3D Digitisation Guidelines: Steps to Success

A GUIDE BASED ON THE EU VIGIE2020/654 STUDY ON QUALITY IN 3D DIGITISATION OF TANGIBLE CULTURAL HERITAGE

EUREKA3D

European Union's REKonstructed content in 3D

3D DIGITISATION GUIDELINES: STEPS TO SUCCESS
A guide based on the EU VIGIE2020/654 Study on quality in 3D digitisation of tangible cultural heritage

This guide is designed to help anyone on their 3D digitisation journey. It is specifically aimed at Cultural Heritage professionals who are considering, or in the middle of, digitising their tangible cultural heritage collections. It outlines and simplifies the recommended methodologies highlighted in the EU VIGIE Study 2020/654 (Study on quality in 3D digitisation of tangible cultural heritage, published April 2022) and written in response to the EU recommendation (EU 2021/1970 on a common European data space for cultural heritage, published November 2021) for Member States to digitise all monuments and sites at risk in 3D by 2030.
This guide has been created within the framework of EUreka3D European Union's REKonstructed content in 3D, project co-funded by the European Union (Grant Agreement no. 101100685).

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Introduction

This guide is designed to help anyone on their 3D digitisation journey. It is specifically aimed at Cultural Heritage professionals who are considering, or in the middle of, digitising their tangible cultural heritage collections. It outlines and simplifies the recommended methodologies highlighted in the EU VIGIE study 2020/654 (Study on quality in 3D digitisation of tangible cultural heritage, published April 2022) and written in response to the EU recommendation (EU 2021/1970 on a common European data space for cultural heritage, published November 2021) for member states to digitise all moments and sites at risk in 3D by 2030. This guide has been created within the framework of EUreka3D an EU project co-funded by the European Union (grant no. 101100685)

User scenarios and stakeholders

Data Acquisition for tangible cultural heritage assets, either movable and immovable, comes with different degrees of complexity, depending on the user scenario and context. For example, user scenarios involving small artifacts in controlled environments are very different to the complexity of scenarios that involve underwater wrecks or objects in caves. Each scenario requires analysis and careful planning in advance to assess the level of complexity. This allows a project manager to prepare for the foreseeable challenges and more accurately complete a project within unavoidable constraints (e.g. budget, time, personnel/professionals, resources, equipment and infrastructure to be used, scope of reuse for the models, etc.).

This guide can help with three basic contexts:

- **Museum Managers** who want to digitise part or entire collections in controlled conditions;
- **Public Administrations** / Monument and/or Site owners willing to digitise immovable large objects;
- **Stakeholders, who have decided** to digitise an entire site.

> **Movable Cultural Heritage** – Movable heritage ranges from photographs and paintings to metals, ceramics, glass, wood, leather, textiles, and other composites. It can be two- or three-dimensional, made of one or multiple materials and consist of a single layer or multiple layers.

Immovable Cultural Heritage – Immovable heritage consists of buildings, land, and other historically valuable items, typically with fixed foundations connected to the terrain. In addition to castles, houses, mansions, and towers, it also includes churches, monasteries, rectories, townhouses and palaces, rural folk architecture, technical and industrial monuments, theatres, museums, plague columns and shrines, among other objects. This category also includes caves and underwater CH such as shipwrecks, underwater ruins and buildings, which hold structurally complex architectural objects, structures and historically-rich movable interior furnishings.

Before you read further we advise you download the full study for more detail on the sections that are relevant to your digitisation scenario.

Why digitise in 3D?

Every object is unique and carries a significant value in the story of humankind. 3D digitisation is a valuable tool in recording an object's memory for posterity. It is important to capture this professionally, correctly and as thoroughly as possible to avoid losing the narrative for the benefit of future generations.

To meet the needs for the protection, long-term preservation and the maximum number of end users, it is highly recommended to digitise at the highest quality available, which includes recording as much information (MetaData, ParaData) and Data (Geometrical Data), as possible. This will increase the usefulness of your efforts and support the monitoring and digital preservation of your content.

A Note on quality

Quality is not simply measured by the output resolution and accuracy of 3D models. Equally important is the completeness of the data records that relate to the object and the digitisation process.

At its simplest an object can be transferred by a single individual into a 3D model using a mobile phone which can be published online, all in a matter of hours. However, the potential of protection, preservation and reuse for these basic models, either for research or promotional purposes is very limited. In contrast, the highest level of complexities will need coordinated teams of experts, capturing a number of different aspects, using specialist high-definition capture systems, in environments which can either change over time or suspend any form of digitisation for any given period. This implies higher investments but offers a result that is truly reusable by different communities of stakeholders (researchers, architects, engineers, creative industry, tourists, educators, general public…) and that grants a long-term preservation of the 3D model.

Regardless of how easy or complex a 3D digitisation project might be, it is of high importance to always strive for the highest level of quality of 3D digitisation in the cultural heritage sector to produce a result which is not limited to geometry and textures, but which embeds and recovers the memory of an object. This includes the interconnected stories, and knowledge that are associated with a tangible object. For example, the origins of the materials and/or its production technology may tell another story in the life of the object. Additional knowledge, therefore, needs to be recorded in the ParaData and MetaData that is associated with the FileData that is generated in the digitisation project.

- **FileData**: relates to the set of files that compose the 3D model.
- **MetaData**: relates to the descriptive information associated to the cultural heritage object represented in the 3D model.
- **ParaData**: relates to the information that describe the digitisation process and context applied to create the 3D model, which also grants to perform quality controls on the model itself.

VIGIE Study Section 3.2: The Public Survey on Quality – gives a valuable insight from professional feedback in relation to quality. Pay special attention to **Section 3.2.2 – Statements from the Respondents about Quality,** which provides a holistic approach to what defines quality and how it can be considered within a wide variety of related aspects involved in 3D Digitisation projects including: accuracy, technology, equipment, standards, data, processing and special fields.

A Note on complexity

The VIGIE Study helps you assess and measure the complexity of your Data Acquisition project. Some of the complexity metrics outlined in the Study, and the Steps below, will be obvious to you, others may not be. By understanding the complexity, you will be better placed to plan and deliver your project on time and within an expected budget. Complexity estimates will help you identify the correct team, the optimum equipment and more effectively record the full story of your objects/site, both visually in 3D and with the associated data that gives meaning to your digitisation. Without having a full understanding of the complexity involved with your project, you are likely to discover that your 3D models are not fit for purpose and only serve as a visual reference, at best. A prior understanding of complexity also allows you to make informed decisions about what you may, or may not, be able to do within the scope of the project or re-assess the scale of your Data Acquisition e.g. quality vs. quantity.

VIGIE Study Section 3: Extensively describes the various layers of complexity for 3D digitisation. Following **section 3.9** and the accompanying **Figures (20-21a-i)** allows you to consider the relevant factors that contribute to the complexity of your 3D digitisation project. **Figures 22-39** allow you to build Radial Complexity charts which when put together will give a clear visual indication of the complexity of the project both to you and your stakeholders in the planning and progress of your project, for end users to assess the quality of the 3d models that have resulted, and for future generations who will have a better understanding when/if a subsequent re-digitisation is ever considered.

3D digitisation: steps to success

1. START WITH A PROJECT PLAN

VIGIE Study Section 2.3: Offers an overview of ideal digitisation project planning for immovable (**Figure 1**) and movable objects (**Figure 2**). Whether you are digitising in-house, or hiring external contractors to digitise, filling in the data for each of the relevant headings of the Project Plan templates shown in the VIGIE2020/654 study will equip you with everything that is necessary to successfully digitise CH objects in 2D/3D. A completed project plan forms the framework of the ParaData of the digitisation process.

The VIGIE Study templates two main project plans:

- Movable objects (Movable Cultural Heritage, **see section 3.5 page 44 of the VIGIE2020/654 Study**).
- Immovable objects (Immovable Cultural Heritage, according to UNESCO **see page 46 of the VIGIE2020/654 Study**).

Each template is divided into the same 4 areas:

- **Project Planning**
- **Documentation and Site Work**
- **Production and Delivery**
- **Archive & Preserve**

The main point of difference for immovable objects (Monuments, Groups of Buildings, Sites) is that the VIGIE2020/654 Study classes them as a “site”. Site based work increases the complexity and additional considerations are required.

1.1. PROJECT PLANNING

The first section of the Project Plan templates are administrative tasks that are separated into Project Management and Project Description.

1.2. PROJECT MANAGEMENT

Some important areas to note which add to the complexity of the project include:

Client: all stakeholders during a Data Acquisition project are expecting results in the form of Deliverables. This maybe the owner of the object/s, a funding body, a private entity or government department, a combination, or even your own organisation. Clear guidelines need to be in place to ensure the project delivers the expectation of the client/stakeholders in a high quality of results.

Identification of Team and Roles: the complexity of your project will increase the level of expertise that your team will require to deliver it. In turn, this increases the budget required. It is likely you will have to return to this section as you assess other areas of complexity.

External Contractors: it is possible that, while some 3D digitisation projects can be achieved internally, the cost and technical skill required to undertake most high-quality 3D digitsations will require external experts to produce the digitisation, or provide other services. In such cases, depending on the procedures in place at the institution (e.g. for public institutions a public tender must be issued), the decision to outsource can affect the project timeline.

If work is contracted, it is essential that the CHI, as the key stakeholder, is able to express their expectations to ensure that essential standards are delivered and does not greatly detach itself from the project. Take careful note of all the external specialists that may be necessary to deliver your project, particularly with "Site" digitisations. The hiring and co-ordination of multiple contractors will naturally increase both the complexity and cost of your project.

> **VIGIE Study figures 21e and f**: For more information about project outlines for contractors and considerations for Contractor/Team Member expertise.

Legal Considerations / Contracts / Site Access / Permits / Intellectual Property Rights (IPR)/ Copyright Issues: all of these are critical to consider in advance as they can create serious, even permanent, barriers to your project. Firstly: site access, permits and contracts may prevent the ability to digitise. Secondly: IPR and copyright might prevent your ability to disseminate (use) the resulting 3D models, this may result in a failure to deliver agreements you have made with your stakeholders (see 1.2). Take note: Site Access and Permits, the timing of these is critical. Rights of access and timing issues also increase in complexity when you are involving external contractors.

> **VIGIE Study Section Relevant Radial Complexity Charts:**
>
> - **Figure 27**: Layers of the Stakeholder's Requirements complexity parameter
> - **Figure 29**: Layers of the Project Requirements complexity parameter
> - **Figure 30**: Layers of the Team complexity parameter

1.3. PROJECT DESCRIPTION

All aspects of the Project Description are essential for the stakeholders of the project. These outline, in advance, the expectations and the timeframes for the deliverables. With good planning, all these areas should be feasible and not add unduly to the complexity.

In the early planning stages, it is of the highest importance to define what the stakeholder requirements are and clarify from the beginning. This includes all of the ethical and IPR aspects (for para-, meta- and data) with any possible third party, by considering how the final results will be used and/or re-used after being shared. For example, in case the owner of the object is external to the institutions (e.g. a lender of a museum object, or the municipality for monuments and sites) it is important to agree on the terms of long term preservation and reuse for the 3D resources. The same agreement is needed in case the 3D digitisation is outsourced to a service provider. In addition to clarifying these aspects, there are other requirements necessary in the planning phase: where and when the data acquisition is planned to take place, which infrastructure, devices, human resources and budget are necessary and what is the minimum required (para-, meta-) data quality.

VIGIE Study figures 21a-i: Supply detailed workflows regarding Stakeholder Requirements, Environments, Object Specifications, Contractor Briefs, Contractor Expertise, Equipment Specifications which should be referred to in the planning and subsequent stages of your project.

2. DOCUMENTATION AND SITE WORK

This section covers three main areas and diverge, dependent on whether the project scenario involves an Object (movable) or a Site (immovable). Both, however, address similar issues.

- Object / Site -Analysis
- Technical Solution
- 2D and 3D Recording Methods

2.1. OBJECT ANALYSIS / SITE ANALYSIS

Here, the VIGIE study encourages you to do a careful review of the site and/or the objects within it, both to measure levels of complexity and prepare for any complications that may occur. As a result, your project may require additional resources, specialist equipment and team members which will help you plan your Team (**see 1.1 Project Management**).

This section works in parallel to the next section which assigns complexity based on the Analysis undertaken here. Therefore, before you complete the Analysis review, it is essential to understand the complexity measures outlined in the next area of the Study (Technical Solution).

Potential Weather Challenges: For "sites", weather is the key variable factor which is both uncontrollable and impacts on the stability and consistency of digitisation. Environmental conditions (controlled or not) that may be perceived as contributing factors of complexity are included here. Both long-term (climate) conditions known to interfere with 3D data acquisition in general, such as rain, snow, wind, frost, fog, and sunshine, as well as physical measurements that become critical in reporting, such as temperature, humidity, barometric pressure, wind speed/direction, air pollution, etc. are taken into consideration (**See figure 21g and 31 of the VIGIE Study**). Weather also has the potential to create delays which must be allowed for during the project planning stage.

VIGIE Study Section Relevant Radial Complexity Charts:

- **Figure 31**: Layers of the Environment complexity parameter.

VIGIE Study Section 2.7 to 2.9: Offers some guidance to Indoor / Outdoor and Controlled / Uncontrolled Acquisition including some advice on equipment and remedy options (**2.9**) that will help you plan for certain challenges. **See also section 2.3 Planning the Process of Digitisation:** which gives some insight to equipment capabilities and what may be possible to enhance your digitisation. For example, **Figure 5** illustrates penetrative imaging and what each technology can show beneath the surface of your object.

2.2. TECHNICAL SOLUTION

Once the Object/Site Analysis has been done you can Make an estimation of the Complexity for the Data Recovery about an object/site by assigning values to the Radial Charts (see A Note About Complexity above).

VIGIE Study Section 3.6-3.8 plus Table 6: Provides detailed information about the complexity of movable objects. See also **Figure 20 Moving from Object Complexity to Process Complexity** which shows Geometry Structure, Surface Structure and Material considerations. An additional factor which might be important for your project is Structural Health Monitoring, this is mentioned in **3.7** and complexity layers are shown on **Figure 34**.

VIGIE Study Section Relevant Radial Complexity Charts:

- **Figure 28**: Layers of the Object complexity parameter.
- **Figure 33**: Layers of the Material quality Parameter.
- **Figure 34**: Layers of the Structural Health Monitoring quality Parameter.

2.3. 2D AND 3D RECORDING METHODS

This relates to the equipment and levels of accuracy, resolution and error agreed with the stakeholders.

The site/object assessment combined to the project requirements and constraints allows you to identify the most suitable recording method and corresponding digitisation equipment.

Proposed Recording Method(s) and Tools

Equipment is critical to the quality of your 3D digitisation and each scenario requires different specialist Hardware to optimise the quality of your output.

For **Museum Managers** who want to digitise small (movable) objects in controlled conditions; a photogrammetry system is most common method which allows flexibility and quality. (**see page 17 of the VIGIE Study**).

The VIGIE Study has a number of different equipment references that can help you identify the correct recording method for your project:

Section 2.3: Planning the Process of Digitisation.

Section 2.4: Active and Passive Recording Categories.

Section 2.5.1: Active Recording Systems.

- Total Station
- Global Navigation Satellite Systems (GNSS)
- Terrestrial Laser Scanning (TLS)
- Mobile Laser Scanners (MLS)
- Structured Light Scanning (SLS) Systems
- Optical 3D Triangulation Systems
- Hybrid Systems
- Depth or Range Cameras

Section 2.5.2 : Passive Recording Systems.

- Aerial Photogrammetry

- Photogrammetry

Section 2.6: Multi-Sensory and Multi Scanning Technologies.

Table 1: Advantages and Disadvantages of various recording technologies.

Table 8: 3D data capture technologies in connection to object complexity.

Figure 26: Overview of the Pre-processing steps.

VIGIE Study Section Relevant Radial Complexity Charts:

- **Figure 24:** Layers of the Software and Hardware Equipment complexity parameter.
- **Figure 25:** Layers of the Pre-Processing complexity parameter.

Agreed Level of Accuracy / Resolution / Error

Levels of geometrical accuracy are essential to 3D digitisation projects, without accuracy your 3D models may be incomplete, lack detail, or create unwanted aberrations that can render a 3D model unfit for use to professional end users. Different equipment types used to record your 3D models will have varying levels of accuracy and are optimised for the different scenarios to show extremely fine detail, or more broadly when surveying large sites. The levels of accuracy / resolution / and error should be agreed by the Stakeholders in the early planning stages of the project. The correct equipment and methods, in hands of skilled operators, should attain high levels of accuracy and resolution but take note that parameters such as Materials, Weather- and Environmental factors can seriously impact accuracy and the margin of error.

The VIGIE Study has a number of references to accuracy/resolution/error:

Section 2.2: Terminology – Accuracy and Precision.

Table 1: Advantages and Disadvantages of various recording technologies.

Section 2.10: Derived Project Data.

Section 3.2.2: Statements from the Respondents about Quality.

Table 4: Degrees of object quality (from two UNESCO studies).

Section 3.4 : Limiting Factors in a 3D Digitisation Process.

Table 5A: Current technology recording limits.

Table 5B: Current fit-for-purpose resolution limits (production).

Section 3.12.1: Uncertainty as a General Expression of Quality in 3D Digitisation.

VIGIE Study Section Relevant Radial Complexity Charts:

- **Figure 35**: Layers of the 2D geometry quality parameter.
- **Figure 36**: Layers of the 3D geometry quality parameter.
- **Figure 37**: Layers of the Texture image quality parameter.
- **Figure 38**: Layers of the Scale image quality parameter.
- **Figure 39**: Layers of the Spectral image quality parameter.

3. PRODUCTION AND DELIVERY

This section of the Project Plan incorporates the final considerations before digitisation, the very important data recording during digitisation, and post-digitisation production tasks necessary for the final delivery.

- Production – Data Management
- Output and Deliverables
- Production

3.1. PRODUCTION – DATA MANAGEMENT

Once the required accuracy and the appropriate corresponding digitisation method and equipment has been agreed, Data Capture Solutions need to be confirmed and Conventions need to be adhered to. When deciding on FileData Formats it is important to retain the full integrity of the digitisation , as well as, the flexibility for users to view the 3D model. As result it is recommended to consider both uncompressed Data files available to Professionals on request, and optimised FileData Formats to allow your 3D models to be disseminated and viewed by the largest cross-section of end users on a wide variety of platforms (paying special attention to the compatibility of 3D viewers/visualisers and the sustainability).

Section 4 of The VIGIE Study details the **Standards and formats** of 3D digitisation data. This includes:

Section 4.1 : Data Types (Propriety Data / Open Data).

Section 4.2 : Data Formats.

Section 4.3 : Metadata Schemas for 3D Structures.

Section 4.4 : Identification of Gaps, Additional Formats, Standards.

Record of Metadata: Metadata models describe digital surrogates. Metadata entry is likely to processed after the digitisation process is completed but can be done in advance on a separate spreadsheet or DAM system ready for import/link to the published 3D models. Metadata, being text based, is essential for the search discovery of your models via search engines. Whether your 3D models are placed in large aggregated platforms, or small local ones, the relevant information you add to the metadata will improve discoverability via direct search, filtered searches, or constructed data searching. In addition, preservation metadata is vital semantic data that supports the long-term preservation of digital object records. It is a crucial step for CH stakeholders investing in digitisation and has become common in the documentation of collections. The greatest challenges in preservation metadata are to developing a uniform framework, including the semantic information needed; and in what format the objects should be modelled.

Section 4.3 of the VIGIE Study describes Metadata Schemes for 3D Structures.

Record of ParaData: The importance of recording ParaData, i.e. the information about the data acquisition process, is highly recognized in the scientific community. The recording of Paradata will begin with the project planning and continues during the digital acquisition. Examples of ParaData include the staff member who undertook the digitisation, the equipment used, the lighting and environmental conditions present at the time of digitisation. All of the complexity information estimated in the planning stage will have a corresponding ParaData value during digital acquisition.

Capturing and delivering ParaData provides key insights that can be of vital importance to some users. Although there are different initiatives and efforts focused on the description of ParaData, Cultural Heritage lacks a formal schema model to express them; additionally, it is evident that recording and maintaining a full range of ParaData can be burdensome for some CHIs, especially in terms of detailed administrative data entry , together with possible updates. Equipment or other tools may help by automatically recording some ParaData, but it is important to ensure best efforts are made to record the details of the digitisation process.

3.2. OUTPUT AND DELIVERABLES

The output and deliverables section covers administrative tasks. There are requirements that are necessary to agree in advance, confirming that the project will deliver a specified output. Number of items, in the agreed formats, with the agreed Data. When the project is being delivered this needs to be verified along with the date of completion with a client sign off.

3.3. PRODUCTION

Production involves the processing of the FileData that has been captured and delivered by the digitisation teams. RAW data produced from the digitisation needs to be first archived and then to be cleaned/pre-processed in order to create a 3D Model that is fit for purpose and meets the expectations of the Stakeholders. Production requires trained multidisciplinary professionals and the complexity levels of the production process mirrors that of the digitisation, i.e. small movable objects in controlled environments are the least complex, whereas full sites and detailed multi-architectural structures consisting of interlinking inside and outside aspects will be highly complex to process accurately and requires highly skilled personnel.

4. ARCHIVE

The final part of the Project Plan is Back-up and have an Archive management plan. It is of vital importance to maintain the integrity of your data throughout your project and for permanent storage once it is complete. Make a generous estimate of the data storage you may require during digital acquisition, together with post processing requirements, and archiving. Considerations include where the storage is kept, in house/on the cloud, the storage provider and the cost for the long term maintenance/preservation of your Data.

3D digitisation produces many files which consume large amounts of digital storage. The integrity of this data is most at risk while the project is in process and the Back-Up of data as it is created and processed needs to be assured to avoid re-digitisation, which will both be costly and create time delays.

Once completed all you project data needs to be archived. This includes FileData, MetaData, ParaData – working files, completed highest quality 3D Models and associated Data, completed optimised quality 3D Model for flexible dissemination. It is highly recommended to keep a full copy on an offline storage array for back-up purposes.

An additional concern is the archiving of personal or private data. Individuals should be informed and offer signed consent when you are storing personal data.

Publication and dissemination

Use and reuse of 3D cultural heritage objects

3D digital objects provide more detail, scale and possibilities for in depth interaction than 2D equivalents. This has various impacts, but most of all 3D experiences can provide more immersive ways of exploring cultural heritage content and engaging visits to cultural sites and institutions.

3D objects are useful resources in learning, education and research, in exploring, preserving and monitoring heritage sites and monuments and in helping reconstruct heritage. 3D models of museum objects, monuments and sites can be reused in Virtual Reality (VR) and Mixed /Extended Reality (MR, XR) or Metaverse experiences, such as virtual tours or remote training, and in Augmented Reality (AR) applications for education, tourism and city/ museum tours. In addition, from the 3D models it is possible to produce printed models (rapid prototyping), useful for children engagement, artifact handling and teaching, sensory and accessibility experiences to be offered to impaired visitors, and other creative reuses leveraging 3D printing.

Last but not least, another important domain that highly benefits from 3D digitisation is research. This is especially relevant for heritage sites, monuments and objects which are deemed at risk. 3D digitisation allows for detailed analysis and monitoring of monuments and sites and of cultural heritage objects, either indoor, outdoor or underwater, including measuring, observing fine details not readily visible to the naked eye or in simple 2D recording, comparing the details of related objects of similar type, monitoring the impact of specific factors on objects over time (such as wind, pollution, erosion, visitor traffic).

Finally, the 3D scanning of objects is crucial in the fight against illicit trafficking of cultural goods: the presence of 3D models in the databases of stolen works used by the police and customs forces allows for a gain in speed and efficiency in the in-situ identification of these objects.

The various stakeholders and categories of re-users for the 3D models may have different needs and requirements; yet the very starting point to enable use and reuse of the 3D models is discoverability. Next to publishing and disseminating the 3D collection on Institution's website, pan-european platforms like Europeana, the Data Space for Cultural Heritage, the upcoming European Collaborative Cloud for Cultural Heritage, and e-infrastructures and repositories dedicated to the various research communities offer opportunities to share and link datasets about 3D cultural heritage to a wider audience.

Publishing a 3D object online: technical challenges

Quite often, processing of 3D data online is done on the client side, so the actual device used by the user plays a key role and must be considered when designing 3D experiences, which are affected by network limitations, computer memory or processing capacity.

The 3D industry has greatly evolved over the years but still lacks the standardisation level that 2D content has. This lack of standards for the use of 3D data makes it a challenge to decide on a universal 3D format.

There is no complete alignment between the 3D software to process 3D data and the software to visualise or deliver 3D experiences to users. Herein, some content providers may use a format for the archival of 3D data, but this may not be the best choice for visualisation or delivery to end users. For example, OBJ is a widely known format, commonly accepted by 3D software and 3D visualisation libraries, but it is less space-efficient for data, making it a poor choice if the data to be sent over a network are too large. Such cases can benefit from a binary format such as PLY. Some algorithms and 3D formats focus on compression ratio, while others focus on performance.

It is usually a trade-off: compression makes more efficient use of space (benefiting, for example, the storage or transfer of a file) but increases processing effort (both for compressing and decompressing the data). These are not intrinsic problems for 3D, as 2D content also suffers from them, but they are more prominent in 3D because 3D is more complex in nature, and 3D content requires extensively larger amounts of space than 2D content, which affects its storage, processing and transfer over a network.

It is therefore recommended to consider the creation of the 3D model in different versions and formats, so to accommodate different users requirements (e.g. professional users may need a higher resolution model available for download and offline fruiting of raw data, while for dissemination purposes a compressed version shared with an embeddable viewer could be sufficient for the user to enjoy the content.

A note about rights labelling

3D objects can generate a complex scenario about the rights to be attached to the model once it is published. In general terms, in order to support the largest use and reuse of the 3D models, it is recommended that an open access approach is considered. Especially when the 3D model is a faithful representation of a real-world object, it is not expected that additional rights are imposed (which means that if the object is in the Public Domain, its digital representation be it in 2D or 3D should be as well Public Domain). Yet, there may be constraints which prevent this approach to be taken, such as national legislations, contractual agreements, or the methods used to create the model. For example, many collection holders do not have expertise or equipment to perform 3D digitisation in-house and thus the task is often outsourced to service providers that are contracted to perform the scanning and generate the models. Also, depending on the methods employed to model the 3D object, the object can be the result of the work of various people, and, in case a creative method is used, the artist's intellectual property. This may also mean that the same physical object may have different 3D reproductions with different features, which may bear different rights (for example, a faithful digitisation of archaeological ruins vs. their virtual reconstruction creatively recolored). It is therefore of the utmost importance to clear the rights in the contract or service agreement with the service provider, in order to allow the content holder to retain the maximum freedom in sharing the model with a reuse license.

Checklist: 3D digitisation step by step

Before you start: Meet and agree with your Stakeholders – Identify what are you digitising? Why it is important?

When you have positive feedback from your Stakeholders devise a Project plan and measure levels of Complexity in-line with the following steps.

Planning

1. What are the Stakeholder requirements. Expectations, Deliverables and Deadlines.
2. Identify and build your team – Internal staff? External contractors? Level of Expertise?
3. Solve legal issues and other barriers to the success of your project. E.g. Site access, Contracts and legal issues, Permits, IPR and Copyright.

4. Create a detailed project description with objectives and development timeframes with input from your Stakeholders/Client.
5. Conduct a site visit and object assessment – measuring potential weather and environmental complexity and challenges that might need to be remedied, where possible.
6. Estimate the Complexity of your digitisation objects/site using the proposed Radial Charts. Reassess timeframes, team, expertise, cost as a result.
7. Agree recording methods (equipment) that is both suitable for your project and to the agreed level of accuracy/resolution required by you Stakeholders.
8. Confirm Data Capture Solutions – Data Conventions
9. Consider the data storage required during digital acquisition and post processing, including the back-ups to ensure integrity during this high-risk phase. As well as sustainability (storage/online) costs of maintaining the 3D models produced in your project.

Digitisation

10. Record detailed ParaData during the digital acquisition. Re-input exact values of any parameter measure previously estimated. Plus, any other information to describe the digitisation process.
11. Record MetaData (the descriptive details of the object itself – include preservation metadata)
12. Assess/validate accuracy resolution and error of the Raw FileData output in comparison to the Stakeholder requirements and the intended use before signing off.

Processing

13. Process your Raw FileData into a workable 3D model. Remember you are likely to need a full resolution 3D Model and associated files stored offline for delivery to professionals, on request. Plus, an optimised 3D model that is flexible to display on a wide range of platforms (3D viewers/visualisers).

Publishing and archiving

14. Create a Back-up of all your finalised Data. Remember to acquire consent if storing personal data.
15. Assign Rights Labelling to your 3D Models according to the permissions of relevant Stakeholders.
16. Publish your 3D models by including all MetaData and ParaData.
17. Disseminate your project to your target Stakeholders.

PARTNERS

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