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A VERY SHORT INTRODUCTION TO DIGITAL ARCHAEOLOGY

UMA BREVÍSSIMA INTRODUÇÃO À ARQUEOLOGIA DIGITAL

BREVE INTRODUCCIÓN A LA ARQUEOLOGÍA DIGITAL

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Abstract

Visual reconstructions of archaeological sites and materials have been around since before the formal construction of archaeology as a discipline itself. However, there has been an expansion of the methods of reconstructing and representing the past in the last decades due to the use of digital technology. 3D modelling of archaeological sites and artifacts can generate aesthetically pleasing visualizations, but there is a danger of over-exaggerating or decontextualizing the past for public audiences. As digital artists and archaeologists, we should use caution with creating and disseminating archaeological visualizations. Considerations for scientific accuracy, ethics and educational value need to be taken into account. Therefore, this article introduces some of the theoretical issues involved with the digital reconstruction as well as an overview of the practical process of performing science-based archaeological 3D reconstructions and visualizations.

Keywords: digital heritage; archaeological reconstruction; computer-based visualizations; digital media.

Resumo

Reconstruções visuais de sítios e materiais arqueológicos já existiam antes da institucionalização da arqueologia como disciplina. No entanto, houve uma expansão dos métodos de reconstrução e representação do passado nas últimas décadas, devido ao uso da tecnologia digital. A modelagem 3D de sítios e artefatos arqueológicos pode gerar visualizações esteticamente agradáveis, mas existe o risco de exagerar ou descontextualizar o passado para o público em geral. Como artistas digitais e arqueólogos, é preciso ter cuidado ao criar e disseminar visualizações arqueológicas. Considerações sobre precisão científica, ética e valor educacional precisam ser levadas em consideração. Este artigo apresenta, de forma introdutória, algumas das questões teóricas envolvidas na reconstrução digital, bem como uma visão geral do processo prático de realizar reconstruções e visualizações 3D arqueológicas baseadas em ciência.

Palavras-chave: patrimônio digital; reconstrução arqueológica; visualizações baseadas em computador; mídia digital.

Resumen

Las reconstrucciones visuales de los sitios y materiales arqueológicos han existido desde antes de la institucionalización de la arqueología. Sin embargo, ha habido una expansión de los métodos de reconstrucción y representación del pasado en las últimas décadas debido al uso de la tecnología digital. El modelado 3D de sitios arqueológicos y artefactos puede generar visualizaciones estéticamente agradables, pero existe el peligro de exagerar demasiado o descontextualizar el pasado para el público. Como artistas digitales y arqueólogos, uno debe tener cuidado al crear y difundir visualizaciones arqueológicas. Deben tener en cuenta las consideraciones de precisión científica, ética y valor educativo. Este artículo presenta, de manera introductoria, algunos de los problemas teóricos relacionados con la reconstrucción digital, así como una perspectiva general del proceso práctico de realizar visualizaciones y reconstrucciones arqueológicas en 3D basadas en la ciencia.

Palabras Clave: patrimonio digital; reconstrucción arqueológica; visualizaciones basadas en computadora; medios digitales.

Introduction

The modern audience increasingly relies on audio-visual aids for rapid absorption of complex ideas or stories (MANOVICH, 1996). As the education sector evolves to keep up with engaging the attention and interest of students, researchers and professionals in museums and cultural institutions should also adapt their strategies for increasing public interest in history, archaeology and the environment. More specifically, in archaeology, the use of visual aids and digital media is paramount not only for public dissemination but also within the academic community. Archaeologists are co-opting tools, techniques and theories from other sectors in order to improve how they collect, analyze and disseminate archaeological data. Sharing findings is an

essential aspect of archaeological research, thus digital media and technology offer diverse and innovative methods for capturing public interest and increasing overall competency and appreciation of the past (MCCLEAN, 2008; GABELLONE, 2015).

Just like in archaeological research, context is an essential part of public dissemination. Although it is nice to make beautiful reconstructions of archaeological sites and features, without also including the basis of our understanding of these past structures the point of sharing visualizations is moot. Without some amount of curation in digital media production of archaeological findings, the visuals might as well be for pure entertainment rather than entertainment with the intent to engage and educate.

This leads to the issue of the best practices in creating computer-based visualizations of the past. Fortunately, the sub-discipline of digital heritage is rapidly growing and gaining an academic foundation of its own in order to address the theoretical and ethical problems involved with visualizations. Attempts at establishing principles and practical standards have been set forth through the London Charter in 2009 and the more archaeology-specific Principles of Seville in 2011. The aims of these manifestos are for the guidance of professionals in developing digital visualizations in a “technically and intellectually rigorous” manner for the purpose of “intellectual integrity, reliability, documentation, sustainability and access” (DENARD, 2009, p. 2).

Whereas recent techniques for computer-generated visualizations have allowed archaeologists to explore more in-depth reconstruction methods, visualizations of archaeological sites or historical periods began long before the digital era (PICCOLI, 2017). Any time one sets out to draw or paint a ruin or imagine the past, they are creating a heritage visualization. Today, advanced 3D software programs aid in this long-held endeavour. Although they are used mainly for animation, gaming and architecture, they are also being used for heritage purposes and can therefore dramatically enhance visuals and aesthetics for the conveyance of a complete image of the past (DENARD, 2012). With careful design, there are a myriad of possibilities to create something visually appealing, scientifically accurate and informative.

With a view to explore the opportunities and challenges that come along with these new possibilities, this article is a very short introduction to the standard practices, process and benefits of implementing digitally visualized reconstructions in archaeology. If the intent of archaeological research is to ultimately inform and engage the wider public, then archaeologists and heritage

specialists have an obligation to take ownership of these digital reconstructions so that they are built and presented in the most scientific, informative and entertaining way possible.

Scientific underpinnings of digital reconstructions

Digitized visual reconstructions of archaeological artefacts, sites, and wider landscapes should be first and foremost based on scientific findings and research. The sources of these findings should be from diverse and relevant disciplines in order to develop a holistic understanding of the site and its scale and landscape contexts. Additionally, because the study of archaeology also attempts to go beyond scientific data for creating interpretations and narratives about the past, the nature of a reconstruction is that it will contain hypothesized elements (DENARD, 2012). Therefore, standards dictate there is proper communication of what is authentic and what is imagined (LOPEZ-MENCHERO; GRANDE, 2011).

Integrating Disparate Data

Before beginning a reconstruction, it is necessary to collect, organize and evaluate all the relevant sources of information available about the site (DENARD, 2009). This is called the *dossier comparatif* (GROS, 1995, p. 322) and should include historical records, drawings and photos in addition to survey and excavation reports, maps and images (DEMETRESCU, 2018). Sometimes a site is unexcavated or parts of the site are unexcavated but there is geophysical data from magnetometry, ground-penetrating radar (GPR) or electrical resistivity imaging (ERI). These methods generate subsurface maps of different material remains or phenomena. If the pattern in the map appears man-made, then analysis and interpretation can be performed for the purpose of a reconstruction.

Other archaeological methods can greatly contribute for a more in-depth reconstruction. The flora and fauna remains from a site will inform which plants and animals were being consumed, as well as general locations of processing, cooking, and disposal. GIS spatial analysis based on concentrations of ceramic and artefact find spots can indicate which rooms were for domestic, dining or leisure activities. Whatever sources of information used, the process and results should be documented and disseminated in order to maintain “rigour and veracity” within the scientific field (LOPEZ-MENCHERO; GRANDE, 2011, p. 15). In recognition of this, researchers are developing methodological processes for organizing and communicating the

various paradata (APOLLONIO and GIOVANNINI, 2015; DEMETRESCU, 2015, 2018; DEMETRESCU and FANINI, 2017; HAUCK, 2014; KUROCZYNSKI et al., 2016).

There are many methods that archaeologists utilize in researching the past and present each method can provide information about a different aspect of daily life. Thus, reconstruction can gather this information and then visualize the amalgamated findings for a science-based, albeit imagined, narrative of the past.

Unknown Factors

For the occasions in which a visualization contains elements that do not have physical evidence, there needs to be an acknowledgement of the scientific accuracy of the model (DENARD, 2009; LOPEZ-MENCHERO; GRANDE, 2011). Otherwise, the result of the model is what is called ‘the Black-Box effect’, whereby the reader or viewer has doubts about what is based on reality and what is an invention of the artist/author (DEMETRESCU, 2018). In this era of ‘Fake News’, it is difficult to navigate how to approach unknown aspects of the past. However, by withholding educated guesses about various aspects from the ancient or contemporary past, this implies that they did not exist in that context or time period. Which can be even more debilitating for a holistic understanding of the daily life.

Depending on the aim of the visualization, there are some proposed solutions for communicating these uncertainties so that there is visual clarification about which aspects of the reconstruction are scientifically authentic and which are based on analogical research. Such examples include the use of colour differentiation for representing not only strict reality-based vs. source-based portions of the model but may also be used to indicate degrees of certainty (BENTOKOWSKA-KAFEL et al., 2012) or temporal correspondence (STEFANI et al., 2010) within the model.

When there are gaps in the data available for a structure, analogies are an incredibly important part of reconstruction. There may be a lack of physical evidence for exactly how a certain structure was built or what objects would have been utilized in which areas of a site. But through research of other contemporary sites and similar patterns and findings that would be relevant to the site, it is possible to attempt to complete the scene with these unknown, but probable, aspects. Although the archaeologist does have license to use a certain amount of imagination in the scene (DENARD, 2012), there should be clear disclaimers about what is based

on existing data and evidence and what is fantasized (DENARD, 2009; LOPEZ-MENCHERO; GRANDE, 2011).

The process of reconstructing archaeological remains in 3D modelling software programs: an overview

In terms of tools and materials, the process of creating a visualization is adapted from digital 3D modelling techniques. When an architect designs a building, they usually need to create a visualization that translates their ideas and the structure's specifications for the client. They sell the project with shimmering glass and clean walls.

For an archaeological reconstruction, however, the rationale should be the opposite. The structure and surrounding area should be based in realism rather than idealism. Archaeological structures are often complicated and compiled of various states of old and new constructions, referred to as the palimpsest effect (DEMETRESCU, 2018). Additionally, the buildings are dirty, stained and have broken tiles or are in half-repairs. Just as the Renaissance aesthetic was to bleach antique statues, today the tendency of architectural visualizers is to idealize these representations of the past, rather than show it in its probable and realistic state of disrepair (LOPEZ-MENCHERO; GRANDE, 2011). We shouldn't clean up the past by removing its garbage or bad smells, figuratively and literally. The sanitation of the past is a eugenic ideology. This is one of the reasons why it is important to take care and consideration in how these visualizations are created and presented to the public

With these principles in mind, it is possible to start the actual modelling process. There is a myriad of 3D modelling software programs that exist in various price levels and capabilities. Sketchup and Blender are free options with good basic capabilities, while Autodesk's 3Ds Max and Maya are more expensive but contain enhanced tools and capabilities for developing the model. In either case, the main limitation is the steep learning curve on how to navigate each software's interface. Fortunately, there is a plethora of free tutorials online for those with the determination to teach themselves.

Building Blocks

The modelling starts as simple blocks to delineate dimensions of the structure as well as estimated or known wall heights and roofing situation. It is at this stage that wall thickness and door and window openings for the structure are included.

With the exception of relative dimensions and door openings, here is where begins the guesswork of reconstructing. Most often, no one knows how many windows were on the structure or how big they were. In order to make the best possible reconstruction, you will need to research contemporary analogies to find the most common trend for the region and time period. In attempting to make the most accurate reconstruction, it is essential to understand how light and water would interact with the structure. Also, some analysis of the spatial assignment of rooms can help to inform whether the area should receive good or poor lighting. The general climate of the region and in which direction the wall structure is facing can tell you much about how natural lighting would have interacted with the structure. Perhaps there would have been a preference for a certain vista, a desire for privacy or even heat retention or avoidance.

Enriching the Scene

After the base model is finalized, the modelling process moves on to other more detailed architectural elements, such as window and door lintels and frames, roof beams and roof tiles, columns, steps, stairways or water receptacles. Again, if these elements are not known from excavation findings, then it will be necessary to research how it *could have been*, by understanding what was the common trend for the type of structure (domestic, public, sacred, etc.) and search for analogies from similar sites.

Depending on the amount of detail desired in the reconstruction, props are infinitely valuable for enriching the 3D version of the site. Ideally, these props will be based on actual artefacts found in the excavation and placed within the scene in the relative find spot (or where it would have likely been used at the time of occupation.) Ceramic analysis from the site can inform the reconstructionist in determining what kinds of wares were used at the site, i.e. storage, dining, cosmetic, lighting and cookware. The relative quality of the wares and the origin of the ware or product can indicate social status and imports to the region.

Where there is little to no artefact remains, decisions need to be made to determine what props to include in the scene based on known daily needs of the occupants. It is best not to overload the scene and thus distract the viewer, but presenting a Spartan view of the past is also inaccurate and therefore poor practice.

Adding Texture and Environment

At this stage, while the model of the structure or site more or less accurate, it still lacks realism and aesthetics. To include this in the scene, it is necessary to add what is called material textures to the 3D volumes.

These materials can be generated from 2D images taken from onsite photography or found online through paid or free licensing. Another method is to create a composite material texture within a photo editing software such as Adobe Photoshop. These images are digitally applied as maps to the volumes with the possibility to add additional information to the texture, such as reflectiveness and bump. Thereby creating the illusion of tactility to the material. In applying these textures to the structure, there is the opportunity to add grittiness in the appropriate locations—such as, water stains leaking from the upper roof; patches of plaster crumbling away at exterior corners; and cracks, dust and dirt on the walls. These small additions are important for imparting realism, not idealism, to the reconstruction.

When the structure(s) is modelled and textured to the best possible accurate and scientific specifications, the result is a wonderful, albeit disembodied, construction. In order to add context to the archaeological reconstruction it is necessary to add an environment scene (DE NAEYER et al., 2000). A robust reconstruction would be incomplete if it showed only “lifeless cities, lonely buildings or dead landscapes, because this is a historical falsehood” (LOPEZ-MENCHERO; GRANDE, 2011, p. 15). Therefore, it is important to include topographical terrain, vegetation, roads, bodies of water, forests, etc.

Other element to be added to the scene is that of lighting. For this, there is less guesswork. Depending on the time of day you wish to represent your scene, the lighting can be simulated for early morning, mid-day, dusk or even a night scene. If the reconstruction is meant to be seen from the interior, it is necessary to manipulate the light settings of the model so that either natural lighting or lamp/fire light illuminates the rooms enough for viewer visibility but so much that it is

unrealistically exaggerated. Sometimes ancient interiors were just really dim, and this should be conveyed to the modern audience.

After the scene has been enriched with the aspects of daily life, there is just a final missing piece—people. The decision about whether or not to include a human element to the scene is dependent on the aims of the project, as well as being a stylistic choice by the researchers. One problematic issue with portraying past peoples is that of perpetuating racial stereotypes, especially in ethnically diverse areas of the world or at a time so distant from today that we have little to no idea which physical characteristics to assign people of a certain site. A commonly used technique for including this human element to the scene is to make dark, semi-translucent silhouettes of people. Although these “ghosts” are racially ambiguous and anonymous, the viewer is still left with an impression that the past was actually lived by real people doing day-to-day tasks. Alternatively, where the project’s parameters and purpose allow, the inclusion of distinguishable individuals can be portrayed in the scene. This may be in the form of digitally-created avatars, photographs, illustrations either newly designed or reproduced from art history, or even live actors dressed for the place and period.

It is very important to include some hint or aspect of the human element to the digital media representation because historical, archaeological, anthropological and ethnological studies are all *human* sciences. In the case of archaeology, the discipline is broadly defined as the study of the material remains left by past peoples. In an effort adhere to a high standard of scientific rigor, archaeological research tends to focus only on the physical structures, objects or events that occurred rather than creating stories about the people who used these objects and lived at these sites. Therefore, when it comes to public engagement and edification there is an argument to be made for the use of emotive storytelling. Storytelling is a useful tool in digital archaeology because it is a “fundamental way we make sense of what’s happening around us, and how we remember things.... [they] help make information memorable, accessible and meaningful” (MCLELLAN, 2008, p. 18). A digital reconstruction devoid of human activity achieves only half of what the study of archaeology is about. Material remains do not naturally occur, human actors with their motivations and struggles made and destroyed these objects and sites. Additionally, it is modern people (possibly even descendants of the group being studied and presented) who are viewing and consuming this media. Because of this, it is essential that their needs and desires are also

considered. Thus, it is our job as professionals to at least attempt to include these stories into the digital narrative.

Final Output

The scene is complete but the intended viewing platform still needs to be decided. Depending on the final use of the reconstruction—still images, animations, or virtual/augmented reality—different software can be applied. For still images, cameras need to be placed within the scene to render (make digital snapshots) images for publication. If a video is the intended outcome, the cameras are placed in the scene and then carefully guided and timed to show the scene from different angles and at a pace that is appropriate for viewer absorption. The process is a bit different for virtual and augmented reality, the whole model and scene need to be exported into a format that can be read and viewed in different viewing platforms, such as Unity, Vuforia, Sketchfab, etc.

Whatever final result of the reconstruction, there should be short, relevant and interesting information about the structure, region and cultural period of the site. Whether in the form of short text, voice explanation or a click and learn interface, the visualization is meaningless without proper context and educational value.

Public and scientific benefits of digital media and reconstructions

Having indicated some of the newest possibilities of representing archaeological findings with new technologies, it is also necessary to stress that there are many risks with the use of digital technologies in research and dissemination of the past. However, the risks can be mitigated by taking into consideration ethical and practical standards for the development and use of these technologies. These principles apply not only to interactions with the non-academic audiences but within the archaeological community as well.

Public Benefits

A computer-based visualization is beneficial as long as it is used to complement the archaeological heritage, rather than detract focus from the physical site or an object in a museum (LOPEZ-MENCHERO; GRANDE, 2011). If designed correctly and with care to context, the digital media output can refocus attention to the physicality of the heritage. There can be a greater appreciation for the artefact or site if they are properly introduced and contextualized about how

significant the heritage is to a wider historical discourse (GABELLONE, 2015). Additionally, the audience can connect more to the ancient or contemporary past if given relevant connections to their own life or worldview. Thus, ethnographical archaeology can add valuable information about the cosmologies associated to the audience and their own feelings and perceptions related to the sites, artefacts and landscapes.

In the past, museums and cultural institutions relied on text labels, press releases, documentaries, books, etc. for communicating to the public significant or interesting archaeological or historical findings. While these methods are necessary and should always be produced, there is a risk that text alone will not be able to retain the wider audience's interest. Integrating digital media and reconstructions into museums, articles and even text books *may* be able to keep the interest and attention of lay people of all ages.

With visualization and technology devices, these audiences have a larger appreciation for the past because they can understand it in a way that is concise, informative and visually appealing. Archaeological research and science is something that captures the imagination of the wider public, but unfortunately many don't know the scientific process of archaeological research or how the research can lead to stories about past peoples (GABELLONE, 2015). Archaeology has a bit of an image problem. Technology and digital reconstructions can help to remedy that and demystify archaeology for the public (MURRAY, 2005).

Benefits to the Academic Community

In addition to the obvious target group, that being the general public, scientists and researchers can benefit from the *process* of producing reconstructions and digital media for public consumption. That is to say, when embarking on a project or excavation there are many aspects that will be kept in mind for a potential future reconstruction, i.e. to make sure they are as accurate as possible, acting as a “compass of the scholar to reflect on his own paradigms, procedures, and outcomes” as well as a “possible architecture of the research's workflow” (BRUSAPORCI, 2018, p. 69). In addition to the individual and project research questions, there could also be questions that will consider the final reconstruction. Knowing what information is needed in order to reconstruct the situation or structure will help to inform the way to approach the excavation and research (DEMETRESCU, 2018). Documenting and excavating with the intention of creating a digital reconstruction can also prepare the field staff for taking extra care with photo and

photogrammetric documentation. Not only is it good practice for the field reports and analysis but also helps with visually and digitally understanding the remains.

When it comes to the stage of physically creating the 3D model, the process of generating digital volumes also aids in the process of research and analysis (DEMETRESCU, 2018). With the ability to build up multiple versions of the structure or city plan, it is possible to visualize how the situation would have been instead of imagine and conjecture about it. As the debates develop about height, roofing situation and construction phases based, on the data collected, the researcher is also invited to take into consideration architectural principles (and common sense) about aspects that would otherwise not be immediate, such as water flow and general liveability and use of the structure. These are valuable insights that do not easily arrive without visualization and subsequent tweaking.

The academic community also benefits when all efforts are made for *scientific transparency*. This means that the model along with the scientific evidence, interpretation and decision-making process by which it was created should be made available to the public for scholarly debate, validation and improvements (LOPEZ-MENCHERO; GRANDE, 2011; BRUSAPORCI, 2018). Therefore, future interpretation about the archaeological feature has published analysis and results that can be expounded upon, or altered if new research comes to light (GABELLONE, 2015).

Final considerations

Digital media and reconstructions have a relevance in scientific academia just as much as it does in educational institutions. If the final output of a visualization is to inform and educate as well as entertain, then the researchers themselves should take part in the process of reconstruction so that all attempts at accuracy and realism are made. The point of archaeology is not to hoard findings and make it elitist and inaccessible to non-specialists (GABELLONE, 2015). The point is to discover through material remains how ancient and contemporary people have lived and developed around the world, preserve these invaluable remnants of past and contemporary cultures and then share artefacts and sites with digestible and contextualized information that adds value and enriches the living cultures. Digital reconstructions and archaeological visualizations (both real and imagined) combined with innovative technologies for viewing or experiencing virtual archaeology can be a valuable tool for actualizing these goals of proper and careful public

dissemination. While at the same time aiding in the way archaeologists conduct research and analysis.

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