Chapter 10
3D Content in Europeana: The Challenges of Providing Access

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Abstract Europeana is an online platform that provides access to millions of items of digital content from Europe's museums, galleries, libraries, archives and research institutions. Although 3D documentation has become more common in recent years, the majority of the content accessible via Europeana comprises of images and text documents. This chapter describes the context and general challenges of making 3D content accessible online, and the specific challenges for Europeana. The creation of highly accurate 3D models of monuments, buildings and museum objects has become more widespread in research, conservation, management and to provide access to heritage for education and tourism. Yet this is still a developing field and organisations that are commissioning 3D media need to make a series of choices on the type of content that is created, how it will be visualised online and for which users. The challenges of storing and providing access to this content include the multiplicity of content types and formats, the technology requirements and limitations faced by different audiences, and issues such as low standardisation, the complexity and volumes of data involved, interoperability, and lack of metadata. Working collaboratively in developing standards for 3D content formats and metadata will increase interoperability, improve access, storage and preservation of 3D media.

Keywords 3D · Digital cultural heritage · Europeana

10.1 Introduction

Digitising cultural heritage to generate 3D models of objects, monuments, buildings and urban centres has become more common in recent years. Technologies for modelling the real world in 3D are being used in research, conservation, building

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management and by cultural institutions to democratise access and to reach new audiences for education, tourism and creativity. There are several aspects to this endeavour. Creating high quality representations of three-dimensional objects which capture their shape, colours and textures accurately, and rendering 3D content in a meaningful way are important. Another aspect, the focus of this article, is delivering 3D content over various platforms and operating systems in ways that are readily accessible to the general public.

10.2 Europeana

Europeana is Europe's digital cultural platform and allows users to search for cultural resources from institutions and organisations across Europe. Launched by the European Commission on 20 November 2008, Europeana currently provides access to over 58 million digital objects including art, music, sound, images of historic buildings and sites and a budding collection of 3D content.

Thousands of European archives, libraries and museums work with Europeana to bring their digital collections to users. The content is digitised and published online by the institutions on their websites who then share metadata descriptions of the content with Europeana in the standard Europeana Data Model (EDM) format. Working with tens of thousands of institutions means that standards, protocols and formats are fundamental to Europeana, which strives to offer end-users easy and immediate access to the content. For images and text files standardisation of formats and their support on the web means that Europeana's main focus is on encouraging institutions to publish high resolution content with a direct link to the files in their metadata, which allows users to view content discovered in Europeana on their devices (Scholz 2019). For audio, video and 3D content users need to be able to play the content to have a full experience, which means either publishing the content in formats that can be played in a web browser or delivering the content in a media player that is embeddable using standard protocols. But delivery is not the only challenge as the volume of data that is being served up (especially for video and 3D) means that the robustness and connectedness of the playout service are relevant factors in terms of the user experience.

10.3 3D Content in Europeana

In January 2019 a Europeana network association task force was established with the aim of increasing the support for 3D in Europeana and its availability for users. It is worth emphasising that Europeana works with a very broad range of institutions – from major national museums, libraries and research institutions to small site museums. There are experts in 3D digitisation in Europeana's network, but for many in the network 3D is still new. Organisations beginning 3D projects are

making a series of choices about how the content is captured, visualised and made accessible to users. A relatively small number of 3D models had been made available via Europeana by the start of 2019. A review found this content offered users a variable user experience, with some 3D objects that could be interacted with online and models available for download not readily distinguished from simple images or videos of 3D content.

An important aim of the task force was to inform, support and encourage organisations which are creating 3D content, and to offer better guidance on the availability of more functional 3D content for Europeana's users to discover, explore and reuse.

10.4 Challenges of Providing Access to 3D Content Online

Until recently sharing 3D data over the internet was considered to be an unsolved need (Alliez et al. 2017). Various solutions existed but often required end users to install specific software on their computers to open the 3D file – either in the form of a browser plugin or a programme to be used to open a file download. The variety of software involved made this process inconvenient and annoying for users and represented a barrier to access. Why would a user download and install software simply to assess whether a 3D file was relevant and usable?

When providing access, a range of factors are important:

- The needs of different audiences
- The types of 3D content
- The technology requirements and limitations (of content and audience)
- The formats of 3D content
- Sharing 3D data over the internet.

10.4.1 Audiences for 3D

Knowing the audience is also important when providing access to 3D content. If we consider five categories of audience:

- Scholars and researchers creating and reusing 3D datasets in their research
- Educators and students using 3D content to meet learning objectives
- Museums creating virtual exhibitions and facilitating user engagement
- Professionals who are creating and using 3D datasets in their work
- General users

It is clear that each of these audiences has their own interests, needs and requirements from 3D. For example, researchers and professionals are more likely to require highly detailed, accurate 3D models that they can download and re-use in

Fig. 10.1 Recording the 3D structure of one the internal tombs at Knowth, BrúnaBóinne using a terrestrial laser scanner. (© The Discovery Programme)

their own projects (Fig. 10.1 illustrates the capture of such detail). Teachers may be looking for good quality models for 3D printing or for lightweight models that their students can explore online. There are a broad range of user scenarios with some audiences looking for well-presented content that tells a story, while others look for scientific content that is made available online in services that allow users to measure and compare objects. While file downloads work for some audiences, most users benefit from being offered access to a lightweight version of a 3D model with enough metadata to allow them to assess the qualities of heavier weight versions being offered for download.

10.4.2 Types of 3D Content

There is a broad range of different types of 3D content that may potentially be made accessible via Europeana. The main types include:

- Content generated from images and measurements of real-world cultural heritage objects, buildings, archaeological monuments and landscapes.
- 3D radiological imaging, magnetic resonance and Computerised Tomography (CT) scanning of objects such as mummies
- Visualisations and virtual reconstructions, which may be based on real-world measurements, modelling projects and academic research to visualise an object in its original context and setting
- Historic Buildings Information Models produced for buildings management
- 3D models produced for games, which use programming techniques to generate scenes and interactions as a player moves through the model
- 3D artworks which can range from animations depicting dances and the intangible heritage, to hyper-realistic drawings and models.

Archaeology is well represented among these content types. Each has its own characteristic workflow, which often involving specific equipment, standards and

Fig. 10.2 Saint Salvator abbey and landscape. (© Visual Dimensionbvba)

formats. Take for example the difference between scanning a biological object (such as a mummy or a skull) using medical imaging techniques and scanning a large historic building using 3D laser scanners. Or the difference between the methods and techniques used for recording an excavation of an archaeological site in 3D and those used to visualise a reconstruction of the site at a previous time (see for example Fig. 10.2). This is one of the reasons why capturing metadata about the process of creating 3D content is important. Metadata is as vital in understanding the quality and accuracy of what is depicted, as it is in helping users to discover 3D content.

10.4.3 Technology Requirements and Limitations

One of the factors that affects people's ability to access 3D content is the hardware, software and connectivity that is available to them. Different audiences operate in very different technical environments for example:

- Professionals/specialists have access to high-powered workstations equipped with specialist software and the processing power needed for highly detailed 3D models.
- Researchers may have access to high-powered computers in their labs but use different modes of access at home and different again in the field.
- General users are accessing 3D content via home computers with standard internet connections or by using on mobile devices.
- Educators and museum professionals generally access content via their organisation's network infrastructure using standard computers rather than high-powered workstations.

There can be other factors that restrict people's access to content, for example:

- Restrictions on software downloads. Many organisations restrict which software can be downloaded and installed on computers. But beyond this, when so much content opens and runs automatically within web browsers, users can be very reluctant to download and install software simply to view a file.
- Bandwidth. High resolution 3D content involves large volumes of data, which can be slow to access and/or download if users have weak network connections.

10.4.4 The Challenges of Interoperability, Usability and Sustainability

The range of different working environments and all this implies in terms of the methods, equipment and software that are being used in 3D projects means standardisation is at a relatively low level for 3D. Few standards are recognised by the International Organisation for Standardisation (ISO) (the Web 3D consortium's X3D standard and the Digital Imaging and Communications in Medicine DICOM standard are both ISO standards (Web3D Consortium n.d.; DICOM 2020)). There are some industry standards or common file formats (e.g. OBJ, PLY, DAE, STL and glTF) but many other proprietary formats are in use. Much 3D content is produced in formats that are specific to the software or equipment used.

This presents challenges for interoperability and usability from the perspective of both users and service providers. Users may find that they need to convert a file into a format that is supported by the software or service that they wish to use for their 3D project. Organisations developing services need to accommodate a lot of different file formats in use. A common approach adopted by organisations offering hosting services is converting files on import to a specified format. For example, Sketchfab supports conversion from more than 50 3D formats to the GL Transmission format (glTF) (Sketchfab n.d.). Software such as Blender provide routines for importing and exporting files in different formats. For end users, conversion to a common format can improve accessibility.

10.4.5 Sharing 3D Content Over the Internet

The number of different formats is related to the challenge of sharing 3D content over the internet. There are three main methods:

- Viewers
- File downloads
- Direct streaming

The early approaches to sharing 3D content on the web almost all required the installation of specific plugins on users' computers. In 2010, embedding 3D content in PDF documents offered a good solution to allow the broad public to view and interact with the content both online and offline (Pletinckx 2011). At that time the functionality needed for 3D was fully supported by Adobe and the content could be activated within most web browsers. But the potential for security vulnerabilities mean that autoplay of 3D in PDF is now disabled by default and use of 3D PDF has declined.

The introduction of HTML5 and WebGL brought about a revolution (Alliez et al. 2017). These days 3D content can be rendered directly on web pages. WebGL is the technology which allows Sketchfab (amongst others) to stream 3D content in real time to web browsers on a range of devices. 3DHOP, the 3D Heritage Online Presenter developed by CNR is another example of a software solution based on WebGL (Visual Computing Laboratory – ISTI – CNR 2020). 3D HOP allows high-resolution 3D datasets to be streamed efficiently and rendered for users. Available as an open-source download package, 3D HOP is available for installation by institutions (Potenziani et al. 2015). Potree is another example of open source software based on WebGl, in this case for rendering large point clouds (Schütz 2020).

WebGL is not the end of the story. Many museums and researchers are looking at 3D printing as a way of making their collections more accessible and for a range of purposes beyond education and outreach (Coates 2020). Once again specific methods, techniques and formats are involved. Projects and services such as "Scan the World" have emerged to make scans of archaeological objects, monuments and buildings available to download for printing (MyMiniFactory 2020).

The International Image Interoperability Framework (IIIF) is an important initiative that is bringing together institutions and individuals with an interest in 3D together to discuss interoperability and open standards. Building on previous work which defined a framework for delivering very high-quality images, text and audio-visual content, the IIIF 3D initiative has future potential to unlock access to 3D content that is currently locked in bespoke, locally build applications (IIIF 2020).

10.5 Challenges for Europeana in Providing Access to 3D Content

Cultural heritage institutions are increasingly thinking about 3D digitisation of sites and objects. A recent report for the European Commission highlighted increased funding by EU Member States for digitisation including monuments, historic buildings and archaeological sites in 3D (European Commission 2019). The fire at Notre Dame cathedral in April 2019 stimulated interest in 3D digitisation for conservation, preservation and providing online access (Veyrieras 2019). Initiatives such as 'Digital Syria' have also brought attention to the potential of 3D digitisation for preservation in conflict areas (Digital Syria 2019). Working with tens of thousands of institutions means that standards, protocols and formats are fundamental to

Europeana, which strives to offer end-users easy and immediate access to the content. More 3D content is being created, and more cultural heritage institutions are thinking about how to make this content accessible online.

10.5.1 Identifying Common Standards and Principles

For Europeana, which works with thousands of institutions, groups and individuals in making content available finding common ground is very important. Identifying principles and standards that are suitable for adoption by people who are creating 3D content in different contexts can only help address the challenges of delivery, access and longer-term preservation.

The final recommendations of the 3D Content in Europeana Task force (Fernie et al. 2019) included encouraging the adoption of a set of common file formats by Europeana data providers and aggregators, and in this way increasing interoperability, re-usability and longer-term preservation. The formats recommended were as follows: glTF, X3D, STL, OBJ, DAE, PLY and WRL plus DICOM (for radiography and computed tomography images) and IFC (for Building Information Modelling). This format recommendation was echoed in the basic principles published by the European Commission's expert group on Digitisation and Cultural Heritage and Europeana (European Commission 2020).

Narrowing the range of formats should begin to help with the next challenge, delivery.

10.5.2 Enabling 3D Delivery with Europeana's Platform

Europeana aggregates content that is hosted externally, usually in institutional repositories but sometimes on service platforms. A link within a Europeana metadata record directs users to the content which is made available:

- As a media file that can be viewed directly within an HTML page,
- Via a viewer that can be embedded within Europeana Collections, or
- Via an external web page

Some of the 3D media formats recommended can be rendered directly on an HTML5 web page, but much of the 3D content currently offered to Europeana is made accessible via viewers or media players.

In 2017 (Murphy and Europeana Foundation 2017) Europeana implemented the Sketchfab viewer within its platform. This development meant that cultural heritage institutions who, like the Discovery Programme, are uploading 3D models on Sketchfab (for example Fig. 10.3) could share the content with Europeana. Implementing the viewer meant that users were able to navigate the 3D content inside Europeana Collections for the first time.

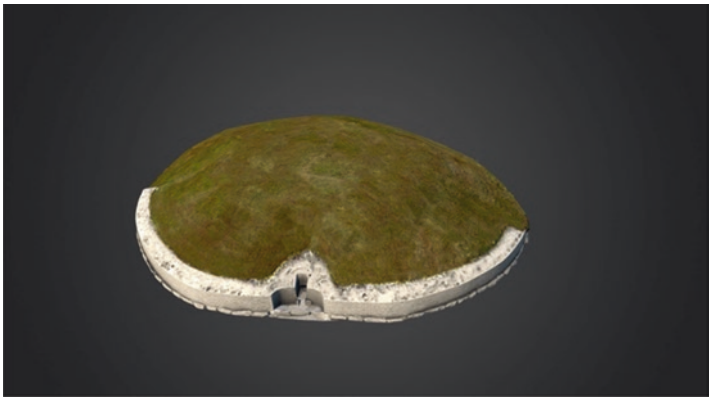

Fig. 10.3 Newgrange. (© Discovery Programme: https://skfb.ly/DwQo)

As different viewers serve different audiences and use cases, the 3D content task force recommended that Europeana should extend its capabilities by seeking to embed additional 3D viewers such as 3D HOP and the Smithsonian Explorer (Fernie et al. 2019).

Work within the IIIF 3D community raises the possibility of developments in standards, APIs and viewers which support 3D and interoperability between 2D and 3D data.

10.5.3 Building Capacity, Adding New Content

Surveys of Europeana's network of data partners and work by the European Commission's expert group on Digitisation and Cultural Heritage and Europeana highlight the need to build capacity amongst cultural institutions. Whilst there is a lot of interest in 3D amongst museums and other cultural institutions, with the notable exception of archaeology and the built heritage, there is limited experience of 3D digitisation. Developing training for cultural heritage institutions is a good way of increasing the amount of good quality 3D content and metadata that is made available to Europeana.

10.6 Conclusions

Improving on the means of delivery for 3D and increasing standardization is currently very topical. The fire at Notre Dame highlighted the challenges of re-using 3D scans and models from past projects to create an integrated knowledge platform (Veyrieras 2019). Surveys of scholars in the field of Digital Cultural Heritage (e.g.

by the Friedrich-Schiller-Universität Jena in Germany) have identified 3D was an area of high demand concerning standardisation and policies. Work by Europeana's 3D content task force and the IIIF 3D community group highlight the interest from commercial, non-profit and academic sectors in developing 3D technologies and in standardization.

There is much potential and much work to be done before 3D content achieves the level of interoperability as still images with web platforms such as Europeana.

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