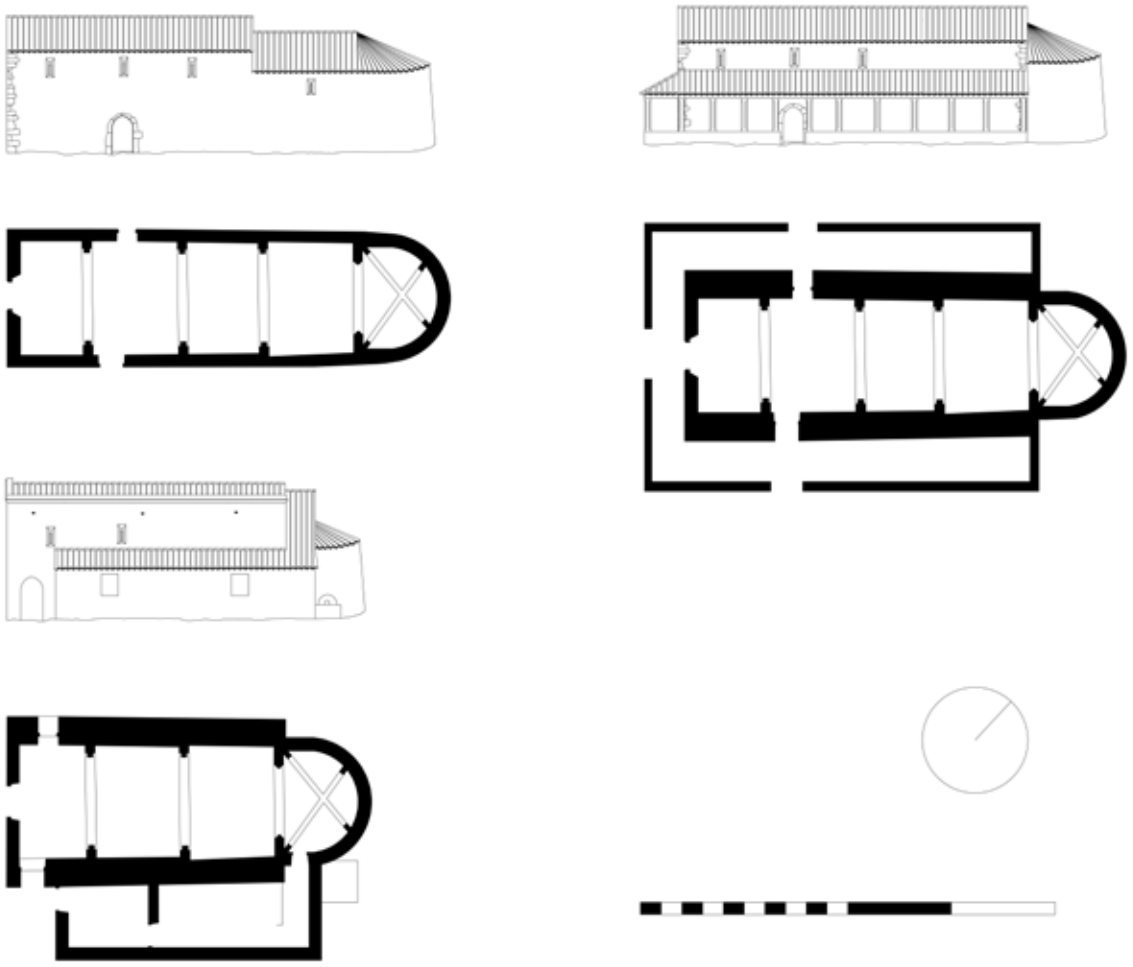
construction and cultural heritage, the division has been almost absent (at least officially). In this sense, we questioned if the 3D models adopted for research could also be used for the final public. Carlos Carpetudo's paper faces the problem with his case study and draws the line when 3D reconstruction and CGI imagery are used in a highly scientific environment. In the process of transmission of knowledge to the general public he does not forget the translation of his work in an appealing and attracting visual form.

SANTO ANDRÉ DO OUTEIRO HERMITAGE CHURCH: AN EXAMPLE OF VIRTUAL ARCHAEOLOGY TO PROMOTE PUBLIC ARCHAEOLOGY

CARLOS CARPETUDO

1. Current state of the ruin of the hermitage church of Santo André do Outeiro.



2. Santo André do Outeiro hermitage church construction phases as identified by Gonçalo Lopes: upper left – the 1st phase corresponding to the late 13th century - early 14th century; upper right – the 2nd phase corresponding to the late medieval period; lower left – the 4th phase corresponding to the 1st quarter of the 17th century.

HISTORICAL CONTEXT AND AN ARCHAEOLOGY OF THE ARCHITECTURE PERSPECTIVE

Located about two kilometres North of the city of Montemor-o-Novo, the hermitage church of *Santo André do Outeiro* has its foundation during medieval times, around the year 1316, as is affirmed by the vicar of the Parish Church of *Santa Maria do Bispo*, Pedro Botelho do Valle, in the parish memoirs of 1758 (Fonseca, 1985). Although this mention exists in this 18th century document, the remaining documentation is scarce, existing only another document dated from 1468 that mentions the application and distribution of rents. Until this hermitage church was abandoned, at the ending of the 19th century, no other document is known. During the 20th century, the hermitage church faced the ruin of the majority of its nave and complete ruin of its facade, being also the target of the implementation of a geodesic landmark on the apse, which still remains there today.

In a perspective of increasing the knowledge of this monument, Gonçalo Lopes published the article *'A ermida de Santo André do Outeiro: Uma abordagem de arqueologia da arquitectura'* (Lopes, 2008, p. 55-80). Thoroughly reading the stratigraphy of the architecture of the hermitage church, the author was able to identify four construction phases which were illustrated by 2D CAD drawings:

1. Late 13th century, early 14th century – beginning with the construction of the apse walls and of the last extension of the nave, followed by the construction of the nave, arches and facade. The wooden roof is then deployed above the structure.
2. Still during the medieval period – the walls were reinforced and the last extension of the nave increased in height. In this phase, the author identified a galilee leaning against three of the sides of the hermitage church.
3. In the early 16th century – there were no structural changes in the building[9], although on the inside a plaster layer was deployed which covered the original expanded mortar joint that characterized the interior in the first two phases.
4. 1st quarter of the 17th century – on this phase, the facade was drawn back probably because of structural problems. The wooden roof was replaced by the construction of a brick vault. The side doors were closed and the galilee disappeared to give place to the house of the hermit. The building also gained a cornice on top.

Despite the scarce documentation regarding the hermitage church of *Santo André do Outeiro*, the study carried out by Gonçalo Lopes produced a great amount of information – unknown until then – regarding the history of the monument which is also one of the few archaeological sites in the region that still preserves its medieval structures intact. Although it was published in 2008, this new information still remains unknown to the main public and the community of Montemor-o-Novo. With that fact in mind, and with the possibilities the digital tools brought forth, attracting the local community to the importance of the preservation of this archaeological site was a priority, raising awareness to what is their historical heritage, and empowering them with the knowledge to pressure the local political agents for its preservation.

3D MODELLING AS METHODOLOGY OF HERITAGE STUDY AND VALORIZATION – ADVANTAGES AND DISADVANTAGES

Modelling a 3D version was the next step towards the enhancement of the appreciation and study of this monument; something easily achieved resorting to the 2D CAD drawings published by Gonçalo Lopes. Bi-dimensional record is a tradition in archaeology, because for a long time 3D recording of archaeological findings was problematic. However, the use of 3D in archaeology is not new, *'archaeology is inherently three-dimensional in its methodology and its primary data is often three-dimensional in nature'* (Lanjouw, 2014, p. 1-12). Because of this, the use of three dimensional tools and its valid scientific use should not still be questionable since it has been around in archaeology for over 40 years now (Lanjouw, 2014). The revolution of the open source software on the last few years has transformed the meaning of the word 'accessibility' and the use of these tools in archaeology is now 'mainstream'. Nonetheless, it is valid to speculate the advantages and disadvantages of the use of these tools for 3D modelling, taking the hermitage church of *Santo André do Outeiro*, our case study, as an example.

Located in a private property, gaining access to the hermitage church of *Santo André do Outeiro* is easier said than done. Working around fences and closed gates, always with the possibility of having the access obstructed at the end, the visitor may not even be able to find the monument at all. Although this is a main problem for most heritage monuments in Montemor-o-Novo's region, given that more than 90% is located on private property with difficult accessibility (Município de Montemor-o-novo, 2010) – either by the use of fences by proprietors, animals on the vicinities of the sites or other natural conditions –, photogrammetric 3D scan may be an easier solution for three dimensionally visualize locations not easily visitable by the general public. Obviously, the barrier of accessibility is also an issue to the archaeology professionals or investigators. So once again, 3D recording is the viable solution, allowing a rigorous recording of the structures' state at a precise date. This also makes the study feasible for future investigators who may not be able to reach the monument or, if the monument ruin state worsens, can successfully study it from the safety of a computer. The photogrammetry three-dimensional scan, which we used in the hermitage church of *Santo André do Outeiro,* is not harmful or intrusive to the monument.

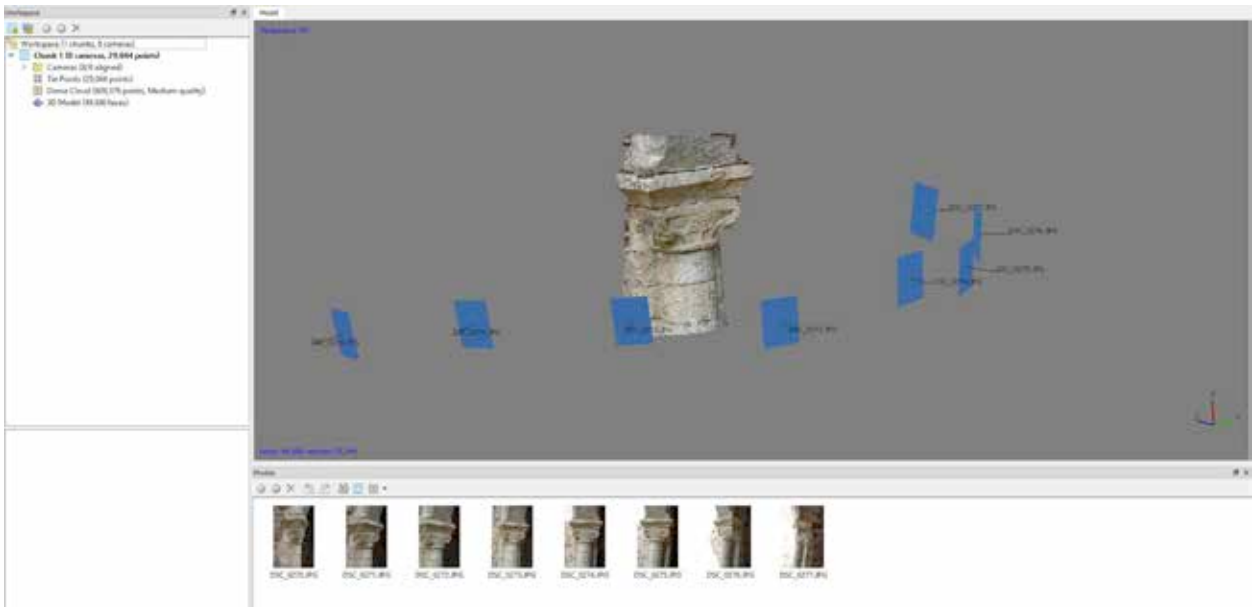
Besides 3D scans, with 3D modelling and the visual component that it adds, the potential to attract the attention of the public, as well as the political power for the necessity of the monuments' preservation, is maximized. All this by easily breaking the barrier between the scientific knowledge and general public interpretation. With this in mind, and on the prospect of a more globali-

9. This is the reason why the 3rd phase is not represented on the CAD 2D drawings.

zing and technological world, these kinds of studies with 3D reconstructions can reach new audiences with the help of social networks and grasp interested people that otherwise would never have access to such information. Nonetheless, these kinds of visual interpretations of the past in three dimensions can condition the vision of new investigators. As believed in marketing, an image is much stronger and memorable than any written essay. Therefore, the necessity for the maximum scientific accuracy when modelling a virtual reconstruction is of the utmost importance, even if we should always take into account the subjectivity of the author.

Scientific communities should also bear in mind that a virtual reconstruction should never be regarded as finished. In face of newer archaeological findings or theories, the 3D model can be changed at any time. Also, the author can speculate several theories or ideas on the virtual model without direct implications to the monument itself. Studying an archaeological site for the production of a three-dimensional model is also more detailed than a non-interpretative study of the architectural structure. Virtual reconstruction in 3D also suffers from the same inconveniences of public archaeology. Since it is a strong image that is being created, the potential to attract unwanted attention in a broader audience is also greater and therefore recreating the monument in 3D and making it public, should always be followed by some sort of 'monument awareness' to the public office that supervises heritage. Avoiding pillage and vandalism and, by consequence, accidents and irreparable losses should always

3. For the apse itself, with 45 photographs introduced to Photoscan Pro, we obtained a dense cloud of 10.492,338 points on high quality, which then produced a mesh of 1.059,208 vertices.

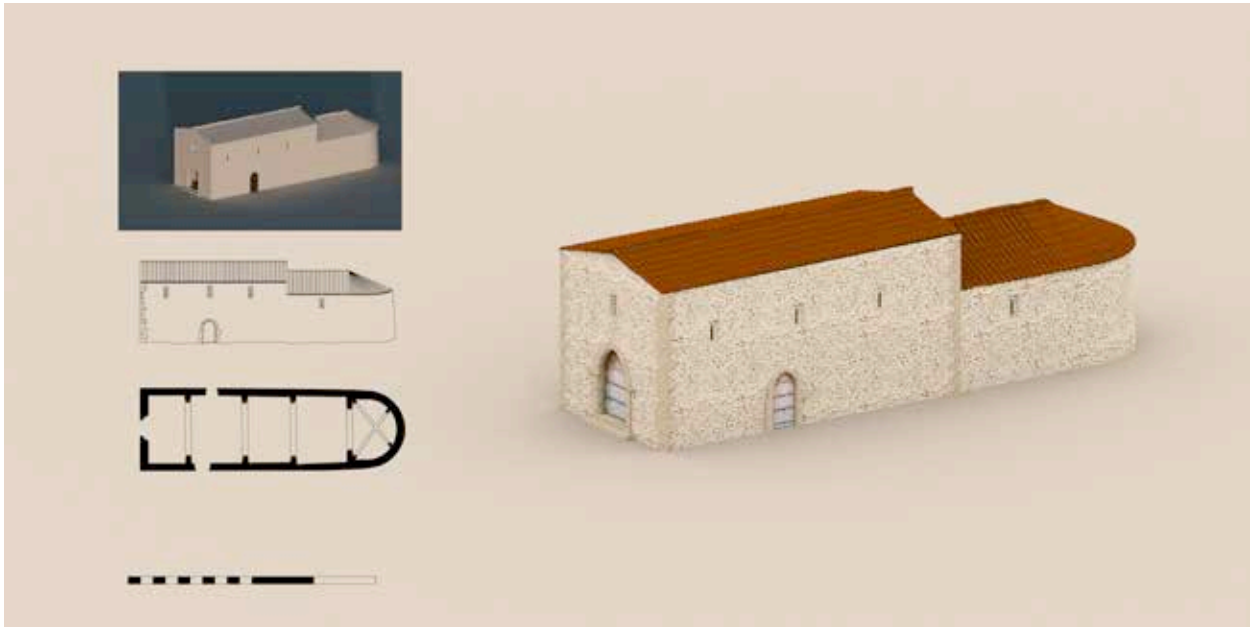


4. For the chapter of the column of the apse arch, we recorded 8 photographs while walking around it. On Photoscan Pro these photos provided a dense cloud of 609,376 points, on medium quality, to make a simple mesh of 25,349 vertices.

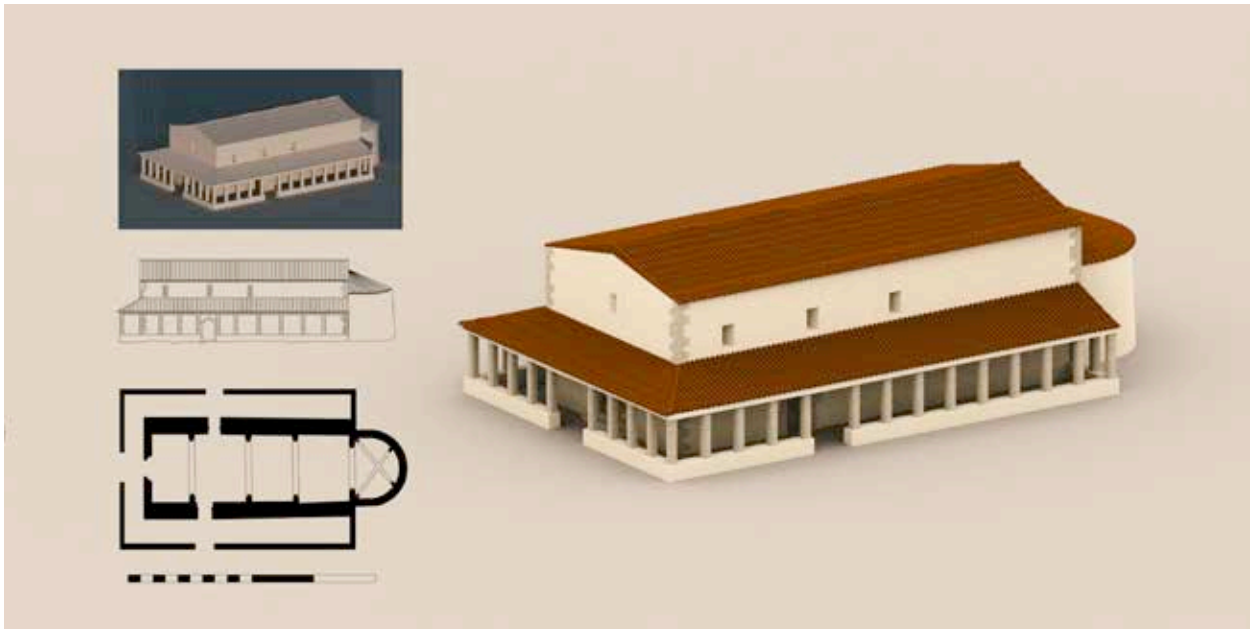
be the priority of heritage professionals. Thus, the virtual reconstruction in three dimensions should be followed by a careful communication that allows the creation of knowledge in an easier way, as well as empowering communities to protect their own heritage.

METHODOLOGY - A NEW VISUAL APPROACH TO SANTO ANDRÉ DO OUTEIRO

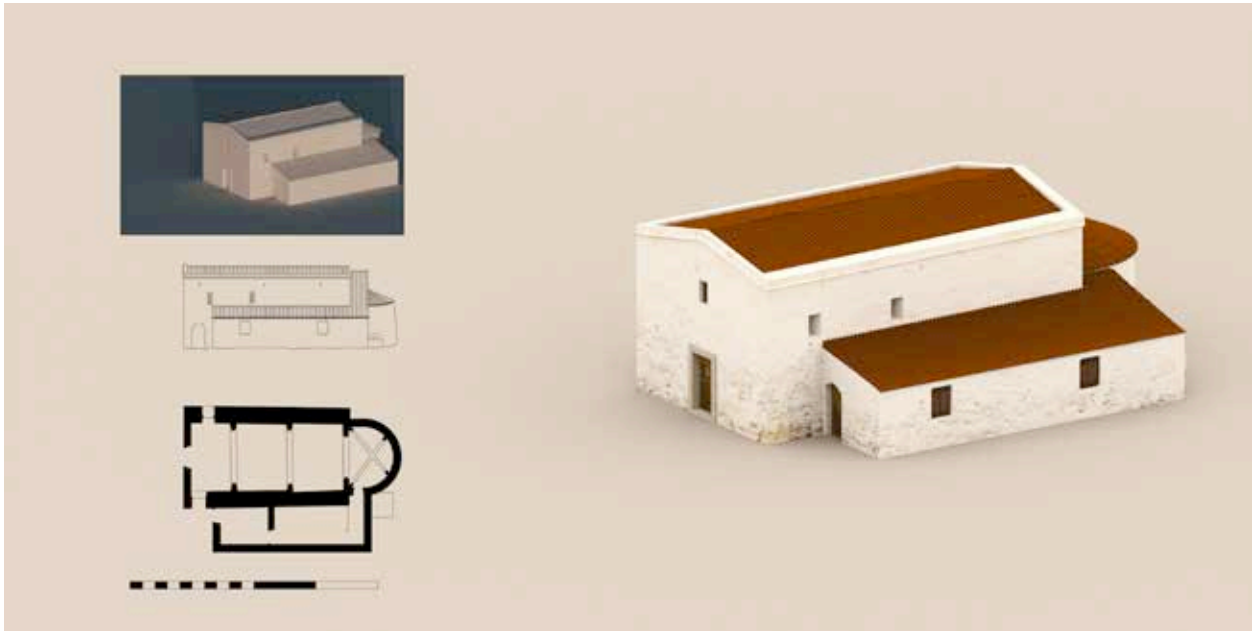
For the virtual reconstruction model, we used photogrammetric 3D scans resorting to the commercially available software Photoscan Pro, which relies upon local processing of the image data provided by the user. For this work specifically we only needed two specific 3D scans: the apse and one of the apse arch chapiters since for the rest of the structure Gonçalo Lopes had provided us with his own 2D CAD drawings (Lopes, 2008, p. 55-80). For the three-dimensional modelling of the virtual reconstruction, the open source software Blender was used, taking advantage of the graphic engine Cycles for the final renders. This was both used on the still images produced (and seen below) and on the animation for the video published on Morbase's channel on Youtube. This video is also available on the project's website - www.montemorbase.com. The renders were all produced using the orthographic view, instead of the perspective view, to provide the mock-up model appearance. On the still images/renders we introduced the 2D CAD drawings, with the permission of the author, to serve as reference to the three dimensional virtual reconstruction.



5. 1st phase: late 13th century - early 14th century. This is the aspect of the first construction phase of the hermitage church of Santo André do Outeiro.



6. 2nd phase: still during the medieval period. As it can be seen in comparison with figure 5, the walls of the building were reinforced, and the last extension of the nave was increased in height. Also the galilee can be seen against the sides of the hermitage church.



7. 1st quarter of the 17th century. In comparison with figure 6, we can see that the facade was drawn back on this phase. Also the side doors were closed and the galilee disappeared to give place to the house of the hermit. The building also gained a cornice on top.

8. Interior view of the changes between the 3rd (left) and the 4th (right) phase, with the implementation of the vault roof in substitution of the wooden roof and the drawback of the fasade on the right interior view with the elimination of one of the arches.

3D VIRTUAL RECONSTRUCTION AS A TOOL FOR PUBLIC ARCHAEOLOGY

The objective of this virtual reconstruction of the hermitage church of *Santo André do Outeiro* was the production of a video that could be published online and also on Montemor-o-Novo's heritage related exhibitions. The narrative discovered on this medieval monument's stratigraphic layers was a story worth telling to the local community but it needed a 'translation' to the general public. A story that should be told via the overlap of the various phases, from the medieval period to the 17th century, a key element for understanding the site and its importance. The narrative of a curious monument, rare because of the architectural options that were assumed during its several construction phases. A monument that lives on the brink of ruin and desperately needs attention, desperately needed public archaeology.

'Public archaeology is where professional archaeologists work with public interests, upholding legislations designed to preserve ancient sites and finds, curating museum collections, presenting the past to the general public, working with developers to reduce the impact of building and construction projects on the remains of the past. Most archaeologists now work in public archaeology rather than in universities, the traditional home of academic archaeological research' (Renfrew, 2005, p. 164). However, nowadays Public archaeology seems to be more than that, more than the transmission of information to the general public, more than the defence of heritage laws and developing the awareness of construction workers. Today, public archaeology is the translation of the heritage notion itself and the gathering of the communities around heritage promotion, conservation and protection. With this step forward, the public is also an agent. The idea is to awake in the communities a sense of belonging that leads them to be more mindful of their own heritage, to protect it, to investigate it, and also to assist in the production of knowledge[10].

Scientific knowledge should not be either a secret or exclusive of its own investigators. Scientific knowledge should be decoded, translated and transmitted to the general public. However, public archaeology does present us some ethical problems, namely in the moment of sharing knowledge and how it is done. To what extent and how should archaeological discoveries be published? Bearing in mind that the attention of pillagers could be drawn. To what extent should archaeological artefacts be removed from its original context to be preserved and defended? To what point do they lose their historical value if taken out of said context? To what extent could the communities extrapolate the sense of belonging and commit acts that could harm, if not hinder, the promotion of the archaeological knowledge? These are many hard questions and for which it is hard to formulate only one precise answer. Every case should be evaluated individually since a rule that could be applied to each and every one of them, and that could solve every heritage problem doesn't exist. Nonetheless, educating people in understanding their heritage may not be the final solution but may ease the problems that often come from neglect. If it is broad, it could help decrease vandalism. If it is persistent, it could help decrease plunder or illegal traffic of archaeological artefacts. Only then, will the act of recovering an archaeological artefact and taking it home become condemnable in the eyes of a wider range of the community members. It is necessary to raise awareness of a common heritage, which is not only the property of a single individual, but of all of them. These are processes that do take their time and do raise a lot of discussion and it is up to us, heritage technicians, historians and archaeologists, to stand by them.

10. As should be common in scientific areas such as industrial and ethnographic archaeology, but not only.

HYPOTHESIS VS. FACTS

NICOLA SCHIAVOTTIELLO

The study of the 3D model with scientific validity, intellectual transparency, tracking and updating of the information for the final interpretation, has become a hot topic during the recent years. However, proposing multiple hypotheses not only to the specialist, but also to the public, is a very important aspect in archaeology and cultural heritage 3D reconstruction.

Problems that have arisen since the diffusion of 3D virtual environments of cultural data, revolve mainly around the scientific rigour of up-datable and transparent digital reconstructions. This issue has been tackled, among others, in the Londoncharter (Denard, 2009) and the Principle of Seville (*The Seville principles 2011*). Although there are still many projects that do not strictly follow these guidelines we further considered these guidelines should be applied also when communicating directly with the public. In short, we agreed the necessity to find a way to maintain the scientific rigour not only at the research stage, but also to show the research methodology that has been followed, in the final commercial outcome. An effort is being made in this direction by revealing the research process and presenting the theories as such rather than as facts. Some recent projects use the implementation of evidence maps, devices that can be quite effective in order to maintain a visual recognition of the hypothesis. Even if they still remain a static device, they can be considered a big step towards the transparent communication of a specific site. Another central problem is the difficulty of updating information when more evidences appear after the models are published. We can see how this problem could be solvable with the deployment of real-time environments. Moreover, with the advent of augmented reality, real and virtual environments are rapidly merging, giving the possibility to correct hypothesis and visualizing them on-site. This will eventually open new frontiers of digital interpretation in cultural heritage and archaeology.

The work of Martino Correia shows a series of techniques that cover the whole process from documentation to interpretation, allowing to explore the site with these new techniques and giving the possibility of site interpretation in a new digital form.