# CGI STORYTELLING IN ARCHAEOLOGICAL AND CULTURAL HERITAGE PUBLIC INTERPRETATION

## SCIENTIFIC FACTS OR HOLLYWOOD MOVIES?

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**RESUMO** Nesta mesa-redonda discutimos algumas estratégias metodológicas recentes para visualização computorizada do património cultural e arqueológico, com e sem narrativas histórico-arqueológicas. Paralelamente, examinamos os factores qualitativos e emocionais muitas vezes essenciais para se conseguir comunicar factos derivados da investigação científica. Integrámos projectos recentes que usaram técnicas CGI de modo a comunicar ao público as histórias construídas, depois do desenvolvimento da pesquisa arqueológica. Assim, o objectivo final desta mesa era abrir a discussão sobre a actual situação da visualização CGI nas práticas arqueológicas e do património cultural. A intenção era associar investigadores com diferentes experiências de modo a abordar o assunto a vários níveis e diferentes perspectivas. Para tal convidaram-se os presentes investigadores para apresentarem o seu trabalho de estudo, construção e divulgação de distintos conteúdos sobre o património cultural. Os temas discutidos basearam-se tanto em exemplos teóricos como projectos reais, uma vez que era necessário manter uma discussão profunda não só sobre as técnicas de visualização antigas e actuais, como também sobre os novos e apurados métodos de escavação e reconstrução digital que tornam os seus resultados mais apelativos para o público em geral.

**PALAVRAS CHAVE** CGI, narrativas histórico-arqueológicas, comunicação, divulgação, património cultural

**ABSTRACT** In this roundtable we discuss recent methodological strategies for computer-based archaeological and cultural heritage visualization with and without archaeological and historical narratives. Moreover to examine the qualitative and emotional factors often essential in order to communicate facts deriving from a scientific research. We have welcomed recent projects that made use of CGI techniques in order to communicate to the public the constructed stories, after an archaeological research has been pursued. The final purpose of this session was therefore to open a discussion on the current situation of digital CGI visualization in Cultural Heritage and archaeological practice. The intention was to put together investigators with different background experience in order to approach the issue at various levels and with different perspectives. This has been achieved by inviting to present the work of researchers involved in the study, the construction and the divulgation of different cultural heritage contents. The themes discussed were both theoretical and real project examples, this is because it was necessary to maintain not only a vivid discussion on the principle of past and modern visualization techniques but also on the new accurate surveys and digital reconstruction methodologies that make these final outputs more appreciable by the general public.

**KEYWORDS** CGI, archaeological and historical narratives, communication, dissemination, cultural heritage

# INTRODUCTION

**NICOLA SCHIAVOTTIELLO**

In the last two decades the exponential production of CGI (Computer Graphic Imagery) in archaeological and historical visualizations for the public has reached a point where computer-based visualization has become an integral part of archaeological and cultural heritage representations. On a commercial level, historical blockbuster films and realistic video games are shaping our perception of the past. This could be because the aesthetic and visual language used by fiction has become more effective and believable than scientific publications or documentaries (Daverio, 2013). A lot of scientific TV programs and documentaries have long adopted different cinematic styles as a way of communicating with the public becoming a true new genre to be watched also at the cinema. In 2013 documentaries accounted for a good percentage of the Cannes Film festival.[1]

It can be said that nowadays the objective of this productions is not only to recount the facts but also to involve the audience and to propose an emotional experience such as in fiction. This is often achieved, as in fiction, by trying to make the viewer emotionally connected with a character (Alderson, s.d.) or by deeply engaging with a digitally rebuilt historical place.

On the other side contemporary aesthetics in digital communication of archaeological and historical researches are sometimes trying to achieve the same goal in order to engage more with the public. However, the lack the cinematic qualities compared to any blockbuster titles is still quite evident when presenting the final product. This happens because the work of a researcher that learns how to operate the visualization tools cannot replace the one of a CG (Computer Graphics) production company professional, specialized for such a task. Even if some excellent cinematic examples of archaeological virtual reconstructions have been produced (see for example the work of Eduardo Barragán[2] and also the latest work of our author Carlos Carpetudo[3]), in general the DIY philosophy does not always succeed for various reasons: such as the presence of a hard learning steeping curve when using 3D programs, the lack of understanding of special communication languages and other type of intrinsic cinematic properties (Schiavottiello, 2016). This is leading to the perpetuation of an entanglement between Virtual Archaeology and CGI in digital heritage communication.

We certainly agree with Benicho when he argues that: *'virtual reconstruction that include a large number of elements that have not been verified either archaeologically or historically cannot be considered as virtual archaeology, but rather as historical narrative, in other words, a genre in which reality and fiction become blurred, in which it impossible for the viewer or the public to distinguish between the two. The same thing occurs between history book and historical novels or between documentaries and filmed based on historical facts.'* (Benicho, 2013, p. 270)

Nonetheless, besides scientific research based on 3D documentation, virtual reconstruction, 3D digitization, virtual anastylosis and in general digital scientific visualization, CGI has become a fundamental tool in the formulation of cultural heritage's facts divulged through narratives to be enjoyed by the public.

Drawing from Benicho, but taking our argument forward, we argue it is important that CGI in cultural heritage, though deeply rooted on Virtual Archaeology, should be addressed for the public as a different part of the production of Cultural Heritage knowledge, oriented to communicating a narrative that is non-the-less scientific.

On one side archaeological research needs to feed from the public appreciation of visual hypotheses of each presented project, while on the other, the public is often looking for an emotional experience when attending an exhibition, visiting a museum and, with recent mobile augmented reality technologies, looking at an archaeological site. CGI interpretation for the public can be considered a different beast from the apparently closely related scientific one. Whereas the former is still usually derived from the latter, we can argue that CGI in archaeological and heritage's visualization for the public should derive from the definition of heritage's interpretation, especially referring to the Tilden's vision (Tilden, 2007 [1957]).

On the semantic level, we need to reflect on how the story can reveal the specificities of the archaeological way of knowledge. So being archaeology a scientific and a humanistic discipline at the same time, the language or languages that are chosen, in order to promote such knowledge, should be encoded with a rigorous and transparent methodology but also in a simple and stimulating way. In turn the necessity is not only to validate the accuracy of the research data and the process to represent them, but also the accuracy of the storytelling and to present it in an appealing visual form to the final audience.

Although this process can result time consuming and expensive, if the aim is to create realistic representations, due to the relatively complex and closed nature of the used tools, the gap that divides real-time and rendered imagery is rapidly fading (Lebowitz *et al.*, 2011), eventually coming to a point where there will be virtually no quality differences between a 3D real-time environments and the rendered ones (see for example the work of Benoit Dereau[4]). This situation opens amazing possibilities because, within a 3D real-time environment, edibility is much easier than in post-production (in this sense we don't refer only to the use of complex video games engines, but to the use of a sandbox like editable

1. http://www.economist.com/blogs/prospero/2013/08/rise-documentary-film. Access date: 25/04/2016.
2. http://italicaromana.blogspot.pt. Access date: 21/02/2016.
3. https://www.youtube.com/watch?v=TnBuJ1PM2TA. Access date: 03/04/2016.
4. Benoit Dereau is an architectural visualization professional using the latest Unreal Engine 4 [http://www.benoitdereau.com. Access date: 22/03/2016].

real-time environment or easy architectural visualization tool such as LumenRT[5] or Lumion[6]). In the area of 3D storytelling for education a very interesting tool is V-SIM[7] which gives the possibility of virtual storytelling starting from real archaeological and historical resources. While archaeological practice can lead to new discoveries and therefore can furnish the basis for the reconstruction of an accurate or less accurate static 3D models, in order to describe these models to a broader audience we need to fill these 'ghost-like' environments with historical events. The form that we use in order to tell the story can highly influence the final product and its message. Historical facts can be transmitted in various forms. However, it is mostly the level of engagement with the public and its emotional side that determines the success of such a communication. Recently, with the advent of hyper-realistic 3D graphic environments and characters, not only in films and TV drama series but especially in more interactive form of media such as video games, we are rediscovering a new way of telling our history, mainly to the young audience. We can argue that these methods are effective for a particular audience. We can also compare interactivity with more linear form of storytelling, although games engage in a form of interactivity where one is compelled *to play* in order to interact. Historical video games are probably as old as video games themselves, showing how this formula (history + game) successfully propagates from generation to generation and demonstrating also how graphic realism is not the only key issue for the success of this genre. In this context we can certainly reference the work of Filipe Penicheiro which in an interview available online[8] explained how video games have an important relevance in the field of education, and more specifically in teaching history. He states in his article that the *'educational value of games is not a secondary product of their ludic dimension but rather there is a confluence between the construction of scientific models that can simulate the construction of society.'* (Carvalho and Penicheiro, 2009). The told stories, in this case, are intended as both hypothetical and factual. The focus here is not only on the scientific validity of the initial raw data and their scientific interpretation, but especially on the methodology used when communicating the final story, or different stories, to the public and how the public has perceived them. In contrast, we can discuss the 3D modelling and the acquisition processes not only as simple documentation techniques, but also as a research tool in order to exploit a specific studied site or artefact. Doing so, we tried to understand if it is possible to communicate in an easy and engaging visual form the scientific, archaeological and historical discoveries and the processes that formulate the hypothesis. Drawn from these conclusions we delineate the main topics of the discussion and the critical approach that we should always maintain when using CGI for the reconstruction of our past.

5. http://www.lumenrt.com. Access date: 21/03/2016.
6. https://lumion3d.com. Access date: 21/03/2016.
7. https://idre.ucla.edu/research/active-research/vsim. Access date: 25/03/2016.
8. http://www.uc.pt/noticias/07_NL_2010/nUC01_072010. Access date: 25/03/2016.

## THEORETICAL REVIEW

We opened our session with Ricardo Dias (researcher of the Faculdade de Letras of the University of Porto, Departament of Heritage Science and Technology), who gave us an introductory talk showing the different languages and techniques of the CGI, digital reconstruction and their validity when used in the cultural heritage material context. After reviewing the different techniques spanning from the earlier 1970's up to contemporaneity, he presented a case study showing different methodologies and tools used for both: the study and the conservation of material cultural, with those used for the cinematography and video games industry. This inside review permitted to find the basis for a confrontation on the decoding of how cultural heritage digital representation and communication has evolved alongside its techniques. Initially, Ricardo defined the meaning of the word CGI and most importantly the areas in which this technique is applied. In this case we can say that the possibilities are many within the visual communication paradigm such as *'arts, films, television programs, videos, etc…'.* He then moves to some of the most emblematic examples, related to heritage, within the film and video games industry such as Gladiator and the Assassin's Creed series. He asserts that during the production stage a team of historians and researchers was consulted.

Although the concept of digital reconstruction starts only in the 21st century, he cites Albrecht Meydenbaue, a pioneer from the previous century, who for the first time explored photography as a mean of documentation for monuments that were damaged; this was a 2D technique that he used it in order to project a possible reconstruction.

In this sense the different between digital heritage reconstruction and CGI according to Ricardo *'is the form in which we present the data, throughout specific storytelling and utilizing as matrix for the graphical component'.* He then presented an example of his major work (Dias, 2014) which was the reconstruction of two Portuguese castles depicted in the *Livro das Fortalezas* [Book of Fortresses] of Duarte de Armas (Dias, ed., 2016),a book that contains the drawings and descriptions of almost all the castles at the borders of Portugal in 1509-1510. After showing his reconstruction methodology and workflow of the latter he resumes his intervention with some important final points. One is that CGI is just a tool to reach an objective and is not restricted to the film industry, since nowadays video games are quite affordable and its learning is more understandable. Second, we should not state that CGI is something that presents scientific information because it is up to each researcher to determine it. And, finally, we should always rely on the most innovative graphic forms.

## SCIENTIFIC INTERPRETATION VS. INTERPRETATION FOR THE PUBLIC

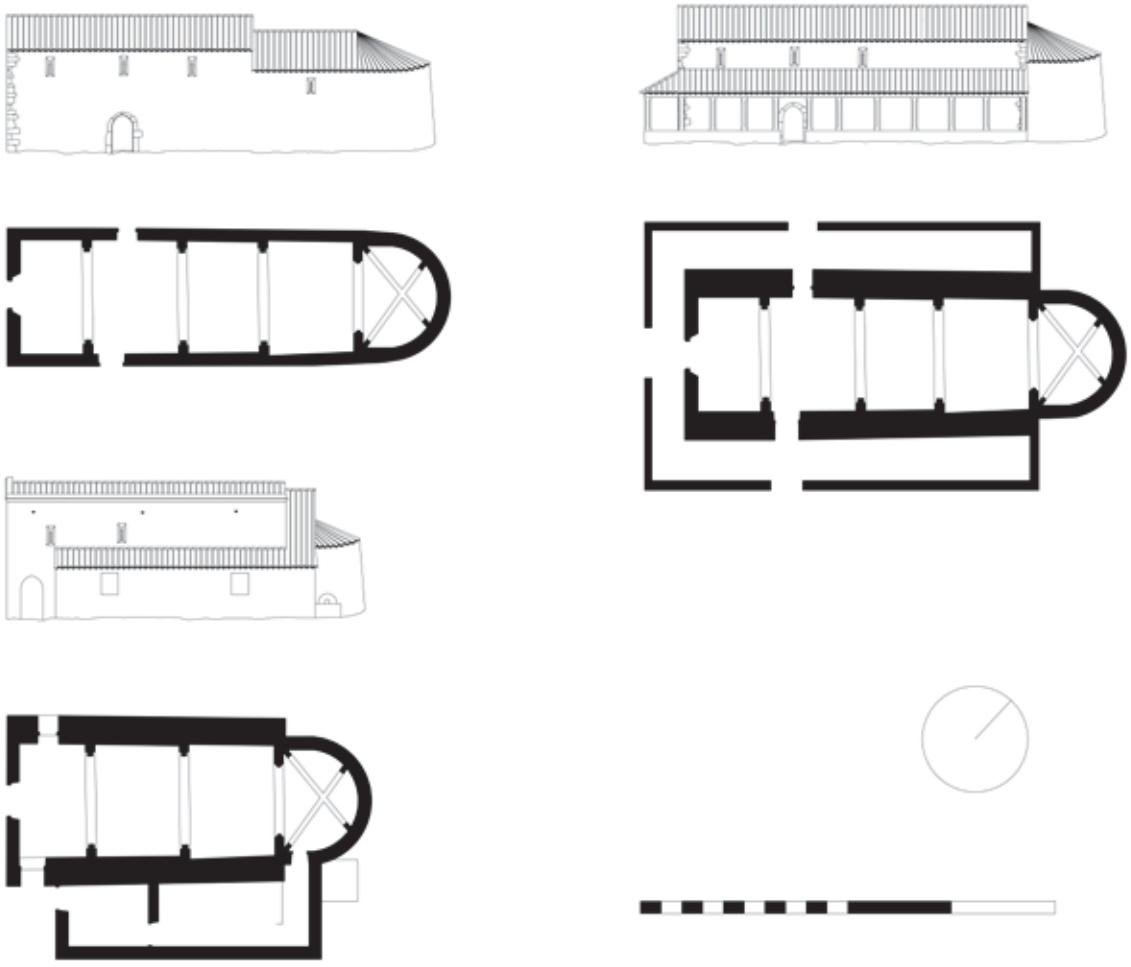
We discussed the role of 3D virtual archaeology compared with CGI communication for the public and argued that, since the beginning of CGI in archaeological re-

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.

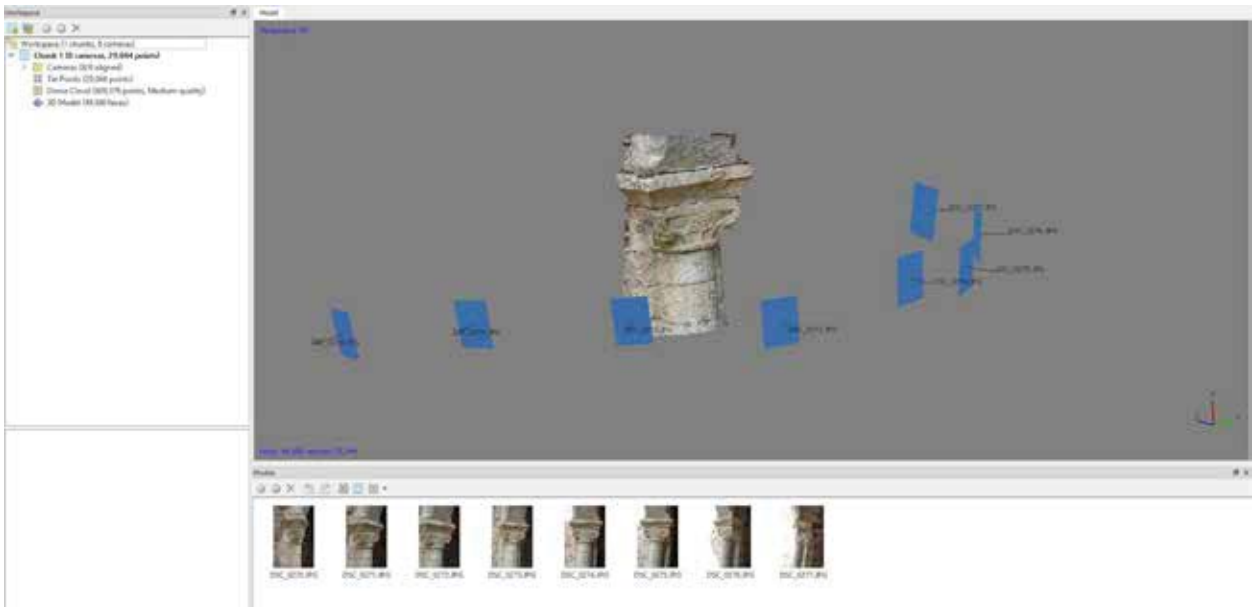
Besides 3D scans, with 3D modelling and the visual component that it adds, the potential to attract the attention of the public, as well as the political power for the necessity of the monuments' preservation, is maximized. All this by easily breaking the barrier between the scientific knowledge and 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.

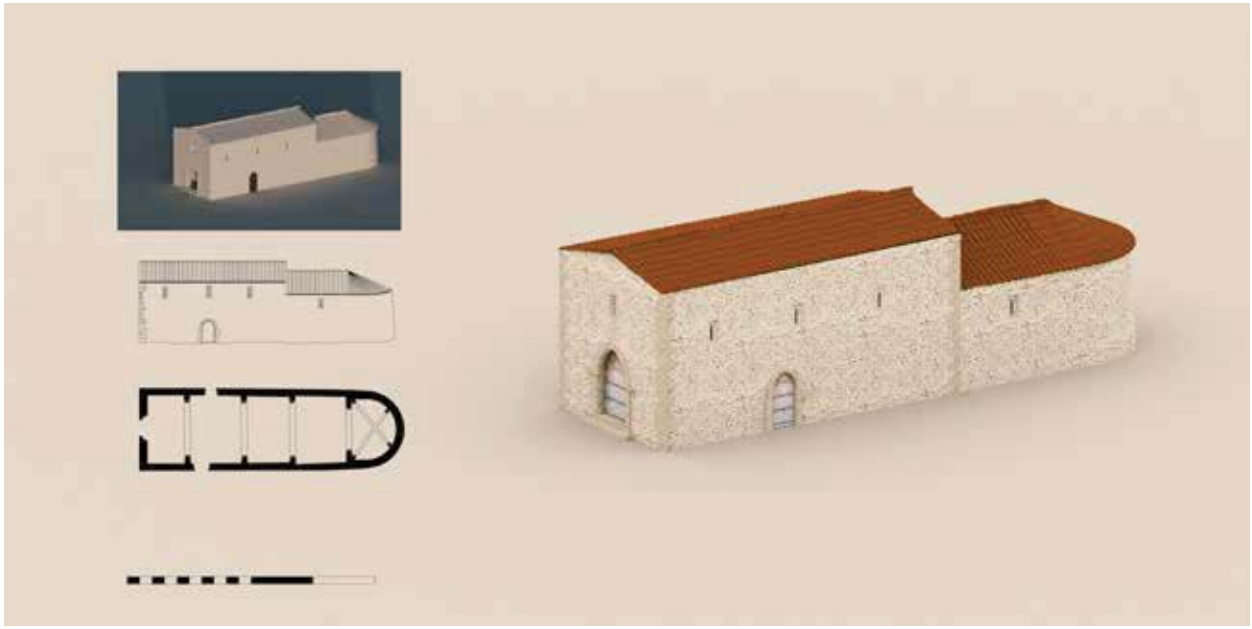


4. For the chapter of the column of the apse arch, we recorded 8 photographs while walking around it. On Photoscan Pro these photos provided a dense cloud of 609,376 points, on medium quality, to make a simple mesh of 25,349 vertices.

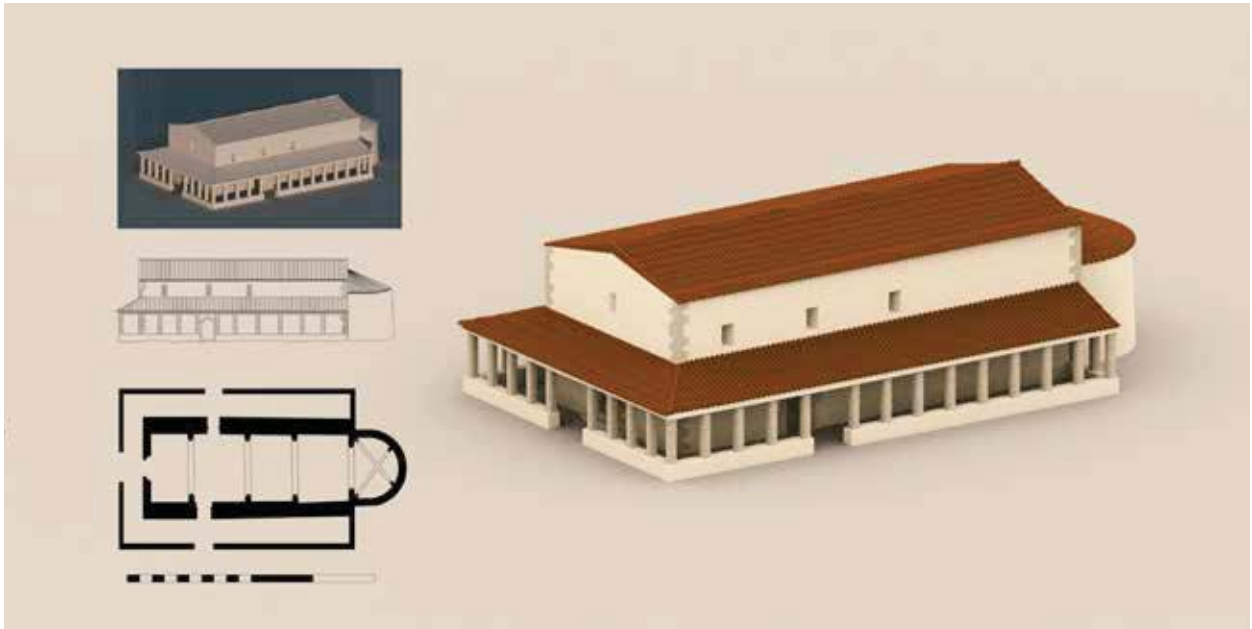
be the priority of heritage professionals. Thus, the virtual reconstruction in three dimensions should be followed by a careful communication that allows the creation of knowledge in an easier way, as well as empowering communities to protect their own heritage.

### *METHODOLOGY - A NEW VISUAL APPROACH TO SANTO ANDRÉ DO OUTEIRO*

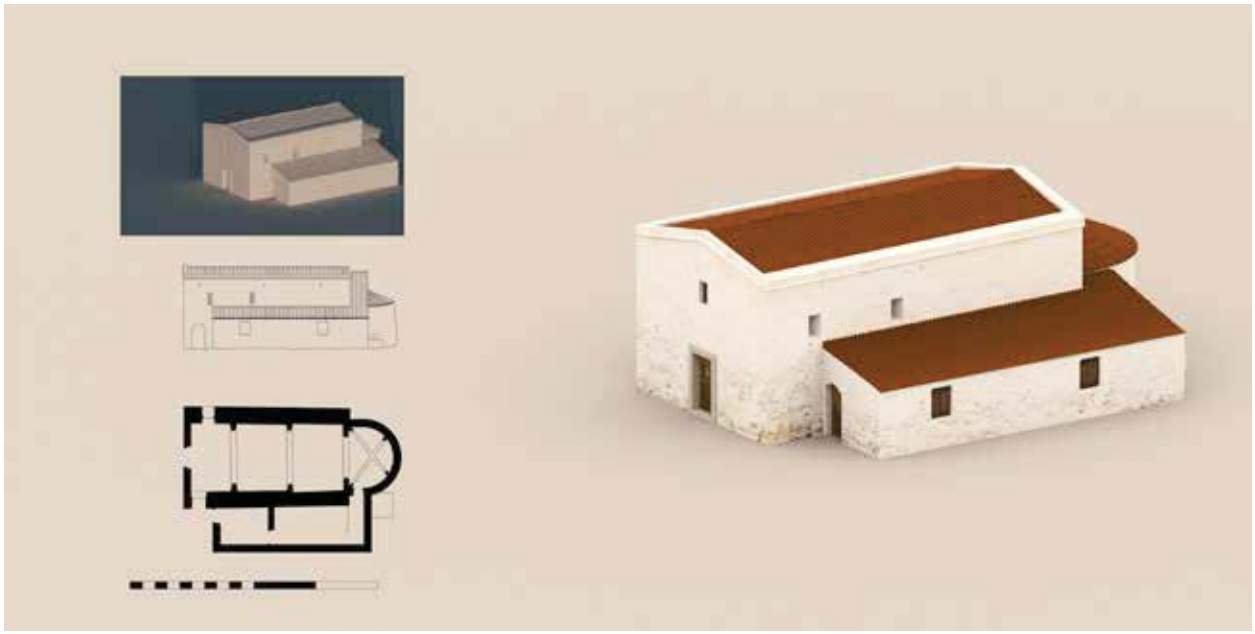
For the virtual reconstruction model, we used photogrammetric 3D scans resorting to the commercially available software Photoscan Pro, which relies upon local processing of the image data provided by the user. For this work specifically we only needed two specific 3D scans: the apse and one of the apse 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.

# VIRTUAL RECONSTRUCTION OF THE TEMPLE OF PAX IULIA'S FORUM (BEJA, PORTUGAL). DIGITAL TECHNOLOGIES AS A BRIDGE BETWEEN PUBLIC AND CULTURAL HERITAGE

**MARTINO CORREIA**

The purpose of this presentation was to address the potential of digital technologies as a bridge between the public and cultural heritage (specially concerning archaeological heritage), using a central case-study, the virtual reconstruction of a Roman temple, located in the forum of Pax Iulia (Beja, Portugal). This specific case is a reflection of several issues of that may be a contribution to the debate generated in the roundtable around the topic 'CGI in archaeological and cultural heritage public interpretation: scientific facts or Hollywood movies?'

The presentation started by giving a few remarks on the concept of model, emphasizing its nature as representation. Like it was defined by Massimo Limoncelli, the model is essentially a graphic or plastic concretization of a prefiguration, always implying a certain degree of simplification (Limoncelli, 2012, p. 119). As such, the application of digital 3D models to the virtual restoration in archaeology and heritage must take into account the degree of subjectivity inherent to any representation or interpretation. To say that the use of models implies certain degrees of subjectivity does not mean, however, that 'virtuality' is a synonym of 'illusion' or 'fake' (Lévy, 1996). Virtual reality is essentially a non-material and non-concrete reality that exists outside our physical dimensions, and yet having a certain degree of immersion (Limoncelli, 2012, p. 17). Virtual archaeology and virtual restoration are subjects that, by definition, manipulate virtual reality to study, recover and present past realities. How to incorporate 'virtuality' in the creation of discourses about the past and how to deal with its subjectivity (making it transparent to the user, so that the model does not function as an illusion) are key aspects that must be addressed.

As already was pointed out by Mark Gillings, the initial reaction of the public (both the general public and the specialized public), when presented with an archaeological reconstruction, tends to be variation of 'How realistic is it?' (Gillings, 1997). A possible way to answer this question might be the use of such tools as the Scale of Historical and Archaeological Evidence (developed by César Figueiredo and Pablo Aparicio Resco), which assigns a chromatic scale to the different levels of speculation and certainty involved in each component of a virtual reconstruction (Figueiredo and Aparicio Resco, 2014). Offering an immediate way of visually recognizing these different degrees of certainty and speculation, this tool might be a way to better educate the public and specialists alike on how to deal with virtual archaeological reconstructions. A generalized awareness of the subjective nature of digital restoration and reconstruction, and the possibility to accurately visualize this dimension in each component of the final model, may contribute to avoid the danger of the representation overcoming the original. This phenomenon, when the representation becomes 'more real than the real', was first described by Jean Baudrillard in the beginning of the 1980's, who coined the term 'hyper-reality' (Baudrillard, 1981).

When one thinks about the risks that endanger cultural heritage, usually factors that may threaten its physical dimensions come to mind (destruction by violence or natural catastrophes, neglect and abandonment, theft…). However, there are other risks, perhaps more subtle and more difficult to detect (especially if one is not conscious of them). The phenomenon of the hyper-real, as it involves a conceptual 'destruction' of the artefact, monument or space (and not a 'destruction' in a physical sense) is thus more elusive. This may assume multiple manifestations, either in contexts of dissemination and contact with the public, or in contexts of investigation and research. For example, it is easy to imagine, in a museological exhibition, that models and representations (especially when presented in seductive technological displays) may easily eclipse the original object in the eye of the visitor. Similarly, models used in research may delude unaware investigators by presenting simplified versions of a much more complex reality that may easily be neglected. So, to avoid all these traps, it is of the foremost importance that everyone in contact with representations of cultural heritage (from the public to professionals) is aware that models are nothing more and nothing less than representations, with all their inherent limitations and potentialities. Educating the public and professionals to correctly deal with representations in cultural heritage is then a necessity, a necessity that should be a concern to the different institutional actors (schools, universities, museums, cultural institutions…).

The digital restoration of the Roman temple of Pax Iulia is part of a much larger project, the Archaeology of the Cities of Beja [Arqueologia das Cidades de Beja] project (Lopes, 2010). It is an urban archaeology project that had its origin in the archaeological research started by Maria da Conceição Lopes, carried out initially to achieve a better understanding of the Roman past of the city and its territory (Lopes, 1996; 2003). However, the chronological limits of this research and analysis go far beyond the Roman period, aiming to obtain an integrated image of the long diachronic dynamics that influenced the evolution of this urban historic landscape, located in the south of Portugal. In addition to archaeological data, this view on the city's evolution resorts to other kind of studies, such the archaeological-geographical analysis of its urban morphology (Chouquer, 2012). Such an approach, moreover, fits perfectly with the nature of this urban context, since Beja has known a continuous occupation from at least the second half of the 1st millennium B.C. to the present day (Grilo, 2007). The excavations in the forum are a perfect illustration of this complex reality.

During the excavations in this area, it was possible to identify several prominent structures. For instance, archaeologists were able to identify such important elements as a large dry stone structure (probably dating from the Iron Age), Islamic and medieval domestic structures or a 16th century mint workshop. But the most iconic elements are arguably the two Roman temples. The older temple is of smaller dimensions and is still largely unknown, mainly because the water deposit that supplied Beja for decades was built on top of this temple. The later temple, of bigger dimensions, has the particularity to be surrounded on three of its sides by water tanks. This feature, however, is not unknown in Roman temples in the region and has close parallels in the well--known Roman temple of Évora, some 60 km north of Beja (Hauschild, 1986; Hauschild and Sarantopoulos, 1995/1997; Hauschild, 2010). This second Roman temple was first identified by Abel Viana during the construction works for the installation of the already mentioned water deposit (Viana, 1942; 1947). Nevertheless, only during the recent archaeological excavations taking place in the historical centre of Beja it was possible to fully study this monumental structure and have a clear perception of its dimensions. The temple was, however, largely destroyed. Only the inferior part of the podium is present, as well as the much of the water tank floors (with the presence of large surfaces of *opus signinum*). Presenting a 3D digital reconstruction of the temple has been, thus, quite problematic.

This work of digital reconstruction owes much to José Luís Madeira (from the Institute of Archaeology of the University of Coimbra), who had already created some bi-dimensional reconstructions, proposing some informed hypothesis for this monument. This reconstruction was based, of course, on the archaeological data collected on site and the architectural record of the preserved ruins. The theoretical principles of Vitruvius, defined in his *De architectura – Ten Books on Architecture* (Portuguese translation by Justino Maciel, 2006), were also taken into account. However, these principles were at all moments critically read and compared with parallels known in the western region of the Roman Empire (Gros, 2011, p. 151-160; Stamper, 2005), particularly the temples of Mérida (Spain), Nîmes (France) and Évora (Portugal).

This is in fact an extremely rich archaeological context but, simultaneously, a very complex one. In addition, many of the ruins are poorly preserved and/or partially visible. Because of this, it is a reality of difficult interpretation and understanding, even by more specialized audiences. Thus, it has been a challenging achievement the effective communication of the archaeological findings to the community. New ways of presenting the heritage to the public are then of most importance, and it was imperative to develop operative tools that could bridge this gap. If this is not achieved, there is a risk of not achieving a real identification by the local community (l*et al*one local authorities and political powers) with these elements of their cultural heritage, hindering the development of preservation and valorization strategies.

With this challenge in mind, the use of digital 3D models was considered as a possible answer to the problem. This allows, on one hand, the construction of visual supports to make the interpretation of the site and its structures easier and more immediate by the public. The contact with these digital models can be achieved using several strategies, with different degrees of interactivity and immersion. It can be done by the visualization of images or renderings and animations. Another line being explored is the use of interactive platforms (created with game--engine software), opening to users and visitors a more personalized experience exploring the site and virtual reconstructions.

One of the great advantages of creating 3D models will be their integration in augmented reality (AR) applications, allowing a visualization in loco of virtual reconstructions. These AR applications are being developed to Android operative systems, to be easily accessible by personal mobile devices such as tablets or smart-phones. The aim is to allow, by creating various digital environments, a more detailed exploration of the archaeological site (using also the digital photogrammetric surveys, done by Ricardo Cabral and Ana Vaz), as well as the exploration of the various proposed hypotheses of reconstruction. This strategy may boost public interest about the archaeological site, contributing to its possible affirmation, in the future, as a key tourist and cultural attraction on regional level. Using AR technology is only possible because 'reality' and 'virtuality' are the two opposing ends of a spectrum that has been defined as the Reality-Virtuality Continuum, or sometimes called the Virtuality Continuum (Milgram and Fumio, 1994). This continuum defines an area between the real and the virtual, named Mixed Reality, constituted by augmented reality (where virtual elements are integrated in a live real-world scene) and augmented 'virtuality' (where virtual environments are enhanced with live real-world data). This intricate mixture of reality and 'virtuality' opens infinite possibilities to combine these elements in new and innovative ways, according to the specific needs for each case.

Another potentiality that has been explored is the 3D printing of the models that were digitally generated. At the Centre of Studies in Archaeology, Arts and Heritage Sciences [Centro de Estudos em Arqueologia, Artes e Ciências do Património, CEAACP], in the University of Coimbra, a 3D printing of the temple's reconstruction was made, using a bq Witbox 3D printer (a work done in collaboration with Ricardo Cabral). Overcoming the barrier between 'virtuality' and materiality, a direct physical contact between the public and representations of heritage can be achieved. The handling of replicas can work at different levels, both in contact with the general public, with didactic and pedagogical purposes or used for technical discussions with a specialized audience. The use of models (either digital or physical) can, moreover, play a key role in the discussions on the heritage and sustainable development strategies between the various actors involved, allowing to explore different scenarios and simulate different solutions. It also allows some level of communication with public that would otherwise be marginalized, such as the visually impaired (Kist, 2014).

An interpretative centre is currently under construction in the vicinity of the archaeological site (the Centre of

Arts and Archaeology). This space will feature exhibitions exploring the Roman past of Pax Iulia and of the territory of the *conventus*. This will present a great opportunity to incorporate digital solutions in the museological discourse. One of these planned solutions will be the use of immersive Virtual Reality (or VR) applications. To this end, some initial tests are being carried out at the CEAACP using VR head-mounted devices (HMD). So far, these experiences involved the use of Oculus Rift and also a more low-cost solution, Google Cardboard. Digital environments can be divided according to their degree of immersion (Fernie and Richards, 2003). In partially immersive environments, users interact with virtual elements but remain aware of their surroundings. Using a desktop computer, where the interaction with the on-screen elements is make via a mouse, joystick or keyboard, is usually considered as one the least immersive stages. Other solutions for partially immersive environments may involve the use of more complex controlling devices, such as data-gloves or motion sensors. On the other hand, we can also talk about totally immersive environments, where users are no longer able to apply their senses to perceive their real-world surroundings (or to perceive very little). These higher stages of immersion are usually obtained using HDM or virtual reality goggles, which can be combined with other devices such as headphones, data-gloves, motion sensors... These arrays of devices are designed to put as much as possible the user inside the virtual environment, simulating sensations and completely altering the user's perception, while still allowing feedback from the user. Exploring how these different stages of immersion can enhance the visitor's experience in a museological context is, then, a very rich field of research, and one which will surely witness a continuous development of innovative and surprising solutions in the future.

If immersion is a topic that is currently being explored to be used in the creation of historical narratives about the Roman forum of Pax Iulia, another line of research has been interactivity. The two are, after all, deeply interlinked. As it was mentioned before, interactive solutions are being developed resorting to game-engine software. This will allow the user to freely explore the digital environments (reconstructions and photogrammetric surveys of the archaeological site). Once these applications are made public, feedback from the users can be analysed to better understand which degree of interactivity works better for each kind of public. Interactivity, while making the experience more personalized, requires a greater degree of commitment from the user. Other solutions, like watching an animation or automatic fly-through, are more passive experiences. As different publics have different expectations (based on each individual's personal background) of the museological experience. Researchers have to carefully analyse, then, which kind of solution works better in each case, and what degree of interactivity and 'free will' should be offered. If the environment requires a lot of input from the user, one can take the risk that the audience will grow tired or become confused, abandoning the experience. But if the environment does not allow any feedback, some public may lose interest in interacting with the digital application. To calibrate all these factors, so that the message is successfully transmitted to the public is then a very complex and indispensable task that the professionals involved have to consider.

The exhibitions may have fixed points where the visitors may access the interactive environments, available to everyone that visits the exhibition. However, these can also be made available on-line, to be downloaded as a standalone version (to be run either on MacOS or Windows operative systems) or accessed directly from a browser, through a web-player plug-in. This ability to facilitate distance learning and dissemination is another advantage introduced by the use of this sort of digital solutions. Besides the mentioned game-like digital environments, the creation of on-line 3D databases is another valuable on-line tool that has been utilized to cultural heritage dissemination with great results. The recent and on-going development of easily accessible on-line platforms where researchers, artists and institutions can upload and display their work (like the well-known Sketchfab platform – www.sketchfab.com) has contributed to a more widespread use of these solutions as a means to successfully establish bridges between the public and cultural and archaeological heritage. Combined with the growing use of photogrammetric software to easily capture in 3D monuments and artefacts, one may attest that the contact between the general public and digital representations is becoming more and more immediate and democratic. How to deal with these new realities is a constant debate that initiatives like this roundtable help to frame. Such a debate is absolutely indispensable. Otherwise, it will reinforce the danger of having 'virtuality' blindly accepted in archaeology and cultural heritage without a comprehensive analysis and criticism over its ontological and epistemological foundations, as Mark Gillings was long aware of (Gillings, 2000).

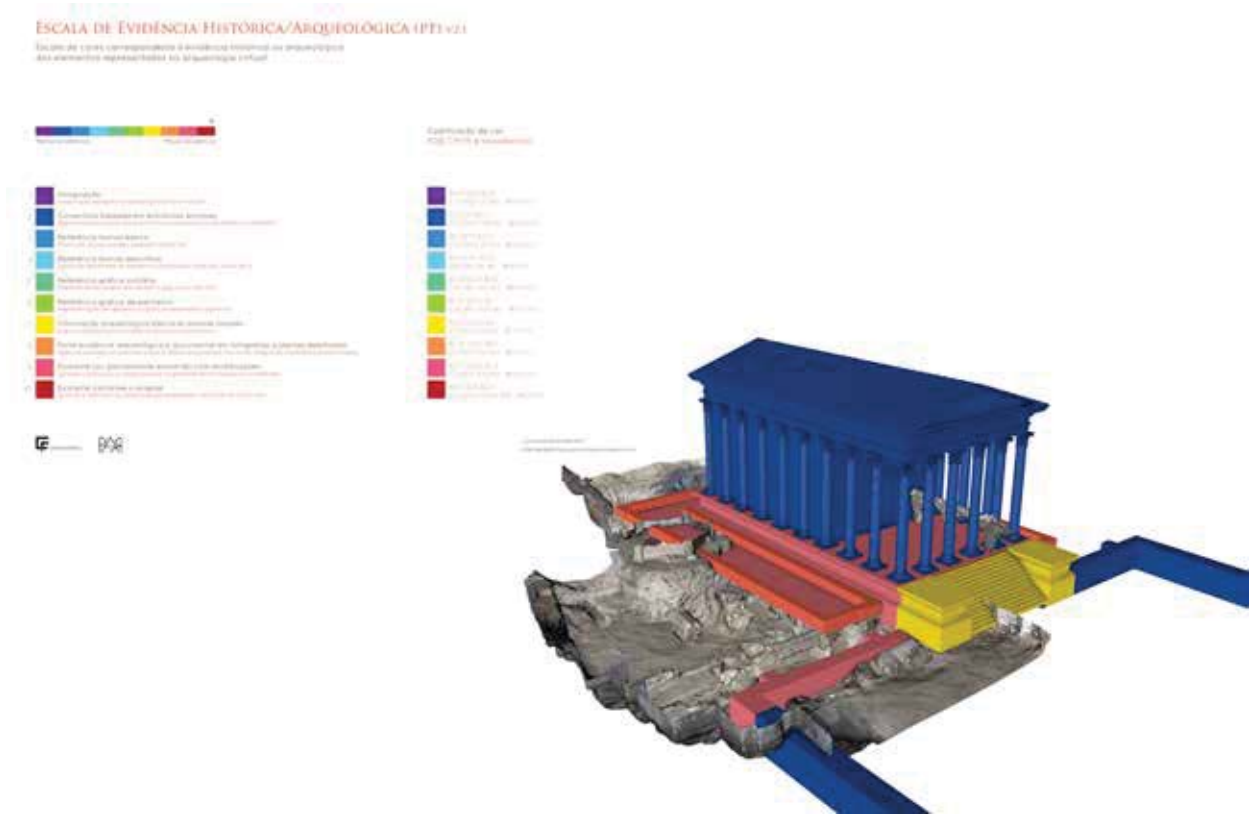
## REAL VS. VIRTUAL

**NICOLA SCHIAVOTTIELLO**

If we want the public to achieve a complete fruition of a certain historical place, we need to understand many aspects of the site and especially its finds. This is not always possible due to various reasons, such as the displacement of the finds in various locations and museums. The advent of virtual museums has partially resolved the problem with many interesting projects to be recognized (see for example Elgewely and Wendrich, 2015). In the final discussion we argued that these physically intangible copies sometimes are more comprehensive and visually appealing that their original counterparts, transforming the virtual museum into a hyperspace of knowledge where the artefacts are enhanced with infinite possibilities of information. However, the benefits of having a virtual museum should surpass these side effects. It is important in this case to choose accurately how to communicate this big amount of information to the non-specialist audience (Lepouras and Vassilakis, 2004).

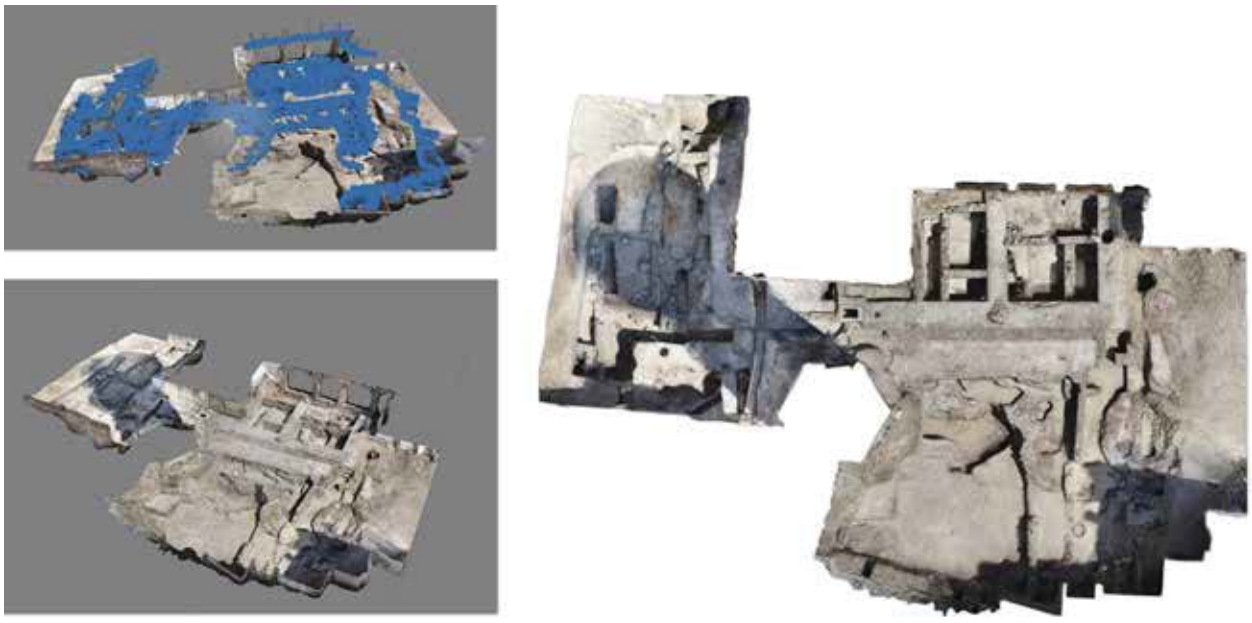
The visual styles of a virtual museum are various, sometimes respecting the form of the same existent museum but often re-worked in order to create a total new digital environment. Ricardo Cabral presents us the creation of one of these virtual spaces, its effectiveness and the way his example has shaped the communication of the artefacts and the history of the studied place.

9. Virtual reconstruction of the later roman temple of Pax Iulia (Beja, Portugal).




10. Application of the Scale of Archaeological and Historical Evidence to the temple's virtual reconstruction.

**11. Possible area occupied by the roman forum and examples of roman construction technologies.**



**12. Photogrammetric survey and ortophotograph of the archaeological site.**

# THE VIRTUAL MUSEUM OF THE VOTIVE DEPOSIT OF GARVÃO: AN EXPERIMENTAL APPROACH TOWARDS INTERACTIVE EXHIBITIONS

**RICARDO CABRAL**

Located in the south of Portugal, the Iron Age votive deposit of Garvão (Ourique, Beja) was first identified in the beginning of the 1980's. The massive deposition of objects on a slope of the Cerro do Castelo (a small hill in the centre of the modern village of Garvão – figure 13) had an intentional nature and has been associated to ritual practices. As the result of several archaeological campaigns, it was possible to recover a great number of archaeological artefacts (mainly pottery), which were purposely deposited and carefully arranged in order to optimize the available space (Beirão *et al.*, 1985; 1987). Archaeometric analyses performed on selected ceramic material (as part of the GODESS project: Garvão/Ourique iron age Deposit – Engaging science studies) allowed the recognition of the ceramic phase composition, ceramic manufacturing processes and origin of raw materials and improved the understanding of the importance of Garvão in this part of the Iberian Peninsula.
Despite its undeniable importance, so far it has been a challenge to satisfactorily publicly exhibit this vast archaeological collection. Therefore, the development of innovative digital tools emerged as a possible solution to overcome this problem. The focus of this work was the development and implementation of 3D technologies as a way to complement a traditional exhibition, installed in the Caetano de Mello Beirão Archaeological Centre (CACMB, Ourique), with multimedia content. Besides the creation of an interactive virtual museum, 3D technologies were also incorporated in the physical exhibition itself, with the use of Augmented Reality (AR) tools, Immersive Virtual Reality (IVR) and the 3D printing of replicas.
The development of these digital solutions took place as part of the IMAGOS/APOLLO project of the HERCULES Laboratory (University of Évora).

## *METHODOLOGY. DATA ACQUISITION*

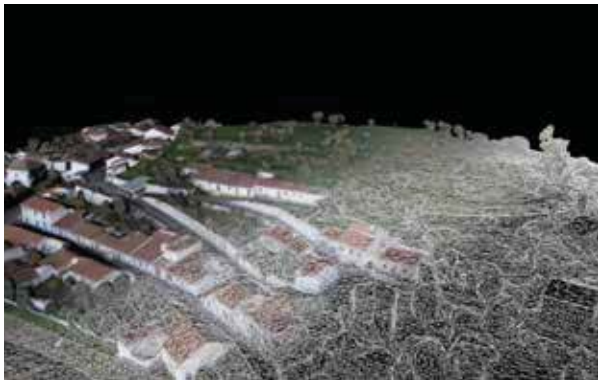
The first exhibition to be featured in this Virtual Museum is dedicated to the large containers (Faia, 2012) and censers (Silva, 2012) retrieved from the deposit. In order to do this, it was necessary to create digital 3D replicas of the objects. Preliminary analysis was conducted in order to determine the suitability of different three--dimensional data capture techniques. A small sample of pottery vessels was thus used to obtain a comparative analysis between photogrammetric recording and laser scanning. Comparison of the resulting 3D models highlighted the strengths and weaknesses of each of the capture techniques and established the usefulness of combining both, according to the morphological characteristics of the objects (figure 14).
The photogrammetric technique allows us to obtain 3D models with a high degree of photorealism as well as its usage in remarkably different scenarios, from small objects to land surfaces with hundreds of hectares. Thus, it presented itself as the most suitable solution for 3D scanning of larger ceramic artefacts as well as for the creation of the 3D model of the archaeological site of Cerro do Castelo (Garvão) (figure 15). The photogrammetric surveys of the ceramic artefacts were carried out both at the CEAACP facilities in Coimbra and at the CACMB archaeological storage in Ourique, using a Canon EOS 5D. The generation of tridimensional models from the set of photographs was processed using Agisoft Photoscan software. The creation of a DTM of the archaeological site was achieved through an aerial photogrammetric survey of the Cerro do Castelo, using a quadcopter Unmanned Aerial Vehicle (UAV) – DJI Phantom 2 Vision+. The post-processing phase was also conducted with Agisoft Photoscan, which enabled the creation of geo-referenced orthophotomosaics and Digital Elevation Models (DEM). The UAV was also used to capture aerial footage of the archaeological site, as well as a 360º panoramic image of the landscape, later featured in the Virtual Museum. Two capture sessions were conducted on site, in which 654 photographs vertical and oblique aerial were obtained, in order to produce a high resolution 3D model of 6.17 hectares.
In the cases where the morphology of the object rendered the application of photogrammetry problematic (or when extensive manual processing was required) a low-cost 3D laser scanner (NextEngine 3D Laser Scanner) was used. This technique was especially useful to deal with the small and detailed decorations of the ceramic censers.

## *METHODOLOGY. MODELLING THE MUSEUM ENVIRONMENT WITH COMPUTER GRAPHICS SOFTWARE*

The virtual museum environment was entirely modelled and textured with computer graphics software – Maxon Cinema 4D. This software enables the creation of digital models through a wide range of manual and procedural modelling techniques (including parametric modelling, polygon, NURBS, or 3D sculpting tools, for example). It also proved essential both for the general layout and design of the Virtual Museum (i.e. the testing of different layouts of the exhibition space) as well as for the creation of digital models of a wide spectrum of secondary and decorative elements that were featured in the museum. The 3D human characters that populate the virtual exhibition for the purpose of recreating didactic scenes were modelled with MakeHuman, an open-source software specifically developed for this purpose.
The development of this virtual environment required extensive work to reduce and simplify 3D models, thus allowing the museum application to be quickly accessed from a browser and older computers with lower processing capabilities. Therefore, different technical solutions

13. Aerial view of Cerro do Castelo (Garvão).

14. Sample of digital replicas captured with photogrammetry and laser scanning.



15. Photogrammetric model of the archaeological site.


16. Interactive environment of the museum exhibition.

were tested, including the production of decimated 'low--poly' meshes from the originals and subsequent 'normal mapping', thereby producing 3D models with simple polygonal meshes and a high degree of detail. The simplification of 3D models and widespread compression of other elements (movies, images, etc.) of the virtual environment provided a considerable reduction in the hardware minimum requirements to access the museum.

### *METHODOLOGY. INTERACTIVE EXPLORATION WITH GAME-ENGINE SOFTWARE*

All the models created using the different techniques described above were brought together in a single virtual interactive environment using game-engine software (Unity). The interactive elements of the environment (including the definition of inputs that allow navigation within this digital space) were programmed using scripts based on Javascript and C# programming languages. This virtual environment, much like a traditional computer game, is open to exploration and experimentation by the user/visitor, using a personal computer (figure 16). It can be accessed online or it can be downloaded and run as a standalone version, either on MacOS or Windows operative systems.

This platform's objective of facilitating public access to the heritage and enhancing their dissemination brought this cultural content to an audience as wide as possible. Unity proved to be a very suitable tool for this task, as it allows the user access to the museum from anywhere in the world from an Internet connection, via a web player. This feature takes on even greater importance considering the fact of Garvão and Ourique are located in large population centres remote areas, helping to combat exclusion, isolation and inaccessibility to the heritage of this region would be subject easily.

### *3D PRINTING*

The 3D printing of replicas of the artefacts allows the public to have the opportunity to physically manipulate real-sized versions of the archaeological objects that would, otherwise, be beyond their reach (Allard, 2005). It has also the merit of allowing groups that are often marginalised from a traditional archaeological exhibition (i.e. the visual impaired) to have a deeper contact with the archaeological and cultural heritage. As such, the 3D model of a censer (figure 17) and the topographic model of the archaeological site were selected for printing in PLA (polylactic acid). The Digital Surface Model (DSM) of the archaeological site generated through aerial photography was processed (point classification associated with vegetation and architecture, extraction and interpolation) in order to create a Digital Terrain Model (DTM), which was later prepared for printing. The physical exhibition will incorporate this scaled model, which will be enhanced with a projection onto its surface of different layers of cartographic data (contour map, digital elevation model and orthophotomosaic) as well as the indication of points of interest.

17. Original (left) and 3D printed replica (right) of a censer.

### *AUGMENTED REALITY APPLICATIONS*

Being virtual reconstruction one of the interesting potentialities of a virtual environment, the same solution can be implemented in the scope of a traditional museum exhibition using augmented reality technology (Ternie, 2012). At the physical exhibition, the visitor can, therefore, use a mobile device (smartphone or tablet) with Android operative system to download a dedicated app. Pointing at targets placed through the exhibition, 360º animated views of the artefacts and/or virtual reconstructions of the fragmented objects are displayed on the screen of the device. The AR tools have been developed with the Vuforia Unity extension.

### *IMMERSIVE VIRTUAL REALITY*

As it has been shown before (Bruno, 2009) the use of virtual reality technologies in the field of cultural heritage allows a deeper fruition of the material remains of the past, potentially attracting new audiences. Hence, the virtual museum application has been adapted to be experienced in a Immersive VR environment using head-mounted displays (Oculus Rift). Virtual reality headsets will, thus, be available at the CACMB in Ourique, providing the visitor with a more immersive and interactive experience.

### *RESULTS*

The work conducted has allowed us to test the applicability of different 3D technologies in the analysis and dissemination of archaeological heritage. It has tested and defined the whole pipeline from data capture to the production and implementation of ready to use models in virtual environments and in traditional exhibitions.
One of the main outputs of this project was the creation of the Virtual Museum. It was structured around six main thematic areas that the user can explore freely, interacting with the surrounding environment:

(1) Regional Contextualization: featuring a DTM of this region of Alentejo (created with displacement mapping from a height map), the main purpose of this area is to give the user more information about the geomorphological context of the archaeological site.
(2) History of the Archaeological Investigation of the Site: using various visual displays, the user can have a deeper understanding of the different archaeological and scientific investigations about this site and its materials, from its discovery to the present day.
(3) Pottery Production Techniques: as the vast majority of the retrieved material is composed by ceramic objects, there is a section of the Virtual Museum dedicated to explain the visitor the different techniques and stages of ceramic production in the 2nd Iron Age in the South of Portugal.
(4) 3D Technology: another section of the Museum is dedicated to the 3D tools involved in the creation of the Virtual Museum itself, explaining to the visitor the principles of photogrammetry, laser scanning and the process of aerial photogrammetric surveying.
(5) Exploration of the Site: there is an area where the user can explore the site itself, but using Points of Interest (POI) identified over the DTM. These POI are associated to pop-up menus with relevant information on the archaeological site that appear when the user places the mouse over the POI in question. This area is also surrounded by a 360º panoramic view of the neighbouring landscape.
(6) Exhibition Area: the first exhibition to be featured in the Virtual Museum displays some of the large containers and censers found in the votive deposit. By clicking in each of the objects, the user can access archaeological information about the artefact and freely manipulate it, observing the object from virtually every possible angle.

### *CONCLUSIONS*

The development of a virtual museum presents itself as a versatile and interactive platform that enables the

dissemination of archaeological and archaeometric data and, at the same time, raises public awareness to the role of new digital technologies applied to heritage. Several considerations can be made about the potentialities of this type of interactive platforms. It has obvious accessibility advantages, since it can be accessed through an Internet connection from anywhere on the planet. This is especially relevant when we are dealing with a small archaeological site, away from the traditional cultural and touristic centres. Even if this first version of the Virtual Museum is only in Portuguese, it can be converted to a multilingual platform in the future, enhancing its dissemination potential. In a future update, it can also display differentiated information to different publics (specialized or non-specialized) according to their specific interests. Updatability is, in fact, another of the strong points about this platform. It allows a regular update of the virtual exhibitions at relatively low costs, providing the opportunity to showcase many archaeological pieces that otherwise would remain hidden from the public in depositories.

The incorporation of digital technologies in physical exhibitions has also merits on their own. They can enhance the public experience, allowing them to be in touch with aspects of the collection that would normally be impossible or off-limits, and see the objects displayed in a completely different way. New digital technologies have also a certain appeal to younger generations, more familiar with these tools, and could be a way to more effectively put these new publics in contact with the archaeological and cultural heritage.

*ACKNOWLEDGMENTS*

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## OBJECTIVENESS VS. SUBJECTIVENESS

**NICOLA SCHIAVOTTIELLO**

The desire of telling stories by projecting images onto canvas or other means can be traced back to the Palaeolithic (see for example the work of Matt Gatton[11]). If CGI has revolutionized the way we construct, perceive and appreciate our cultural heritage, it is undeniable that it developed from visual arts and science but especially from the legacy of photography and later in conjunction with digital photography. With Sheila's Palomares and Pietro Viscomi we explore the relationship between Industrial Heritage and the transformation of photography from a tool of expression to a mean of documentation and interpretation.

11. [www.paleo-camera.com. Access date: 10/03/2016].

## VISIONS OF INDUSTRIAL ARCHAEOLOGY: FROM DOCUMENTAL PHOTOGRAPHY TO THE PHENOMENON OF "URBEX"[12]

**SHEILA PALOMARES ALARCÓN; PIETRO VISCOMI**

Photography is key to the survival and promotion of industrial heritage since the study and disciplinary appraisal of industrial architecture requires photographic representation in addition to architectural plans.[13]

Industrial architectural heritage may be the most ill-treated form of heritage that can be found today (Aguilar, 1998, p. 23). It is a form of heritage that is linked to the concentration of industry in cities and the disappearance of rural life. It therefore has a continuous relationship with the development of urbanisation in cities. Both lack of sensitivity and property speculation have caused a large number of buildings to disappear. The notion of *artistic historical heritage* has changed over time, causing numerous examples of such heritage to be destroyed while others, more fortunately, have been conserved or restored. This situation results, among other things, from the fact that the value of certain buildings or ruins has not being recognised until relatively recently. Numerous Roman constructions, including theatres and amphitheatres, served as quarries for new medieval constructions which were studied, conserved and recognised during the Renaissance. The Gothic period was not classified until the nineteenth century and eclecticism, modernism and art deco were also not recognised for decades although, fortunately, their merits have now been reassessed.

For these reasons, industrial archaeology (Simal, 1989) is a relatively recent discipline. It emerged in Great Britain following a change in public attitude brought about by the large-scale destruction of tangible heritage (including a great deal of heritage associated with the Industrial Revolution) after the Second World War. Different groups of enthusiasts with an interest in specific industries began to publish histories and investigations with which they sought to preserve structures or artefacts. In some cases, these enthusiasts even became personally involved in restoring old machinery. Work such as that carried out by Michael Rix, (*Industrial Archaeology*, 1967) who taught at the University of Birmingham, placed

12. Research integrated in the project UID/HIS/00057/2013 - POCI-01-0145-FEDER-007702.

13. This fuels the demand for specialist photography. However, as the professional photographer Duccio Malagamba stated in his master class 'La fotografía de arquitectura' [Architectural photography] that is wrong to think that visits to buildings can be replaced by the information conveyed to those who commission photographs. Visits are irreplaceable. In other words, it is only possible to become deeply acquainted with an architectural structure by visiting it [https://vimeo.com/27490929. Access Date: 10/03/2016].

all these efforts in perspective. Consequently, in 1959, following the publication of one of his paper on the Industrial Revolution in Great Britain, the Council for British Archaeology urged the British Government to draw up norms to inventory and protect national industrial monuments (Martin, 2009, p. 286).

Kenneth Hudson[14] played a key role in the field of European museology and coined the term 'industrial archaeology' when he published the first book on the subject – *Industrial Archaeology: an Introduction* (Hudson, 1963).

Although industrial archaeology emerged in England, ideas about preserving, researching or documenting industrial heritage were developed in many parts of the world. All over the planet, numerous industrial museums devoted to specific themes such as canals, windmills or railways have served to defend and preserve this heritage. In 1978, as a result of all these occurrences, the International Committee for the Conservation of the Industrial Heritage (TICCIH) was set up to promote cooperation in this field.

As this discipline has existed for little more than thirty years, many of its characteristics are yet to be defined. How, for example, to define industrial architecture as a specific subject of study when, in the nineteenth and early twentieth centuries, this aspect of the field was not included in the theory and history of architecture and only a few treatises on engineering engaged with the subject-. (Aguilar, 1998, p. 24-26).

In order to record, interpret and appraise industrial remains correctly it is necessary to have some knowledge of their history, evolution and transformation. Only in this way will it be possible to establish the importance of these buildings in relation to others with similar functions. To this end, it is essential that a process of classification be carried out in order to define their value and establish scientific foundations that support and justify their regeneration or reuse. These foundations can largely be established on the basis of irrefutable documentary sources: photographs.

Images are more than just shop windows. This is certainly true of the architecture-based documentary photography of Bernhard 'Berna' Becher and Hilla Becher. For over forty years, the Bechers recorded the heritage of an industrial past with the zeal of documentary makers, photographing threatened industrial buildings in order to keep memories of them alive.

The couple were the driving forces behind the Düsseldorf School and their photos brought them recognition as conceptual artists and as the photographers who made the greatest contribution to the development of industrial architecture photography, exerting a strong and lasting influence on the generations of artists who came in their wake, including the photographers Andreas Gursky, Thomas Ruff, Thomas Struth and Candida Höfer.

For the couple, the purpose of photography was to depict reality in an objective way and to use technical means to highlight the sculptural value inherent in these buildings, thereby documenting a declining tradition in the field of construction. Their projects led to their winning the *Leone d'Oro* award for sculpture at the Venice Biennale (1991) for conceiving and photographing industrial structures as if they were genuine 'anonymous' sculptures.

Where subject matter is concerned, the Bechers focused on a particular repertoire of subjects with a rigour that is also evident in the formal aspects of their work, in which very specific boundaries govern the approach to their photographic motifs. They stated that *'through photography, we try to arrange these shapes and render them comparable. To do so, the objects must be isolated from their context and freed from all association'* (Stimson, 2004, quoting T. Liliane, 1989). The result is an inventory of portraits of industrial buildings, images that were not intended to be individual objects (Figure 18) but were conceived to create homogenous groups of constructions. They themselves called these groups *'Typologies'*[15].

The Bechers' project is closely analogous with the work *'The Face of Our Time'* by August Sander (1929).[16] According to the Bechers, Sander made *'portraits of people in the same way that we might portray objects. Sander encouraged them to play their role. Perhaps the objects and plants that we photograph are also able to play their role'* (Grigoriadou, 2010, p.350, quoting James Lingwood, 1996).

14. Hudson was a British journalist, museologist, broadcaster and writer (1916-1999).

15. A term that was also used in their first publication (Becher, B.; Becher H., 1970).

16. Sander's intention was to create an extensive photographic inventory of portraits depicting people of all social classes and occupations living in Germany between the wars. The outlines are clear and everything is in focus, establishing a discourse in which clarity and visibility are essential features.

**18. Bernd & Hilla Becher, Water Towers (*Wassertürme*), 1980.**
**© Bernd and Hilla Becher, Solomon R. Guggenheim Museum, 1981**

The Bechers employed such a degree of painstaking rigour that their compositions took on a scientific character that was sufficient to make them resemble a work of biological research (Lange, 2006).
Images of buildings with identical functions shot with a large-format camera from different points of view are exhibited together, encouraging the public to reflect on the forms and structures in order to understand and compare the different architectural subjects, which are suspended in space and an unmentioned time. Neither the place nor the time at which these photographs were taken can be determined. Although separated by years or even decades, they appear to have been taken in the same session.
In an interview with Michael Köhler in 1989, Bernd and Hilla explained that: *'We don't wish to modify anything in the objects that we photograph, which is a principle that we continue to apply today. We have allowed ourselves, and still allow ourselves, to play just one trick, which consists of isolating the different objects; that is, situating them separately in the centre of the image, which does not correspond to reality as these objects are usually in the midst of chaos, or architectural jungles'* (Köhler, 1989, p. 14-15).
Human figures are absent from the constructions. The architectural structures are placed against a cloudless morning sky or seen on cloudy days with a diffuse light coming from no discernible direction and casting no perceptible shadow.
Over the past few years, in parallel with the Bechers' documentary vision, *'other photographic gazes'* have been developed to reflect on changes in the industrial landscape, manufacturing processes and their relations with society, and the influence of industry on people and nature. In some cases, the presence of the architectural structure is marginal: contrary to what is seen in the Bechers' photographic compositions, only the type of structure can be distinguished. This is true, for example, of 'Vlad #1 (silo boy)' (figure 19), an image created by the American photographer Jim Gold-berg as part of the *'Open See'* project[17], in which the theme of industrial heritage appears to be completely secondary and the architectural structure serves only as a setting and a backdrop.
Nevertheless, this photo was chosen by Urs Stahel[18] for the exhibition *'Industria, oggi'* (2015) at MAST in Bologna, where photographs by 24 contemporary photographers were brought together with the aim of representing industry and triggering reflections around the representation of industrial landscapes.
'Another gaze' is the phenomenon of urban exploration (Urbex), which is becoming increasingly prominent in the world of industrial heritage representation. In general terms, it refers to the exploration of abandoned and, in most cases, hidden man-made structures and almost always involves photographic documentation.

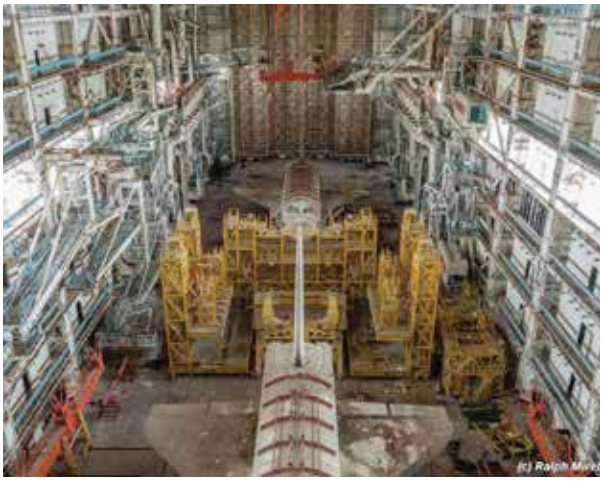
17. This photograph is part of a project for which Goldberg travelled around the world, documenting his encounters with the homeless, migrants and refugees.
18. Commissioner of the MAST (Manifattura di Arti, Sperimentazione e Tecnologia) photo gallery.

It is an approach to architecture that is situated somewhere between artistic and documentary practices. Aside from offering opportunities for adventure and play, it is a way of recording and inventorying changes to industrial structures that immortalize an invaluable heritage of buildings and places in post-industrial society, structures that, in most cases, enter our visual field without being appreciated. According to the anthropologist Marc Augè: *'The contemplation of ruins grants us a fleeting glimpse of the existence of a time which is not the time discussed in history books or that which restoration works attempt to resurrect. It is a pure time to which no date can be assigned and which is not found in our world of images, simulacra and reconstructions, which is not located in our violent world, a world whose rubble, absences of time, has not yet managed to become ruins. It is a lost time which art is responsible for recovering'* (Augé, 2003, p.7).
Thanks to the internet, there has been an exponential growth in web pages, communities and fora that, albeit ephemerally, acquaint us with heritage in real time, since there are as many opportunities for such heritage to be known as to be forgotten. Everything depends on the strength of the images that depict it.
This point is relevant to the work of the urban explorer who goes by the name of Ralph Mirebs. In June 2015, Mirebs posted a series of photos on his LiveJournal webpage[19] which were seen around the world in just a few days. It was the first time that such high-quality images of the MZK building (Assembly and Fuelling Complex) and its contents had come to light (figures 20 and 21). Moreover, the way in which Mirebs tells the 'story' of industrial heritage is very interesting as he focuses not only on the images themselves but also on conveying historical and documentary information through photography as well as its social repercussions. One of the consequences of this 'other gaze' is that the media once again began discussing 'secret space shuttles': the remains of the USSR's most costly space project, which, for over twenty years, remained hidden from the public in an abandoned hangar – the Baikonur Cosmodrome – on the vast steppes of Kazakhstan.

19. http://ralphmirebs.livejournal.com/

**19. Jim Gold-berg, *Vlad #1 (silo boy, Ukraine)*, Open See, 2006. © Jim Gold-berg, Courtesy of the artist and Pace/MacGill Gallery, New York**

20. Ralph Mirebs, Edificio MZK de Baikonur (Complejo de Montaje y Carga de Combustible), 2015. © Ralph Mirebs



21. Ralph Mirebs, La lanzadera 2K dentro del edificio denominado MZK (Complejo de Montaje y Carga de Combustible) de Baikonur, 2015. © Ralph Mirebs

## THE DIGITAL REALM

**NICOLA SCHIAVOTTIELLO**

What are the implications and specifications of hyper realistic images realized through CGI in a world that is continuously reproduced and interpreted by digital photography? Can the two techniques be seen as distinct ones or are they already considered as a unified medium? 3D documentation and 3D digital reconstruction can be considered complementary phases and equally important for the digital preservation of a particular site or artefact. Moreover, these are non-invasive technique that allows reaching an understanding of the studied object without any risk by also permitting further investigation if needed. On a more practical level 3D documentation is not only useful for digital investigation but extremely important for the work of restoration and conservation, by giving the possibility of approaching the best possible solutions after an accurate study of the digital model. 3D data obtained by either photogrammetry techniques or by laser scanning (or a mix of the two) are also extremely useful for a series of other required 2D data (that previously to these techniques were harder to obtain) such as maps, plans, cross-sections and orthoimages. Therefore, having a complete 3D model, that includes also high resolution texture mapping, can speed up the process of investigating a particular site, ruin, or artefact.

Full 3D digital reconstruction is to be considered very important during the investigation and research stage for a more experiential approach and especially during dissemination. Virtual Anastylosis is also a very interesting technique obtained from the marring of 3D documentation and 3D digital reconstruction. It can result quite effective when parts of the studied subject still exist, so that thorough comparative analysis the full object can be reconstructed.

With the advent of cheaper 3D printers, we saw the emerging of the production of replicas for small and medium size objects, these has open great possibility in terms of accessibility to artefacts that usually where restricted to specialists due to their fragile state of conservation. This has almost happened in conjunction with the appearing of Augmented Reality applications where the digital object can be viewed in a physical environment. With devices such as the HoloLens from Microsoft[20], the boundaries that divide the virtual and the real word will rapidly fade. Finally, if we also consider that digital models could be accessible online--onsite and online-offsite throughout web-visualization technologies the possibilities are becoming very interesting. This can bring a totally new way of dealing with important real-time information that would be very difficult to access otherwise.

Photogrammetry and laser scanner are the main tools used in order to obtain digital replicas that are explorable from every angle rather than from a single perspective. These digital replicas can facilitate the comprehension of the artefacts by capturing the extra dimension, also by adding a layer of objectiveness. However, by doing so we are still de-contextualizing the studied objects. Therefore, we discussed if archaeology itself is an infinitive process of de-contextualization and re-contextualization that once we were making with analogue means and now we may be still doing with the digital ones.

With the help of virtual reality in museums and of augmented reality *in situ*, we could explore if these are effective devices of communication, that permit also the re-contextualization of the studied objects for a better understanding of its meaning and not only for their form and consistency.

For the last presentation, we invited Belén Jiménez Fernández-Palacios, who gave an excellent inside of new 3D technologies to revalue archaeology. In fact, from her intervention we clearly understood how the many complex steps for creating digital 3D models are performed before arriving to the final audience. She showed how "the latest developments in 3D recording and modeling offer great potentialities for the accurate

20. Using HoloLens in identifying archaeological finds [https://microsoftstudios.com/hololens/shareyouridea/idea/using-hololens-in-identifying-archaeological-finds/. Access date: 18/03/2016].

and detailed 3D documentation and digital preservation of existing tangible heritages and a large number of tools to make digital heritages more informative, easier to be visited and enjoyed even remotely. The data recorded in 3D can be used for several purposes, such as archaeological studies and analyses of architectural structures, digital documentation, preservation and conservation, 3D repositories and catalogues, virtual reconstruction, computeraided restoration, virtual anastylosis, physical replicas, virtual and augmented reality applications, monoscopic or stereoscopic renderings, multimedia museum exhibitions and virtual visits, archaeological prospection, web access, visualizations and so on" (Jiménez et al., 2013, p. 85-89).

## CONCLUSIONS

Dealing with historical, archaeological and architectural documentation, cultural heritage interpretation, digital storytelling, computer-based visualization and cognitive response of the public, this discussion lies at a cross road of different studies and disciplines. The basic questions that inform its lay were: how are cultural heritage scientific information studied and interpreted? How are cultural heritage interpretations received by the public, with focus on interpretation with computer-based visualization? Finally, is the rendering of digital artefact and environments an effective way of communication and is it reviving the pleasure of learning about our past, or is it generating a totally a new realm?
We saw how the technique de-contextualizing, that in beginning of the 70's has brought with photography a new way of studying the artefacts, can be re-applied with modern technologies by creating a 3D digital model. What seems to be equally important nowadays and difficult to achieve without CGI, is the process of re-contextualization of the artefacts. This opens amazing possibilities for scientific interpretation and interpretation for the public. After all it appears that both processes are necessary for the purposes of understanding, however while the former can be used as a scientific investigation tool, so that by experiencing the reconstructed realm new questions and theories can be formulated, the latter has a very important role in transmitting the same theories to a more general audience in an appealing visual and storytelling form.
Within public communication, Mateos Rusillo defines cultural heritage interpretation as: '*...a creative process of strategic communication that helps to connect intellectually and emotionally the visitors with the meaning of the visited heritage resource, so that he/she will appreciate it and enjoy it'* (Mateos, 2008, p. 58), the binomial relationship between the supplier of the knowledge and the receptors was then the focal point of this debate. Moreover, this relationship can be explored as a two-way direction were the public is not the passive recipient of data but has the capacity to choose objects that catches its interest and create its own path of discover through interactivity.
We acknowledge that the multi-disciplinary engagement with a 3D model at a research stage is probably one of the most important phases when building the model itself, as Opgenhaff and Sepers pointed out: *'It is not the 3D reconstruction of ancient architecture that proves something by itself, but it is how we engage with the model in order to unravel how someone in the past might have engaged with it.'* (Opgenhaff and Sepers, 2014, p. 411). However, we can also sustain another level of public engagement, which happens during the fruition of the final model and its related story. We agreed that this should be presented with valid scientific traceable contents, in order to furnish the public with a product that can be traced back to the original research. This final stage should always have an appealing and emotional visual form; otherwise the risk creates merely conceptual models, only to be decoded by the specialists.
We explored different means used to tell a story, which are central elements for the construction of an effective communication. We have seen how CGI visuals accompanied by audio and written words are still the mainstream. However even if we could not expand on this topic at this stage we know that visual immersive, touch, gesture recognition and smell devices are also becoming very popular in recent applications. Therefore, we are often presented with multimodal examples that enhance the experience of the final user (Adolina *et al.*, 2009).
Sometimes and especially with the advent of immersive environments when presenting 3D reconstruction in cultural heritage, the technology has touched the viewer more than the content itself. This especially happens with 3D applications within museums, directed to a general audience. Therefore, we have to be cautious in amazing the final user with spectacular devices without choosing the most appropriate ones for its content and settings (Londoncharter, 2009).
Here we can feel a pattern starting to emerge, so that if the construction of our cultural history through scientific means (especially the one used in archaeological practice) has revealed a complex process that must be approached by different disciplines (*The Seville principles 2011*), maybe the same digital reconstruction by new technological means should follow the same path by using multidisciplinary at the research stage but also multimodality and targeting when communicating with the final audience.
We hope that with this discussion we touched the main issues when CGI storytelling is used for the visualization of cultural heritage models and environments, until when some of today's issues will be transformed into effective new strategies for research, study and public interpretation of our beloved Heritage.

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