Virtual Archaeology Review

Virtual Archaeology as an Integrated Preservation Method

Daniel Pletinckx
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Visual Dimension bvba, Ename, Belgium

Resumen

Este documento se centra en la arqueología virtual como una actividad científica, que cumple con la Carta de Londres y con la Carta de la UNESCO sobre la preservación del Patrimonio Digital, como una actividad sostenible, y como una actividad de integración para estructurar y preservar toda la información relacionada.

Palabras Clave: *ARQUEOLOGÍA VIRTUAL, CARTA DE LONDRES, PRESERVACIÓN DIGITAL*

Abstract

This paper focuses on virtual archaeology as a scientific activity, that complies with the London Charter, as a sustainable activity, that complies with the UNESCO Charter on the Preservation of Digital Heritage, and as an integration activity to structure and preserve all related information.

Key words: *VIRTUAL ARCHAEOLOGY, LONDON CHARTER, DIGITAL PRESERVATION*

1. Context

Virtual archaeology is more than visualising the human made structures that have disappeared and that are known partially through excavations, iconography, written sources or oral history. We are convinced that virtual archaeology complements perfectly documentation and conservation efforts and even can act as an integration activity to bring all information together in a structured way that allows long term preservation.

Virtual archaeology has a problem of credibility and scientific rigour, as it lacks a widely supported methodology on how to turn its sparse sources into 3D models. The London Charter has outlined the methodology how this issue can be overcome in its various aspects. The InMan methodology, as developed within the European EPOCH project, provides a full implementation of the London Charter that easily can be implemented by the archaeological community.

Virtual archaeology has also a problem of long term preservation of its results. Not only is the lack of 3D standards an important issue, but also the interpretation of the sources needs a form that can be preserved over time, in connection to the 3D models.

3D documentation of still existing archaeological remains or building elements is an important part of collecting the necessary sources for a virtual archaeology project. New developments allow to do this documentation phase, including obtaining correct measures and groundplans, in 3D from photography only, with free tools. This is also important when restoring archaeological remains, of which older phases are reconstructed in a virtual way, as the original state, the restored state and eventual in between states can be recorded easily through this photomodeling technique.

We state that virtual archaeology, as it needs all related sources to come to the most probable virtual reconstruction of historical structures, needs to position itself as an integration activity to structure and preserve all related information.

2. Workflow

The methodology to create virtual archaeology is changing significantly. Not only has a large set of useful tools become available and reliable, but the experiences, successes and failures of the starting phase of virtual archaeology have made clear that it is much more than building 3D models only. Most publications until now have focused on the technical aspects of creating virtual 3D models of lost, human made structures and digitising existing structures, but the key elements are appropriate tools, a reliable and well understood workflow and a successful integration into the relevant institutes and organisations.

This paper elaborates on the sustainable implementation of virtual archaeology, not as a push-action ("what can we do with the available technology ?") but as a pull-action ("what do we need as archaeologist ?"). Hence, we don't focus on presentation aspects only, but merely on the research and documentation issues that an archaeologist needs to deal with when creating virtual archaeology.

A first step into the creation of virtual archaeology is the creation of 3D documentation of still existing archaeological remains or building elements. The easy creation of a 3D textured model in a few hours, without complex digitisation devices, relying on only photography skills and a visually oriented processing, has the potential to change this documentation phase substantially.

A second step in the creation of virtual archaeology is the documentation of the creation process itself, where different sources need to be evaluated, correlated and turned into the most probable hypotheses. Following a well documented, standardised methodology and making the results of this process open for peer review are crucial elements for virtual archaeology to obtain scientific credibility, in which publication of virtual archaeology results is an inevitable part.

A third step is the long term preservation of the results and all its sources in a structured way, which provides the opportunity to use the virtual archaeology process as an integration process and central hub. We state that results, derived from cultural heritage objects (such a digitisations or virtual archaeology) should be preserved in the same way as the objects themselves.

3. 3D Documentation

3D documentation of still existing archaeological remains or building elements is an important part of collecting the necessary sources for a virtual archaeology project. New developments allow to do this documentation phase, including obtaining correct measures and groundplans, in 3D from photography only. One of these developments is the combination ARC3D – MeshLab, which was made available within EPOCH, a European Network of Excellence on the use of ICT in cultural heritage (EPOCH). Both tools, which are available for free, yield a fully operational method to digitise most sites, monuments and objects through photography only, reducing the cost significantly while producing stunning results in a short time.

ARC3D (ARC3D) is in fact fully automatic photogrammetry, it recognises the objects in the photographs and calculates the 3D surface directly from the photographs. The extensive calculations needed to do this are performed on a computer cluster over the internet. In other words, the 3D reconstruction process is implemented as a webservice, the user only needs a normal PC and an internet connection to upload the images. The ARC3D results are returned over the internet and processed on a normal PC by MeshLab (MESHLAB). The processing is simple, intuitive and straight forward (NILSSON, 2007).

A major advantage of ARC3D is that is can be used with any uncalibrated camera, even with zoom lenses, as the software calculates the lens parameters automatically from the images. In other words, there is no need for special or calibrated cameras, and any lens from wide angle lenses to extreme telelenses can be used, giving all flexibility that is needed to make optimal photographs, from overviews to detail shots.

A second major advantage is that 3D results derived from one set of photographs are in the same coordinate system, in other words there is no need for time consuming and error prone alignment of different views, as is the case with all other scanning techniques such as laser scanning. Typically, the outside of a church building will need 50 to 100 different laser scans, hence all these scans need to be aligned with each other, taking at least two days of work. The same building can be digitised through ARC3D with 1 to 3 sets of photographs, hence zero to one hour of alignment, resulting in major time and cost savings.

A third major advantage is that the digitisation process is image based, and that the images are linked automatically to the 3D model. In laser scanning, linking images to the 3D model nearly always needs a separate alignment procedure that takes time and effort. This means that the subtle light conditions within a building can be visualised in 3D, providing an extraordinary experience when exploring the building virtually. As the information is three-dimensional, the 3D model can be visualised on the new generation of 3D screens that provide stereoscopic viewing for groups of people without glasses (very well suited for display in museum and visitor centre context).

The correlation processes in the ARC3D reconstruction process also yield a quality measure of how good each point of the object has been reconstructed. By discarding points with a lower quality when turning the ARC3D results into 3D models in MeshLab, an automatic cleaning of the results is obtained. Practice shows that good photography allows nearly automatic workflow in which no manual cleaning of the data is necessary, yielding substantial savings in time and costs.

The digitised 3D models are metrically correct and undistorted but lack exact scale and orientation as this cannot be derived directly from photographs. Adding correct dimensions to an ARC 3D model requires simple scale and orientation transformation, that can be defined by measuring a few points on the object (preferably through surveyor techniques). In other words, ARC3D reconstructions can be used also to measure precisely such building elements without physical access to those elements. Also, no reference targets, which are common practice in laser scanning and similar techniques, are necessary, yielding extra savings in time and costs.

As putting a digital camera up in the air is much easier than other scanning devices, major cost and time savings can be realised compared to other scanning techniques. Simple technologies such as masts, balloons or UAVs can be used to bring the camera up to the appropriate height or viewpoint. As ARC3D also can make 3D reconstructions of landscapes, it can be used to digitise the site of a historical building or excavation. This is not only useful for documentation and presentation purposes but also for preparation and planning of restoration works or site management.

Another major advantage is the scale independency of the method as we can digitise a site or a small object of a few centimetres through the same methodology and production process. This yields major cost savings as for laser scanning, at least four different types of scanner are needed to deal with this scale range (the same holds for other scanning techniques).

However, the most important advantage is that the digitisation methodology can be integrated easily into the existing structure of heritage institutions as most of these organisations do have a photography department, do have a long term cooperation agreement with a professional photographer or do have employees with sufficient photography skills. As most of the required knowhow to make efficient and successful 3D models through this methodology are professional photography skills, while the computer processing is simple and easy to standardise, the integration in these departments is quite straight forward.

We have developed and tested detailed workflows for both outdoor and indoor digitisation of buildings, and for on site digitisation of objects in monuments and museums (avoiding transport of the objects and the inherent insurance fees and administration). Through several digitisation projects of buildings and objects, we have acquired a substantial body of practical experience, supported by the required equipment (portable photo studio, zeppelins, photomasts, ...) to ensure a flawless and efficient digitisation project. For example, the outdoors of a historic building typically takes one full day from photography to a finalised 3D model, which can go to two days when using extensive ballooning.

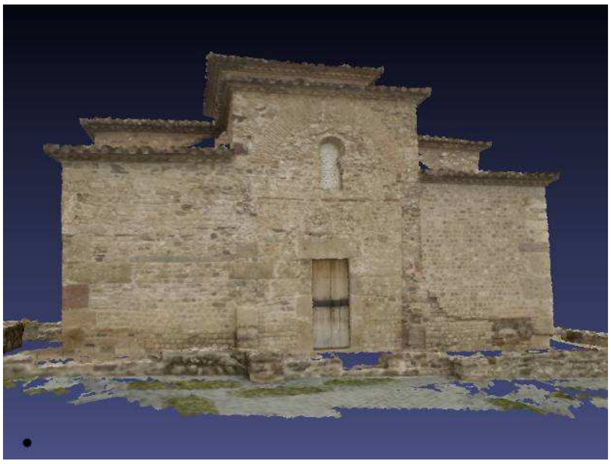

Figure 1. Full 3D model of San Miguel church in Terrassa, Catalunia, Spain, made in one day (ground level photographs : Pol Mayer)

Figure 2. Balloon to photograph buildings for 3D reconstruction (Aurea Imaging)

4. Credibility

Virtual archaeology, as the methodology to visualise human made structures, brings together many skills, ranging from archaeological interpretation over digitisation of sources to creation of 3D models. This means in nearly all cases that virtual archaeology is teamwork, in which interdisciplinarity is the crucial success factor. In the past, we have seen too much virtual archaeology where the archaeologists did not have the knowledge to provide the appropriate data to 3D modelers while the 3D modelers did not have the knowledge to ask the right questions to the archaeologists to create a correct 3D model that represents the correct interpretation of the data. It is exactly this interdisciplinary cooperation that is the kernel of successful virtual archaeology. But this labour intensive, complex process needs guidelines to live up to the expectations of the archaeological community and to gain the necessary credibility as a scientific method.

These guidelines haven been created in 2006 by a large group of computer based visualisation experts as the London Charter (LONDON CHARTER) and is based on a preparatory work from scholars since the middle of the 90s (BEACHAM, 2006). The Charter is been discussed in regular meetings and refined accordingly (currently version 2.1).

A first implementation framework called InMan, based upon the London Charter, has been published shortly after (PLETINCKX, 2008) and is being used in commercial computer based visualisations and virtual archaeology projects. This InMan (interpretation management) framework provides a step by step workflow on how to structure and evaluate the sources we use in the interpretation process, how to 'correlate' the sources to define the kind of reliable information that they can provide to the interpretation process, and to create hypotheses that lead to the most probable reconstruction. This framework also proposes a simple, wiki based platform to document this structured interpretation process and to open it up to peer review and scholarly discussion. The InMan methodology has been published as an EPOCH knowhow book (PLETINCKX, 2007).

We are convinced that virtual archaeology needs to gain scientific credibility by adopting such methodologies, and by using computer based visualisation as a research tool. In the past, virtual archaeology has been seen too much as a communication tool, with too little attention to scientific background and incorporation of all available research.

Figure 3. Virtual reconstruction of the belfry of Roeselare, Belgium, from unpublished sources

5. Preservation

One of the major problems of virtual archaeology is the long term preservation. If we analyse specific virtual archaeology projects, we have to conclude that most of them are ephemeral. This is due to several reasons. As most virtual archaeology projects are focused on the images and animation sequences that result from the 3D model, there is little attention to safeguard the 3D model and its associated files (texture files, georeferencing, documentation on the file structure, …). In other words, as the imagery gets visibility, it has a chance to get integrated in backup and digital preservation schemes, while the 3D models and associated files remain under the control of their creators and risk to get lost on unstructured, unregistered CD-ROMs or crashed harddrives.

Secondly, the swift evolution of 3D software makes that most 3D file formats don't have a lifespan of more than five years. Most people creating virtual archaeology only keep their files in the file format of the 3D software but forget to save their work in open file formats that have a longer lifespan and higher compatibility. Without digital preservation procedures, these files become obsolete and unreadable quite fast.

Thirdly, understanding and interpreting historical sources is a long and slow process, that is prone to be biased by the current society. Further research yields improved insights and more information about historical issues. These can have an impact on the interpretation of data, resulting in other or better visualisations of the past. If we want this to happen to the virtual archaeology reconstructions we make today, we need to create our models and their associated data in such a way that they still make sense in 10, 20 or 100 years from now.

Finally, when analysing the virtual archaeology projects we have realised in the last ten years, we see that most projects are based on unpublished sources, most of them resulting from excavations. Some countries, such as the Netherlands, have rules and quality norms on publishing excavation results, but most countries still lack such regulatory framework. In other words, a virtual reconstruction project is a kind of publication of the unpublished results. In most cases however, the 3D models are 'orphaned' as no reference can be made to the unpublished data, hence these 3D models or the derived imagery become easily obsolete or disconnected as soon as the implicit context (website, people that did the research, research project) disappears. Those virtual reconstructions loose much of their significance as soon as it becomes unclear what they represent.

The UNESCO Charter on the Preservation of the Digital Heritage (UNESCO) gives a clear priority to digitally born data, such as virtual archaeology data. The InMan methodology, presented in the previous chapter, proposes to use a very simple wiki approach, hosted by a responsible cultural heritage organisation, to achieve not only the easy wiki access and the peer review, but also to have central backup and migration procedures that could prevent the data to become inaccessible or unreadable for a significant amount of time.

An important project that will realise this goal in 2009 is SAVE, which stands for 'Serving and Archiving Virtual Environments' (SAVE) and packages the update and preservation process as a peer reviewed digital journal in which you can publish your virtual archaeology results. This project is a spin-off of the Rome Reborn project and relies on many years of experience in both virtual reconstruction and cooperation between scholars and 3D experts.

Finally, the London Charter, currently version 2.1 (LONDON CHARTER), highlights as one of the charter principles the long-term sustainability of the virtual archaeology results.

6. Integration

There are many different areas in which virtual archaeology results can be used, we only name a few that are less known. In restoration for example, a physical anastylosis can be prepared by a digital one, in which can be defined which remains fit together and can be used in the anastylosis, and which parts need to be completed by additional elements. Another use in restoration is the creation of a 4D virtual model (several 3D models that show the evolution of a structure) to decide how to conduct the restoration to show the different phases in an optimal way.

Such 4D models can also be very useful for site management as the reconstructions, based upon partial archaeological data, are in fact the best possible prediction of the archaeological remains that still could be present on the site, so that optimal preservation or minimal disturbance of the possible remains can be implemented. 4D models are also ideal ways to present a research synthesis, both for public display or research purposes.

In any way, appropriate virtual archaeology can only be done if all related sources about a structure or place are collected, structured, analysed and correlated. This also means that virtual archaeology is the activity that brings together all information about a structure or place. If we succeed in storing this information in an organised, sustainable way, then we turn virtual archaeology into an integration activity of cultural heritage information.

This means that, when calculating the budget of a virtual archaeology project, appropriate funds need to be allocated to integrate all sources into a common database structure, to document the interpretation process and to translate the useful 3D files into file formats that are open and are expected to have a long lifecycle (VRML, X3D, COLLADA, ...).

Europeana, the European digital library, integrates the collections of many cultural heritage institutions in Europe and has proven to be very successful and appealing to a wide audience (EUROPEANA). Major efforts are under way to also integrate 3D and archaeology into Europeana. Virtual archaeology should also become a part of the Europeana collection and can do so if we succeed to turn it into structured and integrated activity.

7. Conclusions

Major developments in documentation techniques of cultural heritage through photomodeling, and in structuring and preserving the virtual reconstruction process based upon the London Charter can turn virtual archaeology into a central activity that integrates all related data in a common database, and makes archaeology a much more open and accessible science.

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All URLs have been verified on April 15, 2009.