the remote Cyprus location. The AI 3D Builder (Swing:It) is of interest as it has the potential to assist in optimisation of scanned meshes through generative AI retro topology, the removal of features/artefacts and the possibility of digital restoration of frescoes. Even if at the time of writing, no dedicated planning for the test of this tool by CUT is available, however test cases may be explored later in the project when the primary scenario of the VR/MR experience with Saint Neophytos Englystra is more advanced.

6. Preliminary reflections on expected impact of the pilot scenarios

In this chapter, some initial considerations are provided to complement the planning of the three demonstration scenarios, developed to test in real-life settings the five tools made available by the EUreka3D-XR project to the entire cultural heritage community, in the context of the data space for cultural heritage. The project's approach is expected to make it easier for CHIs to learn and implement good practices and tested workflows to reuse digital collections in XR narratives, together with a better understanding of the tools required to develop them. This will all be communicated to a stakeholder network via dissemination and Capacity Building actions that have been formulated in the project timeline.

Specifically, this chapter relates to two aspects: understanding what the expected impact of the demonstration scenarios would have on stakeholder communities; and what actions are planned to create awareness and increase knowledge in said communities of the demonstration scenarios and their replicability.

6.1 XR Demonstration Scenarios as Use Cases

The XR scenarios in the project have been chosen as use cases to make it easier for CHIs to replicate successful engagement of 3D models and deployment of new narratives to appeal to target communities. The scenarios cover a variety of real-life situations and needs of CHIs, to inspire others in learning from others' experiences, and trying the tools. While the project will promote the tools and scenarios to a wider audience of CHIs and users of the common European data space for cultural heritage, to collect feedback from these communities via a variety of project's events and presentations, the pilots themselves are deeply rooted on their specific locations and thus addressing local stakeholders, from which evaluation and feedback will also be collected via surveys, interviews and one-to-one interactions.

The variety depicted in the three scenarios allows for reflections about the choice of heritage suitable for an XR experience: the effort and expense of creating XR cannot be applied to the full range of 3D digitised models in a CHI collection, and a careful selection for meaningful narratives needs to be done. The scenarios in the project aim to act as inspiration about the types of cultural heritage assets that are suitable and impactful to users, through engagement when XR experiences are applied to them.

EUreka3D-XR offers 3 different XR scenarios exploring 3 types of XR application:

- Reconstructing and showcasing lost buildings or what is not or no longer visible on a heritage site
- Phygital tours imposing digital objects to reality
- Experiences of interactive AR.

In this light, the internal costs and staff effort of developing XR experiences in-house has to be carefully considered, and even when the use of open access tools does not require setting aside a budget for service purchase, that alone does not mean that creating a scenario will come at no cost. However, the three pilots represent real-life settings most CHIs are familiar with, and the lessons learnt in the pilot scenarios should therefore be easily transferable to any type of heritage site and collection.

The timeline of the project, very compact and dense, foresees that the scenarios will be ready for a meaningful demonstration not earlier than M12, thus allowing to collect stakeholders' feedback on the functioning scenarios only in the final months of the project. This will make it difficult to measure the actual

impact of each scenario in the medium and long term, but can offer some indication for projections of expected impact beyond the end of the funding period. In particular, what would be interested to measure in relation to the availability of the three demonstration scenarios would revolve around the following points:

- Impact on upskilling curators: does the scenario provide an inspiration and a learning experience for CHI professionals who improve their knowledge and skills in reusing 3D contents?
- Impact on workflows: how much additional development will be required for any given CHI to apply the XR tools to their own 3D models to create XR experiences of their own?
- Impact on engaging target communities: does the XR experience provide added value to site/collections visitors onsite and online?

The measurement of the impact on cultural heritage staff and professionals, either internal to the project partners and external from stakeholders' communities, will happen collecting qualitative feedback via interviews and surveys. Preparation has also started on the user side to give more evidence that the pilot XR experiences in the three scenarios do increase engagement and therefore, are more impactful than 3D models which do not have XR attached or linked to them (for example a 3D model linked to, but not included in a 3D-XR experience, might receive more engagement than a 3D model in isolation). This ideally involves quite intensive testing and user feedback over a longer period of time than the project allows, but EUreka3D-XR scenario leaders will make an effort to gather some qualitative data to assess this aspect.

6.2 Early feedback from EUreka3D-XR Advisory Board

The project formed an Advisory Board[8] of experts in 3D digitisation, engagement with cultural collections and XR applications for cultural heritage. In the context of the project plenary of M6, held on 7 and 8 July 2025, a meeting was organised with the members of the Advisory Board, to present the scenarios and the tools, and collect initial feedback from the experts. The Advisory Board was impressed by the scope and ambition of the project and felt it was well conceived and covers the needs of the current environment. They also acknowledged the very compact timeframe of the project, 18 months, which would prevent extensive evaluation and assessment of the scenarios and tools.

Some reflections and recommendations received from the experts related to the level of detail and research that the content partners have done, or built on, to create accurate, trustworthy XR experiences as pilot scenarios. This is a point of difference between the EUreka3D-XR scenarios and standard XR which normally addresses a surface level engagement only, tailored to tourists and amateurs who pass through the cultural site or collections fleetingly. Instead, the EUreka3D-XR pilots are based on high quality, scientific and professional level of detail researched, with creation of digital memory twins, with recorded paradata and accuracy/quality. This should be highlighted more and encouraged to professional users, not only to show that the XR is built on accurate professional research and standards, but also to signpost those sources that help guide users to an in-depth enrichment path for both professionals and interested individuals. A suggestion from the experts in this regard was to leverage testimonials from acknowledged professionals in the communication, as they are critical to illustrate and re-iterate the essential need for quality standards and paradata in digital cultural heritage and particularly in 3D.

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[8] https://eureka3d.eu/advisory-board/

In response to the tools which are used in the scenarios, recommendation from the experts relates to the challenge that tools often fail in the long run, mostly due to a lack of documentation. It was recommended to ensure that proper documentation was created and made available to increase sustainability. Additionally, it is noted that often there is a gap between having a best practice scenario and accessing an open-source tool available to create an XR experience. It was recommended that there should be a middle ground, possibly a templated toolkit to allow CHIs to get started and experiment with the potential of XR, rather than start from zero or having a fully completed experience to try and deconstruct to enable the application of tools to their own 3D models.

A next meeting with the Advisory Board is set on the occasion of the first focus group that will evaluate the tools in beta version and the progress of the scenarios, planned in October 2025.

6.3 Creating Awareness to Generate Expected Impact

The three use cases from the scenarios' experiences will be published and disseminated through the project channels, including the creation of specific resources and showcase materials in the common European data space for cultural heritage. These cases will serve to demonstrate in depth the tools in real-life settings and inspire other CHIs to try the tools for XR experiences to engage their audiences in their own context. Each of the case studies will also be disseminated locally, so that it reaches cultural heritage institutions geographically close to the scenarios. For a more general view of the scenarios, the project has released a presentation video of the three pilots and plans to make another complementary one at the end of the project.

The capacity building programme is built up as one of the main ways to disseminate the experiences on the showcase scenarios development. Some of the training activities will disseminate the three scenarios, globally or separately. The use of the Europeana Learning Platform could help much with this, especially to maintain the knowledge generated in the scenarios on the longer term, hosted on the Platform. In addition, three prototype demonstration videos will be developed to showcase the use of the tools in the three scenarios, which will be published together with a formal textual report. These videos will be re-used for dissemination, adapting them into a more understandable language if needed.

The project final conference planned in May 2026 will also highlight the three scenarios as use cases in the context of a high level event that addresses CHIs and also includes policy makers and international institutions.

7. Conclusions

This deliverable illustrated the planning for the three pilot scenarios that demonstrate the use of EUreka3D-XR tools to create engaging user experiences with XR. The deliverable is a means of verification for project's milestone 4 'Definition of Pilots specification and planning', which is successfully achieved.

The EUreka3D-XR Pilots are set in different locations in Europe, and are led each by a cultural institution partnering with a technology provider: CRDI in Girona city with Swing:It; Bibracte in Bibracte site with NTUA; and CUT in Paphos monastery with MIRALab. The pilots follow the general common schedule as sketched in the Grant Agreement, with specific activities that relate to the individual development work with the corresponding technology providers, internal and external evaluation, and local dissemination and testing.

At the time of writing (M6), the iterative development for each application has started on a technical point of view, and the narratives and storyboard of the user experience is defined, according to the expected target audiences. Plans for evaluation with internal staff and external stakeholders are provided. Content selection and strategies for the aggregation of the pilot's cultural content in Europeana has also started. Initial presentation of the pilot scenarios happened in some events already, and a sneak-peek of the applications was delivered to the members of EUreka3D-XR Advisory Board on 8 July 2025, thus collecting initial feedback and recommendations that help preliminary impact assessment.

The next appointments for the Pilot scenarios are:

- The EUreka3D-XR Capacity Building event in Brussels, 26/9/2025
- The internal focus group to test the tools in October 2025
- Activities for presentation and stakeholders engagement at project level and on the local level across the Fall 2025
- The Girona demonstration event on 28-29 January 2026, which will showcase the prototype of each pilot scenario in beta version, for further evaluation with stakeholders, refinements and iterative improvements. This also corresponds to the milestone 5 'Delivery of the prototype V0.1 and of a testing report'
- The actual aggregation of content to Europeana, by April 2026 (milestone 6 'Aggregation') and the very final product is expected by M18, corresponding to milestone 7 'Delivery of an improved prototype (v1.1) and demonstration with target audiences'.

As a culminating showcase moment for the project, the final conference of EUreka3D-XR will happen during the last week of May 2026 in Cyprus, associated with the cultural heritage week celebrating the Cyprus Presidency of the EU, that will also include the 2026 edition of Euromed conference and will mark the conclusion of the Twin-It part 2 initiative.