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

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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

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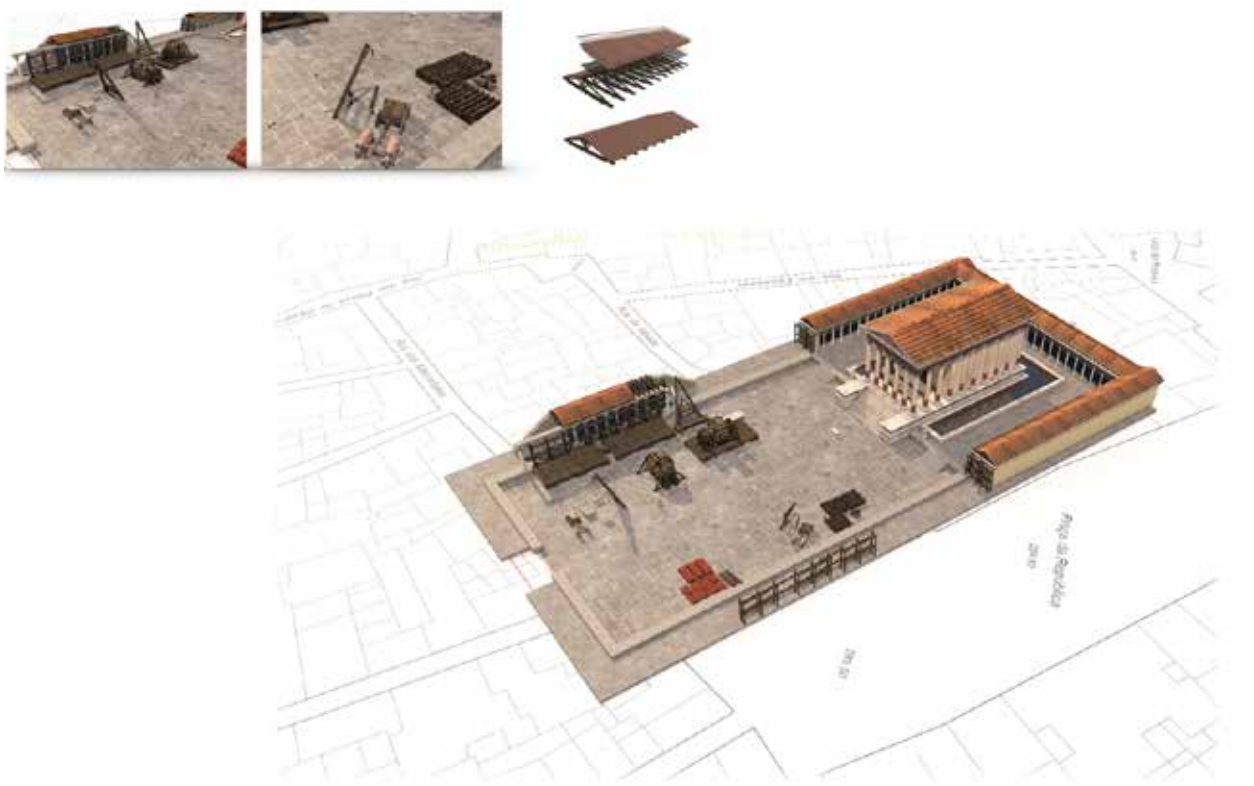
If we want the public to achieve a complete fruition of a certain historical place, we need to understand many aspects of the site and especially its finds. This is not always possible due to various reasons, such as the displacement of the finds in various locations and museums. The advent of virtual 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).

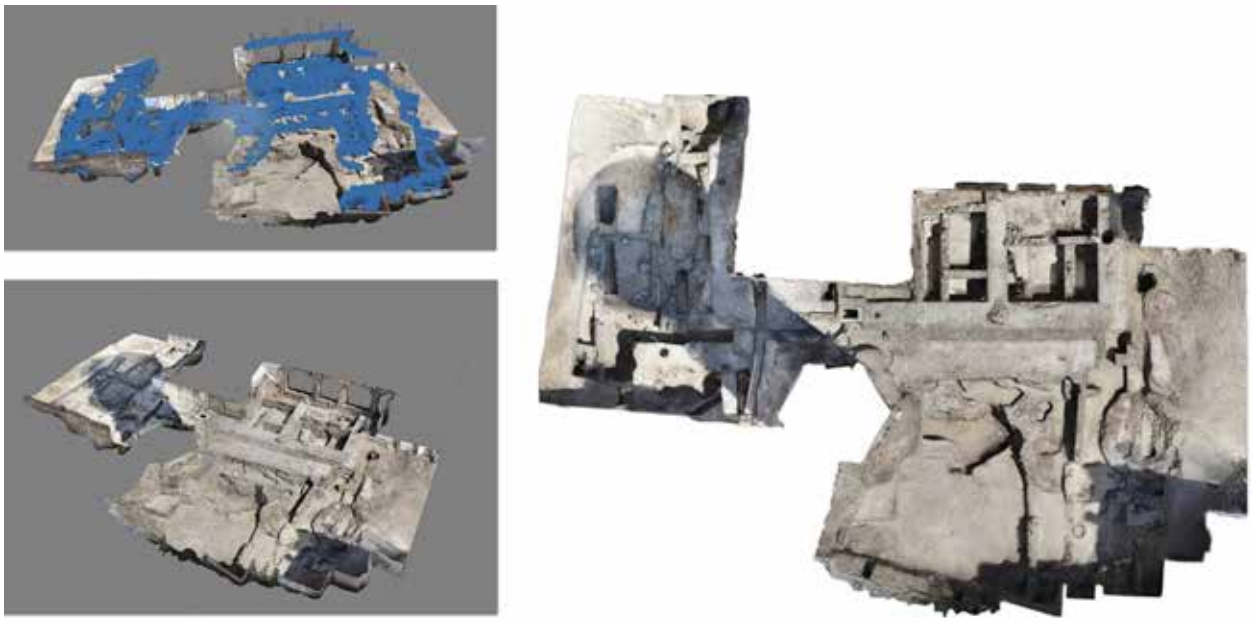
The visual styles of a virtual museum are various, sometimes respecting the form of the same existent museum but often re-worked in order to create a total new digital environment. Ricardo Cabral presents us the creation of one of these virtual spaces, its effectiveness and the way his example has shaped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