DIGITAL ARCHAEOLOGY, CYBER-ARCHAEOLOGY AND ARCHAEOGAMING: POSSIBILITIES FOR A DISCIPLINE FACING THE DIGITAL WORLD

ARQUEOLOGIA DIGITAL, CIBERARQUEOLOGIA E ARCHAEOGAMING: POSSIBILIDADES PARA UMA DISCIPLINA DIANTE DO MUNDO DIGITAL

Matheus Morais Cruz
Universidade de São Paulo, USP
São Paulo, Brazil
matheusmrcruz@gmail.com

Abstract. This paper seeks to present an overview of the implications of the massive development of computer technologies, especially digital games, on archeology. For this, I will discuss some considerations about the area called Digital Archaeology – which came to be integrated into the debates around Digital Humanities. This field has been responsible for establishing the theoretical and methodological foundations for the holistic understanding of the use of computer technologies in the development of archaeological research. Afterward, I will briefly present the relationship between digital games and archaeology, from the main concepts and advances of Cyber-archaeology and Archaeogaming, two of the most essential branches of Digital Archaeology to deal with digital games. I will present ways in which Cyber-archaeology seeks to develop three-dimensional interactive applications for the production and communication of archaeological research based on the concepts of Virtual Reality and Augmented Reality and their fundamental axes (immersion and real-time interactivity); and how Archaeogaming has been established as a fundamental scientific discipline for understanding the representations of different conceptions of culture and society portrayed in games and simulations through digital archaeological excavations. Finally, I will present some of the pioneer initiatives of cyber-archaeological and Archaeogaming projects developed in Brazil.

Keywords: digital archaeology; digital humanities; cyber-archaeology; archaeogaming; digital games.

Resumo. Este artigo tem como objetivo apresentar uma visão geral das implicações do grande desenvolvimento das tecnologias de computação, especialmente dos jogos digitais, na arqueologia. Para isso, serão discutidas algumas considerações sobre a área denominada Arqueologia Digital - que passou a ser integrada aos debates em torno das Humanidades Digitais. Esse campo tem sido responsável por estabelecer os fundamentos teóricos e metodológicos para a compreensão holística do uso das tecnologias de computação no desenvolvimento da pesquisa arqueológica. Em seguida, serão apresentadas de forma sucinta a relação entre os jogos digitais e a arqueologia, abordando os principais conceitos e avanços da Ciberarqueologia e dos Jogos Arqueológicos, duas das mais importantes vertentes da Arqueologia Digital que lidam com jogos digitais. Serão apresentadas as formas pelas quais a Ciberarqueologia busca desenvolver aplicações interativas tridimensionais para a produção e comunicação de pesquisas arqueológicas, com base nos conceitos de Realidade Virtual e Realidade Aumentada e seus eixos fundamentais (imersão e interatividade em tempo real); e como os Jogos Arqueológicos se estabeleceram como uma disciplina científica fundamental para compreender as representações de diferentes concepções de cultura e sociedade retratadas em jogos e simulações por meio de escavações arqueológicas digitais. Por fim, serão apresentadas algumas das iniciativas pioneiras de projetos de Ciberarqueologia e Jogos Arqueológicos desenvolvidos no Brasil.

Palavras-chave: arqueologia digital; humanidades digitais; ciberarqueologia; jogos arqueológicos; jogos digitais.

INTRODUCTION

The vast and fast development of digital and computational technologies has, since the mid-20th century, had a profound impact on archaeology and cultural heritage management. Beyond the simple common sense that computers function merely as technical tools, archaeologists worldwide have sought to understand these devices' direct implications and influences on the nature of archaeological studies.

Over the past three decades, interest in how computing can be holistically incorporated into archaeology has grown exponentially. Computers have presented a crucial role in reintegrating theoretical issues into the field, laboratory, and research practices, impacting all aspects of archaeological studies from planning to publication/communication. This concern, along with a rigorous fusion between archaeological theory and the practical knowledge of professionals in the field, has led to the emergence of a subfield of archaeology called *Digital Archaeology*.

Among the fields of investigation of this subarea are those directed to the study of the relationship between archaeology and digital games, which, in recent years, have received significant attention from the academic community. These studies encompass not only the critical analysis of historical contexts and material culture representations in digital games from an archaeological perspective but also the development of three-dimensional models and interactive applications by archaeologists. In addition, games

and digital simulations present an active and educational potentiality and have been repeatedly portrayed as a complementary alternative to the different genres of scientific publication/communication.

Based on this trend, I will take the first pages of this paper to briefly present some considerations about Digital Archaeology and the initial contributions of digital technologies applied to the development of archaeological research.

Subsequently, I will discuss more specifically two scientific fields of Digital Archaeology responsible for much of the theoretical and methodological development of the study of the relationship between archaeology and digital games: Cyber-archaeology and Archaeogaming. I will discuss: 1) how Cyber-archaeology seeks to develop, based on the concepts of Virtual Reality and Augmented Reality and its fundamental axes (immersion and real-time interactivity), three-dimensional interactive applications, aiming at the production and diffusion of archaeological research; and 2) how Archaeogaming has been established as a fundamental scientific discipline for the understanding, based on digital archaeological excavation practices, of the representations of different conceptions of culture and society portrayed in games and simulations.

Finally, I will present some of the pioneer initiatives in Cyber-archaeology and Archaeogaming developed in Brazil.

ARCHAEOLOGY AND THE DIGITAL WORLD

The ubiquity of computers and digital technologies is the hallmark of our age. In a short period, these devices have gone from being large and heavy machines used for performing advanced calculations to becoming essential resources for maintaining ordinary everyday activities. Nevertheless, we are only beginning to understand how to apply them productively to our lives.

This reality, however, does not only apply to people's daily lives. Nowadays, it is inconceivable that scientific research could be carried out without using computers and the Internet. These tools have become vital for the proper functioning of academic institutions, and this is due to the nature of the technological advances and transformations that permeate our daily lives almost imperceptibly. According to Paletta (2018), these transformations are the result of three phenomena:

- the convergence of the technological base (digital processing);
- the dynamics of the industry (price drop and popularization of the use of machines);
- and the growth of the Internet (enabling access to data and information).

However, even in academic contexts where technology and digital media have for some time played fundamental roles in all stages of scientific production, attempts at a totalizing understanding of the implications of the digital impact on the core of the disciplines are still very recent (Schreibman, Siemens, & Unsworth, 2004, 2016).

The application of computational tools to explore questions in the Humanities goes back to the context of the emergence of digital computing, which made significant advances after the creation of transistors in 1947 at Bell Telephone laboratories in the United States (Martire & Pina, 2019). Some theorists attribute the first publication to seek an application of computing methods within the Humanities to the *Index Thomisticus*: a project designed to index the works of Thomas Aquinas undertaken by Italian Jesuit and theologist Roberto Busa in 1949 in partnership with IBM founder Thomas J. Watson (Busa, 1980).

Despite this first initiative, the discussion about the real influence of the digital on the Humanities came into perspective only in the last decades. The use of digital technologies is not a neutral or transparent act; its study demands the creation of interdisciplinary critical spaces capable of linking the growing number of new digital media to the disciplines' theoretical bodies with which they are associated. Thus, as a response to these concerns, scholars in the Humanities began to dedicate themselves, especially in the last two decades, to the foundation of new research areas to study the relationship between digital technologies and their specific disciplines. These areas gave rise to what we call Digital Humanities (Schreibman, Siemens, & Unsworth, 2004, 2016; Berry, 2012; Gold, 2012; Drucker, 2014).

In the case of archaeology, the greatest exponent of this movement is Digital Archaeology: a scientific field that presents an essential role in providing methodological foundations to the theoretical perspectives of the discipline, as well as direct and indirect influences on the very development of its theoretical body.

Computers and computational skills have always been necessary for archaeologists since a substantial portion of the archaeological record remains in its computerized form (Eiteljorg, 2004; Evans & Daly, 2016). The digital revolution that has marked the last few decades has impacted the disciplines' paradigms in many ways. We can cite how computational technology has enabled the creation of representations of

the real world (physical, sound, or image) in compact and efficient ways; the facilitation of the counting, manipulation, and analysis of statistical data; the efficient modeling and simulation of complex processes in human history; the creation of virtual worlds independent of actuality; and the transmission of these manipulations, representations, and ideas to audiences worldwide almost instantaneously (Zubrow, 2016).

These digital innovations, however, are not universal or unrelated to the theoretical perspectives of archaeologists, as they directly influence the scope of the theory. In addition to leading to the revision of premises and concepts of the discipline, one must also keep in mind that these computational tools are limited to answering specific questions posed by the researcher (Plets, Huijnen, & Oeveren, 2021). Just as important as knowing how to use them is knowing which one to use. Archaeologists adhering to cultural-historical approaches tend to show great interest in how these tools facilitate statistical analysis and the manipulation and storage of data, seeking to reconstruct human cultural units throughout history, whereas archaeologists adhering to Cognitive Archaeology approaches seek to work with aspects of AI, individual modeling, and visualizations, aiming to answer questions concerning human behavioral patterns (Zubrow, 2016).

In any case, today, the relationship between archaeological work and computers manifests itself from the simplest to the most complex tasks in the daily lives of professionals in the field. As a result, new fields of research have emerged concerned with the role that computer technology plays on methodological and theoretical aspects of archaeology: areas that deal with the use of specific software for reading data generated by geoprocessing work (Geographic Information Systems-GIS), geophysical analyses (such as metal detectors, radars, resistivity, conductivity, magnetometry), satellite photography, multispectral imaging, geochemical analyses, etc. ; the Agent-Based Modeling (ABM) (Romanowska et al., 2019; Graham, 2020), whose application aims to establish patterns of behavior to programmed agents in order to create digital simulations; the 3D scanning of archaeological and cultural heritage; Retrogame Archaeology (Aycock, 2016), whose goal is to reverse engineer the software and hardware of old videogames to explore the techniques that developers used to run their products on very restricted platforms; Reflectance Transformation Imaging (RTI), whose computational photography method allows interactive illumination on the surface of objects in order to explore details hardly captured by the naked eye; and, finally, Archaeogaming (Reinhard, 2018) and Cyber-archaeology (Forte, 2010), areas that will be approached in more detail in the course of this paper.

ARCHAEOLOGY AND DIGITAL GAMES: DIVERGENT FIELDS?

When we talk about digital games, our first reaction is to think of those computer and video games produced by large corporations, very profitable products made exclusively for the billion-dollar entertainment industry. We think of the old LAN Gaming Centers or cybercafés, full of teenagers who asked their parents for money to spend the day playing and surfing the Internet with their friends or the weekend get-togethers at the homes of friends who could afford their videogame consoles. We also think of today's eSports, with their big championships televised on the major TV stations, played by young people who are already millionaires and sponsored by famous brands in entertainment and technology.

There is, however, another domain of this universe, less glamorously seen by the public but of fundamental importance: digital games in education and science.

In recent years, the academic community, including professionals in archaeology, has shown great interest in the relationship between digital games and simulations, research, education, and communication. Part of the misconception that hovered over this media has been abandoned due to its significant impact on people's daily lives. Its exponential popularization can be partly explained by the decrease in prices of these products and by its potential to convey feelings of immersion, competitiveness, and interaction among users (Champion, 2017; Morgan, 2017).

However, would digital games and archaeology be divergent fields? Archaeology aims to study material culture and its physical, functional, and symbolic aspects through specific research methodologies. Digital games are nothing more than human products, recorded in physical or digital media and created from the fusion between four elements: programming codes, texts (computational linguistics), audio, and art (graphic design) (Copplestone, 2017), being, therefore, a part of contemporary material culture loaded with meanings as a result of subjective interpretations of reality by groups of people. On the other hand, games can also be broadly defined as ludic means of learning that date back hundreds of years (Martire & Pina, 2019) and provide complex approaches to the past and the present through interpretative frameworks correlated to a contextualized use of technology (Ribeiro & Trindade, 2017).

The use of digital games by teachers and students of elementary schools not only increases daily activities but also stimulates the understanding of their elaboration stages. Furthermore, it helps improve the communication between elementary education and university and provides a product based on archaeological research that can be critically analyzed, promoting an accurate teaching-learning process of historical knowledge (Fleming et al., 2017).

As pointed out by Erik Champion, digital games offer a learning potential through tools focused on non-textual visualization, besides their ability to convey stories and meanings (Champion, 2015). Although games are received socially, above all, as commercial products, they also assume the role of diffusers of a specific knowledge shaped and programmed by their developers. Therefore, they can be worked from an educational perspective and should be understood as primary or secondary sources to be analyzed with the criticality required by the scientific process.

Understood as a new type of media (Copplestone, 2017), digital games should be examined as critical opinion-forming vehicles. It is then necessary to reflect on the possibilities presented by this tool of convergence between the production of scientific knowledge (specifically, the interpretations and representations of the past and its material culture) and specific practices of development of these games guided by interdisciplinarity.

Thus, I will present the two main disciplines, branches of Digital Archeology, responsible for establishing the theoretical and methodological foundations regarding the dialogue between archeology and digital games production and analysis.

Cyber-archaeology: Immersion and Real Time Interactivity

Cyber-archaeology emerged as a branch of Digital Archaeology and became popular among archaeologists in the academic community after the publication of the BAR International Series volume titled *Cyber-Archaeology*, edited by Italian archaeologist Maurizio Forte in 2010 (Forte, 2010). This volume was responsible for gathering several articles from two workshops on digital tools applied to archaeology, which aimed to discuss and systematize the discipline's epistemological, technological, and methodological issues.

In Brazil, the first major publication in the area, responsible for spreading the concepts and practices of Cyber-archaeology, was the doctoral thesis of Brazilian archaeologist Alex da Silva Martire called *Cyber-archaeology in Vipasca: the use of technologies for interactive archaeological reconstruction-simulation*, published in 2017 by the Museum of Archaeology and Ethnology of the University of São Paulo, which also resulted in the development of the game *Vipasca Antiga*[1] (Martire, 2017).

Cyber-archaeology is essentially defined as the application of practices and concepts inherited from cybernetics, mainly Virtual Reality, to the study and analysis of archaeological material culture (Forte, 2010; Martire, 2017). First, however, to understand the implications of the prefix "cyber" for archaeology, it is necessary a brief overview of the epistemological developments comprised by the three great waves of research that characterize the history of cybernetics (Hayles, 1999).

The first wave (from 1945 to 1960) is considered the first major initiative to establish the field's theoretical and methodological foundations. During this period, the works of the American mathematician Norbert Wiener (Fig. 1) stand out. During the Macy Conference on Cybernetics in 1946, Wiener stressed the idea that employing the development of the concept of *homeostasis*, the centrality of information is the most critical entity in the man-machine relationship, which built the foundation for the application of human languages to synthetic systems (Wiener, 1968; Hayles, 1999).

[1] Available for free download at: http://www.larp.mae.usp.br/rv/vipasca-antiga/

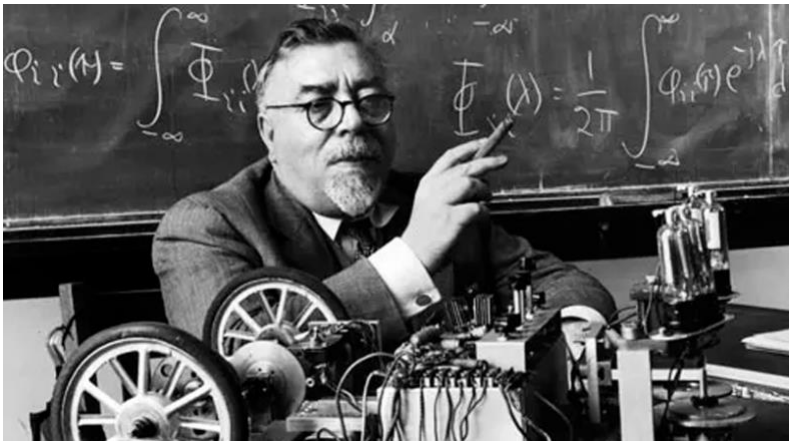

Figure 1. Norbert Wiener. Source: Estado da Arte (2017).

Between 1960 and 1985, what is usually called the Second Wave of Cybernetics emerged. Above all, this period is characterized by the introduction of the concept of *autopoiesis* into cybernetics, which drew the attention of researchers to the impact of the observer's role within regulable systems. This concern started from the principle that the understanding of cybernetics would intensely depend on reflexivity: that is, the idea that the observers' own experiences shape the way the observable world presents itself to them (Forte, 2010; Martire, 2017). Among the principal works of this movement, the research of Chilean biologists Humberto Maturana and Francisco Varela (Maturana & Varela, 2011) stands out as some of the most emblematic.

Finally, according to Hayles (1999), the third wave contemplates the theoretical and methodological developments from the mid-1980s to the present day. During this period, cybernetics scholars (like Varela himself), criticizing the second wave's limitations and deeply driven by the rapid and substantial computational development, sought to emphasize the evolution of systems in new directions, with virtuality as the central concept. Starting from the expansion of the self-organization notion (based on the concept of *autopoiesis*) to artificial systems, these scholars sought to understand not only how these systems (including machines) could replicate themselves but also how this reproduction tendency could work as a starting point for their evolution (Hayles, 1999; Martire, 2017).

In this scenario, the fields of study of Artificial Life, Artificial Intelligence, and Virtual Reality[2] emerged; the latter as the key concept for understanding Cyber-archaeology (Martire, 2017).

The concern with the use of electronic devices for research and communication in archaeology accompanies the discipline even before the emergence of the concept of Virtual Reality. Three-dimensional models driven by advances in computer graphics, for example, were already present in the vocabulary of archaeologists in the early 1980s, especially with the so-called *Virtual Archaeology* (Reilly, 1990).

Concerned with extrapolating the limits of traditional academic production, Virtual Archeology sought to develop digital simulations of archeological contexts, which, in theory, could be used mainly by researchers who did not have access to these sites during excavations. However, in practice, due in part to the limited processing power of computers of the period, the simulations produced by archaeologists of this area were limited to rendered animations of three-dimensional reconstructions of archaeological sites and objects. Thus, they were passive simulations, which ended up being little explored by the archaeological community, receiving much more visibility in television programs, cinema, and educational videos (Martire, 2017).

The difference between Virtual Archaeology practiced in the 1980s and 1990s, and Cyber-archaeology is that the latter applied to these three-dimensional models the cybernetic concepts of Virtual Reality and Augmented Reality, and, with them, their fundamental axes: real time immersion and interactivity (Forte, 2010; Martire, 2017).

It means that instead of rendered animations with which the public deals passively, cyber-archaeological applications started to demand new cognitive processes from users achieved only through an active posture, in which the man-machine relationship is fed back from immersion and interactions held in the digital environment.

[2] The concepts of "real", "virtual", and "actual" are discussed and analyzed in detail by Lévy (1995).

Thus, according to Martire, the applications of Cyber-archaeology can be divided basically into two categories: 1) for the collection of data in the field and laboratory analysis, with the use of 3D scanners and other devices that transform physical data and information into digital data; and 2) for the communication of results, with the production of interactive three-dimensional virtual environments of a didactic and educational nature, including digital games (Martire, 2017).

Figure 2. Example of cyberarchaeological application for field data collection: FARO Focus 3D S120 scanning Neolithic buildings in the North Area of Çatalhöyük's East Mound. Source: Lercari (2016, p. 18, fig. 8).

It is important to note, however, that the goal of Cyber-archaeology is not to reconstruct the past through the 3D modeling of archaeological sites and objects. Although the term reconstruction is quite recurrent in the cyber-archaeological bibliography, including the works by Maurizio Forte (Forte, 2000, 2010; Forte & Campana, 2016), its use can imply a misreading of the aims of the discipline. This term is rooted in archaeology, coming from a Kroeberian vision[3] of archaeological practice, focused on establishing cultural norms and exact reconstructions of the human past, widely spread between the 1930s and 1950s.

According to Clark (2010, p.67), a perfect (digital or not) reconstruction of the human past would be impossible, since, besides having a fragmented and lacunar access to the vestiges of the past, our interpretations are the result of relationships between multiple variables established from our subjective experiences. Clark proposes the use of the terms "models" or "constructions", which would be capable of conveying scientific or interpretative models "produced from the interplay between empirical observations, assumptions, logical interpretation and extrapolation, and creative imagination".

Cyber-archaeological applications, therefore, are not attempts to replicate a particular phenomenon from the past. Instead, they seek to propose interpretative 3D models from archaeological research, which operate as tools capable of making us reflect on complex phenomena of human history.

Archaeogaming: an archaeology *in* and *of* digital games

Archaeogaming is a field of research in archaeology derived from the doctoral thesis of American archaeologist Andrew Reinhard, defended in 2019 at the University of York in England. However, its

[3] Alfred Louis Kroeber was a leading American cultural anthropologist, a disciple of Franz Boas, and a professor in the Department of Anthropology at the University of California, Berkeley.

introduction into the academic community dates back a year earlier, with the publication of the book *Archaeogaming: an introduction to archaeology in and of video games*[4] in 2018.

Before the publication of his work, however, Andrew Reinhard had already conducted some works whose goal was to understand the relationship between digital games and archaeology. The most important of them was excavating a landfill in a desert area in the city of Alamogordo (New Mexico-USA) in 2014 (Moura et al., 2020). This excavation project, which came to be considered the first to deal with material culture related to physical traces of digital games, was responsible for identifying hundreds of thousands of copies of cartridges of the game E.T.: The Extraterrestrial (popularly recognized as the worst game of all time) and other titles developed by the company Atari (Fig. 2), discarded and buried at this site in 1983, due to the enormous commercial failure of sales of the products[5] (Reinhard, 2018).

Figure 3. Remnants of Atari games found during excavation at Alamogordo (New Mexico-USA).
Source: Reinhard (2018, p. 24).

The excavation of Atari games was paramount to developing the first notions of what would become Archaeogaming. Besides integrating aspects of Public Archaeology – since the project involved not only archaeologists but also professionals from the gaming industry, journalists specialized in digital games, gamers, and interested people in general – the excavation also attested the need to read these objects as artifacts capable of carrying historical and cultural meanings produced by humanity (Reinhard, 2018; Moura et al., 2020), both from the physical point of view of the natural world and from the digital point of view of the synthetic world.

Archaeogaming is thus constituted as an interdisciplinary approach to the so-called Archaeology of the Present, also incorporating elements from media studies (Reinhard, 2018), which would later come to receive its own denomination among scholars in the field: the Archaeology of Media (Parikka, 2012; Ávila, 2020; Telles, 2020). As the primary reference for researchers interested in the dialogue between archeology and digital games, its goal is to systematize and spread the bases for developing a scientific methodology for the archeological work of and in digital games.

In setting up the archaeology *of* digital games, Archaeogaming starts from the physical point of view of the natural world, comprising that material culture composed of cartridges, consoles, and CDs, among other supports produced for the storage and operation of these games. While these materials can be understood as archaeological artifacts, old game stores, arcades, factories, development studios, or even landfills (as in the case of Alamogordo) can be understood as true archaeological sites to be excavated. In

[4] The book's digital version is accessible at the following link: http://andrewreinhard.com/wp-content/uploads/2020/03/Archaeogaming-Ebook.pdf.
[5] The excavation is one of the topics covered by the documentary Atari: Game Over (2014), directed by Zak Penn, whose script is dedicated to the history of the Atari company.

his book, Reinhard exemplifies this way of doing Archaeogaming by proposing the establishment of typologies and chronologies for the rescued artifacts – one of the standard practices in archaeological studies. or that, he proposes analyzing their graphic changes over time or their various versions (the so-called builds) - responsible for correcting technical problems and execution errors – as a parallel with the traditional stratigraphy of archaeological artifacts and sites (Reinhard, 2018).

Understanding physical media as archaeological artifacts and gaming spaces (arcades, arcades, studios, etc.) as archaeological sites also encompasses concerns about the conservation, preservation, and exposure of this material and these places. The technological environment leads to the vertiginous disappearance of digital data with every hardware and software update of the devices. In addition, just like any other artifact artificially produced by humankind, these objects tend to degrade, causing the total or partial loss of important information about their history and development. As a result, Reinhard also defends the reflection on the existence and role of museums focused on digital games (Reinhard, 2018).

Moreover, the study of this materiality can answer questions that permeate other levels of human interaction that also make up the production of digital games, such as the work organization in game companies, issues related to digital ethics, financial and environmental costs, workers' physical and emotional, among others (Moura et al., 2020).

On the other hand, Archaeogaming can also be understood as the archaeology *in* digital games. This aspect starts from the digital point of view of the games' synthetic world, with the transposition of methodological aspects of the natural world, as well as of theoretical aspects of the discipline, such as the quantitative perspectives of the Processual archaeology, and contextual perspectives from Post-processual archaeology (based on the actions of the developers, the players, and the player's digital avatar), to the digital world (Moura et al., 2020).

In this case, games are not only seen as artifacts but also as archeological sites since they are environments (although digital) built by people (or algorithms created by them) which can be used – or even "inhabited/occupied", as in the case of games played for months or years. Moreover, games are also able to record the present and past activities of these human beings since they: document the developers' programming codes and their changes over time; have installations on physical media or hardware; are modified by player interaction; and, mainly, are constituted by landscapes and environmental contexts (vegetation, topography, hydrography, ecosystems, worlds, countries, cities, buildings, monuments, dwellings, ruins, among others) created by developers and shared with users (Reinhard, 2018).

Thus, games are amenable to applying archaeological research methods from the natural world, like great archaeological sites. As with any research program, these archaeological sites can be explored by surveys, surface (or, in some cases, subsurface) prospections, georeferencing (through screenshots or the coordinates intrinsic to the game), among others, drawn primarily from the area known as Landscape Archaeology. Later, through a series of digital tools often offered by the games themselves or by independent software, these sites can be prepared, recorded, measured, photographed, stratigraphically analyzed, etc. Their artifactual elements can be collected or left in place, restored, studied, confronted with other documents, and displayed. In his book, Reinhard presents a case study conducted on the game *No Man's Sky* (Hello Games, 2016) (Fig. 3) as a result of the *No Man's Sky Archaeological Survey (NMSAS)* excavation project, which even accompanies an appendix with its own code of ethics (Reinhard, 2018, 2019).

Figure 4. Abandoned site from the game *No Man's Sky* (Hello Games) excavated in the scope of the NMSAS project. Source: Archaeology Data Service (2019).

Archaeology in digital games, with its wide range of theoretical and methodological possibilities, represents an effort to answer questions concerning the human presence in the so-called Anthropocene, as well as the modern notions of culture, history, and society shared among people in the present time from digital environments created and modified mainly by two agents: the developers and the players.

It means that Archaeogaming makes it possible to understand how both dialogue with the world. As previously addressed, games and simulations are never reconstructions of reality (Clark, 2010), whether partially or entirely fictional or based on existing human societies and cultures in history. Instead, through the creation, use, modification, and appropriation of games, these agents establish their personal or communal interpretations and projections of reality based on their own lives and experiences.

Being within the so-called Archaeology of the Present, Archaeogaming still faces resistance from the more traditional fields of archaeological research. Nevertheless, its goal is nothing more than developing new ways to reflect on the materiality we produce and the way we relate to it (Reinhard, 2018) because it is only through the knowledge of things and objects to which we are engaged, amalgamated and entangled, that we can know ourselves and the world around us (Ingold, 2012; Pina, 2019).

CYBER-ARCHAEOLOGY AND ARCHAEOGAMING: PIONEER INITIATIVES IN BRAZIL

Cyber-archaeology and Archaeogaming have been established internationally as the two main areas regarding the relationship between digital games/simulations and archaeology. It is reflected by the exponential increase of academic events on this topic (Interactive Pasts Conferences, CAA Conferences, Archaeogaming Con., Theoretical Archaeology Group Conferences, among others) and the flourishing of research groups and centers around the world (VALUE Foundation, Center for Cyber-Archaeology & Sustainability - UC San Diego, Centre for Digital Heritage - University of York, DIG@Lab - Duke University, etc.).

In Brazil, Cyber-archaeology and Archaegaming – or even Digital Archaeology as a whole – still have a little expression in museums and research institutions. Moreover, only a few universities have disciplines, laboratories, groups, and study centers directed to these areas. Despite this, some pioneering initiatives have promoted the development of projects and investigations responsible for disseminating their knowledge to archaeologists and the general public.

With the publication of the already mentioned *Vipasca Antiga* game, Cyber-archaeology has started to receive some attention from the scientific-academic community in the country. It is possible to mention, for example, the work developed by the *Laboratório de Arqueologia Romana Provincial (LARP)* coordinated by archaeologists Maria Isabel D'Agostino Fleming and Vagner Carvalheiro Porto and based at the *Museu de Arqueologia e Etnologia* of the *Universidade de São Paulo (MAE-USP)*, which seeks to adopt and develop new computational technologies concomitantly with the development of scientific research on Roman antiquity (Fleming et al., 2017).

Among the laboratory's products[6], we highlight: *Roma Touch*, an application in which the user can navigate through a three-dimensional map of Ancient Rome and obtain information about the monuments and buildings that composed the city's landscape; *Interactive Map of the Roman Empire*, composed of textual resources, 3D models of archaeological remains, and a photographic collection visually plotted in each region that composed the Roman Empire; *DOMUS*, an interactive 3D simulation of a Roman house; and *O Último Banquete em Herculano* (Fig. 4), an adventure game, accompanied by an eBook (Fleming & Martire, 2019) and a teaching guide (Gregori & Pina, 2018), that aims to disseminate knowledge regarding the multiple spheres that composed the daily life of the inhabitants of Herculaneum, a city devastated by the eruption of Vesuvius in 79 AD.

Figure 5. Screenshot of the game *O Último Banquete em Herculano*.
Source: *O Último Banquete em Herculano* (LARP-MAE-USP, 2019).

Besides LARP, the Research Group *Arqueologia Interativa e Simulações Eletrônicas* (ARISE)[7], coordinated by archaeologist Alex Martire and also based at the *Museu de Arqueologia e Etnologia* of the *Universidade de São Paulo*, emerged from an initiative to create a group of researchers who wanted to bring the discussions about the potential of the digital world and its applicability in archaeological studies to the Brazilian academic production in Archaeology.

Founded in 2017, ARISE seeks to foster the academic analysis of interactive electronic media (electronic games, serious games, digital simulations) based on the concepts from Archaeogaming and to produce interactive cyber-archaeological resources for museums and educational institutions.

Although recently founded, the group presents in its history a vast list of scientific productions:

- promotion of events and academic courses focused on several topics of Digital Archaeology accessible to students and the general public, such as the first national symposium exclusively focused on Digital Archaeology;
- production of videos and papers where the representation of Archaeology and material culture in digital games are analyzed;
- archaeological excavations based on the methods from Archaeogaming and performed in digital games with the participation of the community, through live-streaming platforms, among others.

Based on the use of electronic devices for analysis and communication of archaeological research results in three-dimensional interactive environments, the Research Group ARISE and the *Grupo de Pesquisa em Educação Patrimonial e Arqueologia-GRUPEP* of the *Universidade do Sul de Santa Catarina (Unisul)* established a partnership for the development of the game *Sambaquis: uma história antes do Brasil* (Fig. 5). In addition to the game, which was supplemented by a educational guide (Cardoso, Silva, & Zamparetti, 2019) and a low

[6] The interactive 3D applications of the *Laboratório de Arqueologia Romana Provincial (LARP)* can be downloaded for free through the link: http://www.larp.mae.usp.br/rv/
[7] To learn more about ARISE's projects, access: http://www.arise.mae.usp.br/

poly version[8] released in 2021, this partnership also resulted in the publication of an Augmented Reality app called *Arqueologia R.A. - Grupos Pré-Coloniais de Santa Catarina*. This app is intended mainly for teachers, educators, and students of Brazilian schools and allows the visualization of archaeological artifacts belonging to the region's ancient inhabitants.

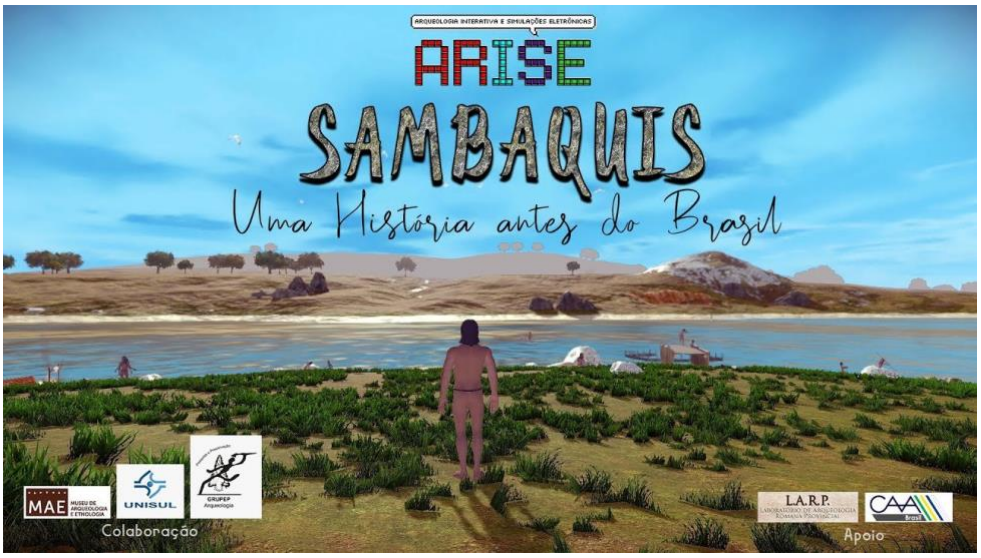

Figure 6. Cover of the game *Sambaquis: uma história antes do Brasil.*
Source: ARISE-MAE-USP, 2019.

Another laboratory from the *Museu de Arqueologia e Etnologia* of the *Universidade de São Paulo* is the *Laboratório de Estudos sobre a Cidade Antiga* (LABECA)[9], which was also responsible for developing cyber-archaeological projects. Among them are the digital models of a port, a house, and a temple from Ancient Greece, used for actions of scientific communication and educational practices.

Initiatives in the Cyber-archaeology field have also been developed through a partnership between the *Centro Interdisciplinar em Tecnologias Interativas (Citi)*, based at the *Escola Politécnica* of the *Universidade de São Paulo (Poli-USP)* and coordinated by engineer Marcelo Zuffo, the *Museu de Arqueologia e Etnologia* of the *Universidade de São Paulo* and *Duke Immersive Virtual Environment (DiVE)*, from Duke University, in the United States. This partnership was responsible for the 3D scanning and development of simulations of the blast furnaces of the *Real Fábrica de Ferro São João de Ipanema (Iperó-SP)* historical buildings and the *Abrigo de Itapeva* and *Abriga da Santa* (both in Itapeva-SP) and *Bastos* (Dourado-SP) archaeological sites.

Other more recent initiatives regarding the study of archaeology and digital games involving Cyber-archaeology and Archaeogaming are the extension project *ERGANE: Arqueologia Digital para o Ensino* from the *Universidade Federal do Rio Grande do Sul (UFRGS)* and the *Grupo de Estudos de Arqueologia e Mídias Eletrônicas (GAME)*, coordinated by the archaeologist Bruno Sanches Ranzani da Silva from the *Universidade Federal de Sergipe*.

CONCLUDING REMARKS

In this paper, I present some considerations about the role that the new digital and computational technologies have played in archaeological research for the last thirty years. From the reading of voluminous statistical data to the development of digital simulations of complex processes of human history, these technologies have presented themselves as indispensable tools for archaeological work and scientific dissemination.

Although archaeologists are still gradually acquiring an interest in the understanding of how computing can be holistically incorporated into the discipline, this concern has led to the development of several

[8] *Sambaquis – Uma História antes do Brasil (Low-Poly)* is an optimized and adapted version of the original game. This version aims, through the development of stylized modeling of a few polygons (low-poly), to provide a final product that can run on low-cost equipment such as smartphones, tablets, and computers with low processing capacity.
[9] LABECA's digital models can be found at the following link: http://labeca.mae.usp.br/pt-br/professores/maquetes-digitais/

initiatives, which resulted in the creation of what we call Digital Archaeology: a subfield of archaeology which attempts to provide the theoretical and methodological foundations for this debate.

These digital innovations, however, represent not only methodological tools for archaeological research but also starting points for different theoretical reflections that compose the discipline.

Digital Archaeology encompasses many sub-disciplines, research lines, and methodologies that seek to deal with the voluminous amount of data and types of digital media that exist today. Among these media, digital games stand out. They have drawn the attention of the academic community due to their playful and educational potential and their existence as primary or secondary sources for the understanding of aspects of social, cultural, and symbolic life in contemporary society.

Although still very recent, Cyber-archaeology, disseminated in 2010 by Maurizio Forte and brought to Brazil in 2017 by Alex Martire, and Archaeogaming, created by Andrew Reinhard, are disciplines that have sought to deal with the still little-explored relationship between archaeology and digital games. They also show themselves as fields with great potential for producing and communicating archaeological research.

Thanks to the concepts and practices aggregated by both, today, it is already possible to interact three-dimensionally with simulations of objects and contexts from the past rescued by the archaeological practice, as well as to better understand the human presence in the Anthropocene through new ways of understanding how we interact and appropriate materiality.

REFERENCES

Ávila, C. (2000). *A incrustabilidade durante em jogos digitais:* Escavações de uma Archaeogamer. [Master's thesis, Universidade do Vale do Rio dos Sinos].

Aycock, J. D. (2016). *Retrogame Archeology:* Exploring Old Computer Games. Cham: Springer International Publishing Switzerland.

Berry, D. (Ed.) (2012). *Understanding Digital Humanities*. London: Palgrave Macmillan.

Busa, R. (1980). The Annals of Humanities Computing: the Index thomisticus. *Computers and the Humanities*, 14, 83-90.

Cardoso, J. M., Silva, R. E., & Zamparetti, B. C. (2019). *Sambaquis:* uma história antes do Brasil: guia didático. São Paulo: MAE/USP.

Champion, E. (2015). *Critical gaming:* interactive history and virtual heritage. Surrey: Ashgate.

Champion, E. (2017). Bringing your a-game to digital Archaeology. Issues with serious games and virtual heritage and what we can do about it. *SAA Magazine*, 17 (2), 24-27.

Clark, J. T. (2010). The fallacy of reconstruction. In: Forte, M. (Ed.). *Cyber-Archaeology*. Oxford: Archaeopress, BAR, 2177, 63-73.

Copplestone, T. (2017). Adventures in Archaeological Game Creation. *SAA Magazine*, 17 (2), 33-39.

Drucker, J., Kim, D., Salehian, I., & Bushong, A. (2014) *Introduction to Digital Humanities*. Concepts Methods, and Tutorials for Students and Instructors. Los Angeles: University of California

Eiteljorg, H., II. (2004). Computing for Archaeologists. In: Schreibman, S., Siemens, R., & Unsworth, J. (Eds.). A *Companion to Digital Humanities*. Oxford: Blackwell Publishing, 20-30.

Evans, T. L. & Daly, P. (2016). *Digital Archaeology* – bridging method and theory. London/New York: Routledge.

Fleming, M. I. D., Abreu, T. B. A., Bastos, M. T., Martire, A. S., & Gregori, A. M. (2017). A importância das novas tecnologias para a arqueologia e suas possibilidades de uso. A Impressão 3D e os projetos do LARP. *Vestígios - Revista Latino-Americana de Arqueologia Histórica*, 11 (1), 57-79. doi: 10.31239/vtg.v11i1.10551

Fleming, M. I. D. & Martire, A. S. (Orgs.) (2019). *Humanidades digitais e arqueologia*: o desenvolvimento de o último banquete em Herculano. São Paulo: MAE/USP.

Forte M. (2000). About virtual archaeology: disorders, cognitive interactions and virtuality. In: Forte, M., Barcelo, J., & Sanders, D. (Eds.). *Virtual reality in Archaeology*. Oxford: Archaeopress, BAR, 843.

Forte, M. (2010). Introduction to Cyber-Archaeology. Forte, M. (Ed.) *Cyber-Archaeology*. Oxford: Archaeopress, BAR, v.2177, p.9-13.

Forte, M. & Campana, S. (Eds.) (2016). *Digital Methods and Remote Sensing in Archaeology* – Archaeology in the Age of Sensing. Cham: Springer.

Gold, M. K. (Ed.) (2012). *Debates in the Digital Humanities*. Minneapolis: University of Minnesota Press.

Graham, S. (2020). *An Enchantment of Digital Archaeology*: Raising the Dead with Agent-Based Models, Archaeogaming and Artificial Intelligence. New York: Berghahn Books.

Gregori, A. M. & Pina, A. D. V. (2018). *O último banquete em Herculano*: Guia Didático. São Paulo: MAE/USP.

Hayles, N. K. (1999). *How we became posthuman*. Virtual bodies in cybernetics, literature, and informatics. Chicago: The University of Chicago Press.

Ingold, T. (2012). Trazendo as coisas de volta à vida: emaranhados criativos num mundo de materiais. *Horizontes Antropológicos*, 18 (37), 25-44. doi: 10.1590/S0104-71832012000100002

Lévy, P. (2007). *O que é o virtual?* São Paulo: Editora 34.

Martire, A. S. (2017). *Ciberarqueologia em Vipasca*: o uso de tecnologias para a reconstrução-simulação interativa arqueológica [Doctoral dissertation, Museu de Arqueologia e Etnologia, Universidade de São Paulo].

Martire, A. S. (2019). Desenvolvendo O Último Banquete em Herculano – Humanidades Digitais e Arqueologia em ambientes interativos. In: Fleming, M. I. D., & Martire, A. S. (Orgs.) *Humanidades digitais e arqueologia:* o desenvolvimento de o último banquete em Herculano. São Paulo: MAE/USP, 20-25.

Martire, A. S. & Pina, A. D. V. (2019). Humanidades Digitais e Jogos Eletrônicos como Meio de Aprendizado Histórico. In: Fleming, M. I. D., & Martire, A. S. (Orgs.) *Humanidades digitais e arqueologia:* o desenvolvimento de o último banquete em Herculano. São Paulo: MAE/USP, 6-12.

Maturana, H. R. & Varela, F. J. (2011). *A árvore do conhecimento*. As bases biológicas da compreensão humana. São Paulo: Editora Palas Athena.

Morgan, C. (2017). An unexpected Archaeology: an interventionist strategy for video games and Archaeology. *SAA Magazine*, 17 (2), 28-32.

Moura, C. H., Martire, A. S., Pina, A. V., Cafagne, T. P., & Cruz, M. M. (2020). Uma conversa sobre Archaeogaming com Andrew Reinhard. *Aedos*, 12 (26), 721-739.

Paletta, F. C. (2018). Ciência da Informação e Humanidades Digitais – uma reflexão. In: XIX Encontro Nacional de Pesquisa em Ciência da Informação, 2018, Londrina. *Anais do XIX Encontro Nacional de Pesquisa em Ciência da Informação*. Londrina: ENANCIB, 147-162.

Parikka, J. (2012). *What is Media Archaeology?* Cambridge: Polity Press.

Plets, G., Huijnen, P., & Oeveren, D. (2021). Excavating Archaeological Texts: Applying Digital Humanities to the Study of Archaeological Thought and Banal Nationalism. *Journal of Field Archaeology*, 46 (5), 289-302.

Pina, A. D. V. (2019). Os artefatos arqueológicos podem jogar? O estudo da materialidade no contexto ciberarqueológico. *Revista Arqueologia Pública*, 13 (2), 97-123. doi: 10.20396/rap.v13i2.8657333.

Reilly, P. (1990). Towards a virtual archaeology. In: Lockyear, K., & Rahtz, S. (Eds.) *Computer Applications in Archaeology 1990*. Oxford: British Archaeological Reports (Int. Series 565), 133-139.

Reinhard, A. (2018). *Archaeogaming:* An introduction to archaeology in and of video games. New York: Berghahn Books.

Reinhard, A. (2019). *No Man's Sky Archaeological Project [data-set]*. York: Archaeology Data Service [distributor]. Disponível em: https://doi.org/10.5284/1056111

Ribeiro, A. I. & Trindade, S. D. (2017). O ensino da História e tecnologias – conexões, possibilidades e desafios no espaço das Humanidades Digitais. In: Porto, C., & Moreira, J. A. (Orgs.). *Educação no ciberespaço.* Novas configurações, convergências e conexões. 1ed. Aracajú/Santo Tirso: Editora Universitária Tiradentes/Editora WhiteBooks, 145-159.

Romanowska, I., Crabtree, S. A., Harris, K., & Davies, B. (2019). Agent-Based Modeling for Archaeologists: Part 1 of 3. *Advances in Archaeological Practice*, 7 (2), 178-184. doi: 10.1017/aap.2019.6.

Rua, H. & Alvito, P. (2011). Living the past: 3D models, virtual reality and game engines as tools for supporting archaeology and the reconstruction of cultural heritage – the case-study of the Roman villa of Casal de Freiria. *Journal of Archaeological Science,* 38 (12) 3296-3308.

Schreibman, S., Siemens, R., & Unsworth, J. (Eds.) (2004). *A Companion to Digital Humanities*. Malden: Blackwell.

Schreibman, S., Siemens, R., & Unsworth, J. (Eds.) (2016). *A New Companion to Digital Humanities*. Malden: Blackwell.

Telles, M. (2020). Arqueologia das Mídias como Pós-História das Mídias. *Questões Transversais*, 8 (16), 14-21.

Wiener, N. (1968). *Cibernética e sociedade:* o uso humano de seres humanos. São Paulo: Cultrix.

Zubrow, E. B. W. (2016). Digital Archaeology – a historical context. In: Evans, T. L., & Daly, P. *Digital Archaeology* – bridging method and theory. London/New York: Routledge, 8-26.