

# 3D-ICONS: World Heritage Sites for Europeana

## Making Complex 3D Models Available to Everyone

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**Abstract** – 3D-ICONS is a European project which will enhance the content base available to Europeana users through targeted 3D digitization of European architectural and archaeological monuments. The "3D Icons" will be selected through their listing by UNESCO on its World Heritage (WH). The project aims to complement the collections which are being made accessible to Europeana via CARARE, Europeana Local, Athena and other projects which have developed the content base for the cultural heritage. 3D-ICONS aims to complement the 3D content brought to Europeana via the CARARE project, enabling public access to complex models and increasing the critical mass of this engaging type of content.

*Keywords-component; Europeana, 3D-ICONS, 3D models, digitisation, UNESCO, cultural heritage, public access.*

### I. INTRODUCTION

3D modeling and reconstruction have been used for several years by archaeologists for scientific and research purposes (and by other sectors for automotive design and medical diagnostics, for example). In a parallel universe, 3D models have made rapid inroads in leisure pursuits such as gaming, TV and films. The challenge for cultural heritage is to take existing complex archaeological and architectural models and adapt these so they made be accessed and enjoyed by a wider audience and to provide the end user with a range of recognizable and engaging content, whether these are 3D real life models of individual objects, monuments and complete sites or virtual reality models or "fly-throughs" etc.

To date, relatively little 3D content has made its way to Europeana and the digitisation of Europe's rich cultural heritage in 3D is piecemeal. There have been both technological and communication challenges to be addressed when digitising very large and complex objects: technical challenges, to acquire, manage and represent faithfully the complexity of surfaces and volumes; documentation challenges, to capture relations between the components of each monument and to cultural facts; cultural challenges in conveying the significance of the masterpiece; and communication challenges in publishing the results in a way which is understandable, interesting, entertaining and accessible to general Internet users. Previously funded EU

research projects ([1], [2], [3], [4]) have solved most of the individual issues quoted above, but still mass digitisation of complex monuments is lacking.

The 3D-ICONS Project will address the key issues of making complex 3D models available to a wider audience whilst providing a rich and diverse selection of 3D content to Europeana based on UNESCO World Heritage sites and other items of European cultural significance.

### II. 3D-ICONS OBJECTIVES

The 3D-ICONS project, which started in February 2012 and lasts 3 years, focuses on digital content that includes 3D models and reconstructions, enlarged models of important details and related images, texts and videos. It will also include and re-contextualize in 3D, objects belonging to a monument but presently located elsewhere, for example in museums. The project's activities will include both new digitisation as well as the conversion of some existing 3D data into formats which are accessible for Europeana users. 3D-ICONS is expected to make a significant impact by making accessible through Europeana an unprecedented quantity of high-quality, 3D, well-organized and attractive information about the masterpieces of European architecture and archaeology.

The project aims to complement the collections which are being made accessible to Europeana via CARARE, Europeana Local, Athena and other projects which have developed the content base for the architectural and archaeological heritage. Most notably, the results of 3D-ICONS will complement the 3D content brought to Europeana via the CARARE project and to increase the critical mass of this engaging content. It is also an important objective of the project to build on the results of previous EU projects, most notably on CARARE, for the aggregation services and guidelines on the publication of 3D for Europeana, and on 3D-COFORM for the 3D creation, management and visualization tools.

The target users of the 3D-ICONS include:

- members of the general public, tourists and students who wish to be able to explore and enjoy architectural and archaeological masterpieces which are often inaccessible to

visitors either as a result of their remote locations or because conservation management restricts access to only parts of the monuments.

- Europeana users who wish to access, explore and enjoy 3D models together with the related high-quality information.

- The cultural institutions who are in charge of internationally and nationally important monuments and buildings and who need tried and tested mechanisms to produce high quality 3D documentation and publish the results for Europeana as well as on their own websites.

- UNESCO and cultural institutions wishing to find new ways of delivering their missions to promote understanding and increase the sustainability of world and European heritage.

- Content providers and creative industry SMEs wishing to identify sustainable business processes and models.

3D-ICONS will both contribute to the expansion of Europeana's content base and also offer enhanced experiences for its users by bringing exciting and engaging content for archaeological monuments and historic buildings. The content will comprise of a range of formats including 3D models, movies, texts and 2D images.

### III. 3D-ICONS CONTENT & IPR

The content which will be created and adapted by the project includes many of the most famous monuments and buildings in Europe, such as:



The Colosseum and the Fora in Rome are among the most famous monuments in the world, attracting more than 33 million visitors per year.



The medieval towers of S. Gimignano



Pisa, the Leaning Tower (a universally known icon of Italy) and the Cathedral



Giotto's paintings in the basilica of St. Francis in Assisi

- The Royal Site at the Hill of Tara in Ireland;
- Etruscan necropolises with their painted tombs;
- the Coliseum with the Roman Fora and Pompeii;
- the Italian medieval city of S. Gimignano;
- the Leaning Tower and the Cathedral of Pisa;

- the Renaissance Centre of Florence;
- the palace of Versailles;
- the Arc de Triomphe and the Centre Pompidou in Paris.

There are 16 partners from 11 different countries providing 3D content. The first step is to survey what is available and to gather the associated technical information (e.g. format, size, rights), the content gaps (which can be filled by additional scanning or use of other content such as images to create surface layers). Added to this list is the proposed new 3D content that partners plan to acquire over the next 2-3 years. The criteria that will be used to select the 3D content to be used in 3D-ICONS will take into account the cultural significance of the subject, ease of transformation into a user-friendly format such as 3D-PDF, processing cost and resource usage. At the end of the project in three years time, around sixty iconic monuments and sites will be available through Europeana, incorporating several hundred 3D models of buildings, even more 3D models of architectural details and related objects and several thousand high-resolution images.

The digitization of archaeological and architectural monuments requires arrangements with the authorities in charge of the monument. For content directly digitized by the project, agreements have been made for provision, re-use, improvement and aggregation with already available content. For future use by others, the project will describe an IPR management model that is acceptable for most European public authorities, according to the very diverse legislations existing in Europe. It envisages free access for personal and "fair" use, such as access through Europeana using applications such as 3D-PDF and Venus 3D [11], but allows IPR protection for commercial use. The tools used in the project will be mainly based on open source technologies and the "production pipeline" that the project plans to establish will be made publicly available for use by cultural institutions and other owners of 3D cultural heritage content. The skills developed by the partners may enable them, individually or collectively, to offer consultancy and expertise services. This may include updating the technology.

### IV. TECHNICAL SOLUTIONS

The technologies likely to be used by the project include:

#### A. Scanning equipment

Many different technologies exist and have reached a sufficient level of stability and effectiveness to be used in standard digitization campaigns:

- short-range scanning based on triangulation,
- long-range scanning based on time-of-flight,
- images-to-3D reconstruction based on different incarnations of stereo-matching and photogrammetry,
- modalities for gathering enhanced 2D media, such as polynomial Texture Maps (PTM) or very large panoramic image).

### B. 3D Data acquisition

The 3D data acquisition process involves technologies for both surveying and modeling (topographic surveying, 3D laser scanning, image-based modeling, etc.). A range of technology solutions are available for the processes and are well known and tested, and the equipment used will be selected on a case-by-case basis according to the features of individual objects.

### C. 3D model construction

The technology available for 3D model construction is mature and includes these examples of open source software created within previous EU projects:

- MeshLab, a well-known open-source software also developed within the 3D-COFORM project. MeshLab [6] supports a complete set of instruments for the easy and complete post-processing of raw data (range maps and point clouds), generating derivative models and so on. It is a very stable and consolidated system, with a wide user community (thousands of users worldwide).

- Blender [7] is a tool for further post-processing of the 3D models.

### D. Creation of 3D models

The project will use procedural modeling for the creation of 3D models, for example in the reconstruction of models of destroyed or transformed structures or for the generation of large-scale 3D models (i.e. in the case of a city). A tool which supports this process is CityEngine, also developed in 3D-COFORM, which is commercially available (a light version is offered at low cost). The free version of SketchUp (the commercial version sells for less than 400 €) provides a tool for rapidly generating good quality content.

### E. Metadata and harvesting

Building on work by the CARARE project, 3D-ICONS will implement tried and tested infrastructure to support interoperability and data exchange with Europeana (DEA) including:

- OAI-PMH compliant repositories. Research on repositories for complex 3D models and their metadata has been carried out within 3D-COFORM and other research projects, producing prototypes that may be useful for 3D-ICONS deployment.

- Metadata Mapping and Ingestion Tool (MINT) developed by the National Technical University of Athens and implemented by CARARE and a number of CIP-ICT-PSP funded Europeana Aggregation Services (including Athena, EU Screen amongst others).

- CARARE repository (MORE), based on the MOPSEUS system developed by the Digital Curation Unit of the Athena Research Centre which is in turn based on the widely used Fedora platform.

### F. Publication

Building on the recommendations made in the CARARE for the publication of 3D models online in formats suitable for

access by Europeana users, 3D-ICONS plans to convert complex 3D models to 3D PDF, a format supported by Adobe and which is widely used and fully mature.

3D-ICONS will monitor new open source technologies like WebGL as alternative technical solutions for bringing complex 3D content to popular Web browsers. However, these technologies are not yet fully matured and are currently supported by a limited number of web browsers and are not suitable for (not capable of) rendering complex 3D models.

Data will also be made accessible to external users in the Portal section of the web site via dedicated high-quality browsers and visualization tools such as the open source Nexus multi-resolution representation proposed and endorsed by 3D-COFORM [2], availing of the experience of partners on using web-based technology for sharing 3D models over internet (as for example, the SpiderGL library [8] and the existing demos).

As existing solutions such as HTML5 and WebGL mature and stabilize, 3D-ICONS will be able to offer a widening range of technologies available across all commonly used end user platforms for the visualization of world heritage sites through 3D complex models and objects.

## V. INNOVATIVE ASPECTS AND COMPARISON WITH EXISTING SOLUTIONS

3D-ICONS will build on the achievements of the CARARE project, using the CARARE aggregation service and extending CARARE's coverage by digitization in 3D of monuments and buildings to create a large number of related digital items such as 3D models, images, texts, and possibly more. Each digital replica will be considered an aggregation in the ORE OAI sense - that is a conceptual combination of many digital objects pertaining to the same monument in order to capture the cultural complexity of such masterpieces. Content will be published according to the Linked Open Data paradigm, by identifying things with standardized references (URI). This will align with the developments in Europeana (EDM, Danube release), building on the services already provided by CARARE and incorporating results from other Europeana-related projects such as EuropeanaConnect and Linked Heritage, 3D-COFORM, an FP7 Integrated Project on 3D collection formation and others, for example CASPAR (long-term preservation of digital data) [9].

The combination of these existing tools and services, so far tested only on a sample of sites (3D-COFORM), will result into an innovative service scheme addressing all the steps of the production pipeline from data creation/acquisition to publication. The experience of other initiatives such as CyArk [10] will also be used to inform development. The characteristics of the proposed pipeline are the following:

1. Flexibility in data creation. The project is adopting state-of-the-art, open source software with guaranteed performance and quality results but will use different systems for 3D data acquisition and modeling on different monuments enabling comparison of their relative advantages. An important outcome of the project will be clear guidance for future users in choosing one technology over another.

2. Advanced semantics. Rich metadata will be added to digital content produced by the project in order to comply with Europeana specifications for flawless ingestion. The project will adopt the CARARE schema which is being implemented by projects on the tangible heritage, preparing an extension for 3D capture if needed. Terminology will be based on existing standard thesauri, building among others on those adopted for historical buildings and archaeology by ICCD (IT), English Heritage (UK), Ministère de la Culture (FR), and using widely accepted standard lists such e.g. as VIAF, ULAN, geo-names for other related information. Standardization will facilitate implementing a Linked Open Data approach. By adopting the aggregation approach proposed by ORE-OAI and creating conceptual objects from the aggregation of others, the complexity and multi-faceted nature of architectural masterpieces will be maintained. Geo-spatial data formats will ensure compatibility with the INSPIRE Directive metadata.

3. Quality outcomes. The project will adopt relevant charters and best practices for the creation of 3D cultural heritage models and their use – mainly the London Charter 3 – and thus the methodology proposed by the project will guarantee high-quality results from a cultural perspective. Technological quality (e.g. high resolution) will be incorporated in the models, with provisions for publishing versions to optimize the balance between required bandwidth and high definition.

4. Business considerations for future implementation. The project will develop a business model including:

- Cost analysis of the different data creation solutions,
- IPR management models enabling free access through Europeana and exploitation for commercial use,
- Organizational models proposed to content owners, usually public cultural institutions, and service providers, usually SMEs.

5. Attractiveness and wide interest. The public will appreciate the possibility of accessing so many famous European monuments and the related information. Europeana provides the means by which various objects and items can be connected to each iconic site and explored by its end users. Altogether, the sites digitized attract millions of visitors every year, a measure of the interest for the digitized masterpieces which in turn can be expected to attract new visitors. Content owners will have a safe IPR management model and content producers will rely on a tested business model.

## VI. CONCLUSIONS

By January 2011, Europeana provided access to more than 14 million books, maps, recordings, photographs, archival documents, paintings and films from 1,500 cultural institutions across Europe exceeding the content targets which were set for it by the European Commission. 3D-ICONS will contribute by enabling increased access to important cultural heritage sites through an effective use of digital technology. Through 3D models, the general public can visit sites which may be in remote locations, fragile and, in some cases, difficult to understand. For example, 3D PDF provides an excellent

solution for smaller models (under 20MB in size) as the models may be embedded in text which provides content and explanations for the end user.

Work has started on the planning of the project activities which includes making a full inventory of all the 3D content available, the formats, IPR status and other relevant information so that the digitization activities can be prioritized for commencement in the summer. Over the next three years, 3D-ICONS will provide a wealth of world heritage sites and associated objects for visualization via Europeana, bridging the gap between complex models produced for scientific research purposes and exciting and engaging new 3D content.

The anticipated challenges will be to find suitable formats for representation of the larger, highly complex 3D models and the means by which these can be reduced and simplified without sacrificing quality or the potential enjoyment of the model by the end user. By the end of the project, 3D-ICONS will be able to provide a tried and tested process for the conversion and production of 3D content and the associated metadata which includes the technology and tools, best practice guidelines and wide expertise built on many years of partner experience. This will enable other cultural heritage owners of 3D content to likewise contribute their models to Europeana, raising awareness and increasing the knowledge base of all the identified stakeholders.

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