3-D Virtual Replicas and Simulations of the Past

"Real" or "Fake" Representations?

by Fabrizio Galeazzi

This paper investigates the ontology of 3-D replicas and simulations of archaeological and heritage sites. In the past 20 years, the use of new technologies for the 3-D documentation and reconstruction of cultural heritage has altered approaches to the analysis and interpretation of tangible heritage. The preservation and recreation of the past is becoming increasingly "digital." Scholars are debating the authenticity of 3-D digital reproductions in heritage and archaeology. How should we consider these digital and virtual reproductions? Are they original digital representations of our cultural heritage or just virtual "fakes"? It is argued that it is not possible to define universal predetermined categories for the definition of "authentic" in the digital domain, since 3-D digital reproductions of tangible heritage are always influenced by the subjective interpretation of the creator of 3-D content. To support this argument, three case studies are presented that deal with the contested and controversial concept of authenticity in different domains: physical, digital, and a combination of physical and digital.

Introduction

Digital technologies provide an opportunity to bridge the gap that exists between past and present, guiding people in emotional immersive experiences that can improve their consciousness of the past, described by Lowenthal as "a foreign country" (Lowenthal 1985:xvi). The experience of people today is limited to what remains of our ancient past in the form of archaeological sites and artifacts. They are decontextualized (i.e., removed from their original context) ruins that evoke the memory of a monument's shape but do not retain its original spirit.

These remains bridge past and present and should be considered not simply ruins but animated objects. "A ruin, an abandoned building, gives hospitality to melancholic ghosts that a good restoration and its appropriate reuse can certainly exorcise" (translated from Ruggieri Tricoli 2000:11). Throughout a site's history, in fact, diverse societies will have changed and reused the material remains found there, altering their shape and symbolic meaning. This process can be considered an evolution, or a biography of things, that reflects past experiences and can be traced by analyzing monuments and artifacts. Several scholars have exhaustively studied "things" by analyzing their biographies, starting with Igor Kopytoff (1986), who discusses the cultural biography of things in archaeology. From this discussion, other scholars have developed object biographies for the analysis of material culture (Holtorf 2002; Knappett 2002; Spector 1993; Tringham 1994). Allan Pred describes "humanly made objects" as having life histories that have continuous paths through time and space and which intersect with one another (Pred 1984:281).

From the perspective of object biography theories, it seems clear how the study of ancient artifacts should consider not only their original context but also their present status as physical remains. It is this status that archaeologists and the general public relate to. Moving in the present landscape, people experience a constant embodied engagement with material remains of the past that fundamentally conditions our daily routine. This engagement is strongly influenced by the relationship that exists between our body and our mind (Lakoff and Johnson 1999; Seremetakis 1994; Varela, Thompson, and Rosch 1999).

By experiencing the sensory landscape created by surviving material remains, our mind is able to activate subjective mental interpretation processes to simulate the potential original shape and context of the landscape. In this process of the mind, there are at least two steps. The first is the mental construction of the contemporary site that we create through our working memory (Tversky 2001:371). The second and more complicated part of the process is the mental interpretation of the landscape's original shape. When we visit an archaeological site, if we close our eyes with the remains in front of us, they suddenly disappear and are substituted with our interpretations of the remains' past aspect.

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The meaning of "space" is the result of human mental processes. As such, it must be clarified and understood from the perspective of the people who have given it meaning. For this reason, a sense of "place" is intrinsic to the human experience. Furthermore, according to the human geographer Yi-Fu Tuan (1977), we have both an internal and external perception of "place." We live our lives in a place and have a sense of being part of a place, but we also view place as something separate from ourselves. Contemporary society, characterized by an increasingly scientific and technological worldview, is transforming the subjective point of view—a centered view in which we are embedded within a place and time—into an objective point of view—a decentered view in which we seek to transcend the here and now (Entrikin 1991:7). Scientific theorists stress the capacity of society to increase the "distance" between the subjective and objective view as a result of the decentered view of science's successes—a decentralization that has supported a perspectiveless view, a "view from nowhere" (Nagel 1986:70). Virtuality and virtual reconstructions facilitate the objective, perspectiveless view of place, as they allow for a holistic and 360° visualization of a space and can provide different levels of perception of the physical landscape.

Virtual reconstructions allow people to transform their mental interpretations of place into something more "physical" and "concrete," such as a 3-D virtual world. Furthermore, the virtual world has the capacity to take into account and integrate different subjective views of the same space, which then constitute the visual representation of the place-making process. As has been expressed very well by Latour and Lowe (2011:278), with virtual reconstructions we should focus not on the delineation of one version from all the others but rather on the assemblage of original(s) and virtual copies in our attempt to describe the rewritten biography and transformations of the real object. Reconstructing in this way makes it possible to simulate different pasts rather than just one past and to navigate within this interpreted reality, having an embodied experience with it. This paper aims to demonstrate that 3-D virtual copies and simulations of tangible heritage are not a substitute for the real site, nor do they remove the "aura" from the real site, but they can instead provide added value for the analysis, interpretation, and understanding of our material past.

Thanks to the use of new technologies, it is now possible to interpret and recreate monuments in their original context and to restore artifacts virtually. A person's mental landscape can now be fixed in a virtual simulation which, when it originates from a scientific process of interpretation, increases their comprehension of the past (fig. 1). Because our long-term memory cannot preserve them and our working memory is too limited to construct them (Tversky 2001:376), these 3-D representations

Figure 1. Livia's villa (Ancient Via Flaminia Project). *a*, Archaeological site. *b*, 3-D replicas of the archaeological site. *c*, Superimposition of the 3-D replicas of the site and the reconstruction of the ancient villa. *d*, 3-D reconstruction of the ancient villa (Galeazzi 2008:132). A color version of this figure is available online.

can be a powerful tool to fix our interpretations and preserve them in time. In this way, it becomes possible to compare different interpretations of our past landscape.

3-D Replicas of the "Real"

Before discussing all of the implications relating to the 3-D simulation of ancient sites and landscapes, it is important to stress the differences that exist between the simulation of past landscapes and the 3-D metrical reproduction of contemporary sites through the use of 3-D documentation techniques, such as laser scanning and photogrammetry.

The development of 3-D technologies has resulted in a major growth of work for the 3-D digital copy and facsimile industry in archaeology and heritage studies. The dissemination of laser scanning technologies and 3-D prints has increased the diffusion of 3-D replicas of art works in museums. For example, the Van Gogh Museum in Amsterdam, in cooperation with Fujifilm, has developed a technique for the creation of 3-D reproductions of Van Gogh masterpieces.

> The special 3-D technique, by means of which these reproductions are produced, goes by the name of Reliefography. This technique is a combination of a three-dimensional scan of the painting and a professional, high-resolution print. A Relievo consists of a faithful reproduction of the front of the painting, as well as of the back and comes in a frame. During the production process, experts of both Fujifilm and the Van Gogh Museum closely monitor highly rigorous quality checks. Size, colour, brightness and texture are reproduced as accurately as possible to create a full-scale premium 3-D replica of a Van Gogh painting. The final result has been approved by the curator of the museum.[1]

The advent of 3-D digital copies has challenged the previously discussed notion of aura. Benjamin believes that early pre-digital copies of the original—films and 2-D images created during the age of mechanical reproduction—lack the "authentic" aura of their sources (Benjamin 1969 [1936]:223), and his discourse is still central today in discussions about the real value of 3-D reproductions of contemporary monuments and sites.

The diffusion of 3-D digital replicas of archaeological sites and monuments has generated discussion between archaeologists and experts in heritage studies interested in the analysis and preservation of the excavation process and material remains as to the real value and nature of those replicas. The central question is, Is it possible to generate a copy of tangible heritage that conveys the "aura" of this heritage?

Recently, Bruno Latour and Adam Lowe considered how it might be possible to migrate the aura to the reproduction or reinterpretation of the original (Latour and Lowe 2011:283). They underline the obsession of the age for the original and how this obsession increases as more accurate copies of the original become available and accessible. Latour and Lowe argue that "the real phenomenon to be accounted for is not the delineation of one version from all the others but the whole assemblage of one—or several—original(s) *together with* its continually rewritten biography" (Latour and Lowe 2011:278). They move the attention in their analysis from the common question—"Is it an original or merely a copy?"—to another, more decisive question, especially in a time of digital reproduction—"Is it *well* or *badly* reproduced?" Latour and Lowe theorize that

> facsimiles, especially those relying on complex (digital) techniques, are the most fruitful way to explore the original and even to help re-define what originality actually is . . . To say that a work of art grows in originality thanks to the quality and abundance of its copies, is nothing odd: this is true of the trajectory of any set of interpretations. (Latour and Lowe 2011:278–279)

According to Latour and Lowe (2011:285–286), three main factors are essential for the determination of a replica's originality: the relocation of the copy in the original context, the availability of the original, and the reproduction of all the surface features of the original.

But what happens when these three elements are reconsidered in respect to 3-D digital heritage reproductions? Does the presence of all three elements also increase the originality of a 3-D digital replica of an archaeological site or monument?

The first aspect, the relocation of the 3-D replicas of archaeological sites and monuments, is achievable through the use of 3-D technologies. The 3-D reproduction of a site or monument can be visualized on site and allows comparison between the original monument and its 3-D copy (fig. 1*a*, 1*b*). There are several preservation projects that use 3-D replicas to monitor the physical decay of tangible heritage over time (see, e.g., Gruen, Remondino, and Zhang 2002; Kuzminsky and Gardiner 2012; Sanz et al. 2010). But the real added value of 3-D replicas of archaeological sites and monuments is that they can be experienced in multiple locations. These reproductions can be visualized and analyzed by multiple experts through the web, encouraging new interpretations of the same context. But the internet and cyberspace do not allow for relocation of 3-D replicas in the real physical context, which prevents the attainment of the first factor for adding originality to the copies. In fact, cyberspace only allows for the virtual relocation of the site or monument in a 3-D reconstructed simulation of the original context, which cannot give the comprehensive sensorial experience of the real landscape.

The second element of originality is availability. In the past few years, the speed of urban development has forced archaeologists to collect information on ancient sites rapidly before they are covered over again and disappear under modern buildings. An example is the Cuizhuyuan, also known as the Green Bamboo Garden tomb (M1). This Western Han Dynasty mural tomb was acquired in 3-D within the "Virtual Museum of the Western Han Dynasty Project" (Di Giuseppantonio Di Franco

1. https://www.vangoghmuseum.nl/en/business/van-gogh-museum-edition-collection.

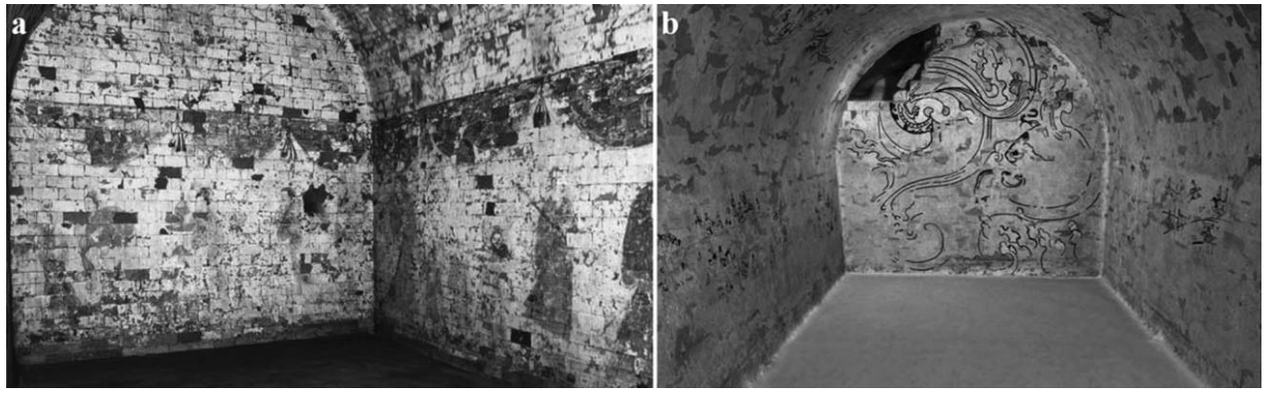

Figure 2. Western Han mural tombs. *a*, Green Bamboo Garden mural tomb (M1). *b*, Xi'an University of Technology mural tomb (M27). A color version of this figure is available online.

and Galeazzi 2013:346; fig. 2*a*). The second tomb acquired, the Xi'an University of Technology mural tomb (M27), is still accessible but, because of the precarious condition of the frescos, cannot be opened to the public (Galeazzi, Di Giuseppantonio Di Franco, and Dell'Unto 2010:97; fig. 2*b*). Despite this, the paintings inside the tomb are disappearing because of the critical conditions of the plaster and colors. Since they are painted over a very thin layer of plaster, applied directly onto the bricks composing the structure, their removal from the walls and preservation inside a museum is impossible.

For these tombs and other World Heritage Sites and monuments that cannot be opened to the public because they are at risk, 3-D technologies are of extreme importance, because such technologies permit the preservation of the monument through digital documentation. In addition, they allow the visualization of the metrical copy in virtual exhibits that can be easily reproduced in different parts of the world. In the absence of the real site, the delocalized facsimile provides appropriate access to the public, while keeping the real site or monument safe and accessible only to the small number of specialists who require such access for continued study and monitoring.

For an increasing number of sites, the 3-D copy provides the only means of public access. Moreover, 3-D replicas allow a superior visualization of the site or monument, because they are not subject to the physical constraints of the real site. The 3-D virtual space gives users the opportunity to explore challenging archaeological contexts that would otherwise be difficult or impossible to access, such as remote areas in the recesses of caves or subterranean tombs.

The third element of originality is the reproduction of all the surface features. The main factor preventing 3-D replicas from perfectly reproducing the surface features of tangible heritage relates to the impossibility of producing a wholly objective copy of the real. In spite of the rapid development of 3-D technologies for the documentation and reproduction of archaeological sites and monuments today, it is still not possible to produce 3-D copies or replicas of the real that are totally accurate. The 3-D reproduction process is characterized by several different steps, including on-site data collection, data processing, and data visualization. The role of the operator is still necessary at all stages of the procedure, making the process subject to operator choices: (1) During the 3-D documentation on-site, the operator decides the resolution of the acquisition and how to acquire the scans and images that will be used for the creation of the 3-D model (e.g., position, best time during the day to acquire the images, and so on). (2) When processing laser scanner data, the operator decides which are the best scans for the alignment, which parts of the scans are unnecessary for the final 3-D model, which filters to apply to the scans, and so on. For the image data processing, the images have to be selected and the different parameters for the processing chosen. For example, as shown below in "'Fake' versus Original: From the Physical to the Digital", the number of faces selected for the final 3-D model may affect its accuracy. (3) The role of the operator is crucial in the optimization of the processed 3-D model for the visualization of the 3-D replica in an interactive visualization system, since this depends on the tools selected and the extent of the 3-D model's optimization.

It is clear from this description that, although there is currently movement toward total automation of the process, the 3-D reproduction of real archaeological sites and monuments is still subjective. Thus it is not possible to produce totally objective copies or replicas of the real.

While assuming the possibility of creating an objective replica in terms of shape, color, and texture, it is still not yet feasible to produce copies that give people the same sensorial experience of the real. But is the reproduction of the "real" truly central to the documentation, analysis, and preservation of archaeological sites and monuments?

The true value of 3-D replicas of archaeological sites and monuments resides not in the creation of an objective and perfect copy of the original but in the ability that such a copy can give to researchers to analyze and interpret—and to students and the general public to understand—cultural heritage. Because of their digital nature, 3-D replicas give new opportu-

nities for the exploration and analysis of archaeological sites. They increase dissemination, providing the opportunity for multiple scholars to analyze and interpret the same archaeological context. The trajectory of the work of art described by Latour and Lowe (2011:278) assumes new significance when applied to the 3-D digital reproduction of cultural heritage and the attempt to reproduce the "aura" of the real. The possibility of retrieving the aura from the flow of copies has to be reconsidered today in relation to the web. In a discussion about the reproduction of text, Latour and Lowe (2011:283) argue how it is crucial

> to consider what happens to *the original* now that we are all inside that worldwide cut-and-paste scriptorium called the web. Because there is no longer any huge difference between the techniques used for each successive instantiation of some segment of a hypertext, we accept quite easily that no great distinction can be made between one version and those that follow.

The internet and cyberspace increase dissemination of the reproduced context through multiple 3-D digital replicas, which in turn can be reinterpreted and generate new 3-D reproductions. However, while offline virtual applications may give the opportunity to analyze the virtual with the real object and context, online visualization systems totally detach the 3-D replicas from the real. This detachment can represent a risk for the analysis and interpretation of the site or monument, since 3-D copies cannot substitute for the real but aim to provide added value for the exploration of the surface features of an object. It is crucial to be able to discriminate between good and bad reproductions through accuracy, understanding, and respect, and this is only possible with an accurate analysis that starts from the original, tangible heritage. The attention of visitors to museums and archaeological sites has to be shifted "from the detection of the original to the quality of its reproduction . . . the word 'copy' need not be derogatory; indeed, it comes from the same root as 'copious,' and thus designates a source of abundance. A copy, then, is simply a proof of fecundity" (Latour and Lowe 2011:278). Digital reproductions can thus be seen to add a new and important component to the controversial and debated topic of authenticity in archaeology and heritage studies.

Having discussed the potential and limitations of the use of digital technologies in the reproduction of our present tangible heritage, consideration will now be given as to how the discourse on authenticity changes when we deal with the simulation of our past. Examples will be used to explain how the reconstruction of tangible heritage can be physical, digital, or a combination of physical and digital.

Reconstructing the Past: Original or "Fake"

3-D metrical replicas of archaeological sites and monuments are powerful tools for the analysis, understanding, and interpretation of tangible heritage. These 3-D replicas can preserve the information digitally through time, providing the opportunity for different scholars to revisit the copies over the longer term. This allows multiple interpretations of the site or monument to be proposed on the basis of new discoveries and technological developments. In fact, starting from 3-D metrical replicas of archaeological sites and monuments facilitates the activation of different interpretation processes and may result in multiple 3-D simulations of past landscapes.

What is the origin of this human need to reproduce, reconstruct, and simulate the past through its material remains? The reconstruction of the past is not a new phenomenon. Human beings have always interpreted and simulated the past. Jean Baudrillard (1983:121) believes that the primary motivation for reconstruction and simulation is absence, stating that, when object and substance have disappeared, there is a panic-stricken production of the real and the referential. He states that this need for simulation creates a hyperreality of culture that involves "cutting up," "regrouping," "interference of all cultures," and "unconditional aestheticization," all common practices in contemporary traditional museums (Baudrillard 1994:68).

Umberto Eco considers the necessity to preserve and celebrate the past in a full-scale authentic copy as the result of a philosophy of immortality through duplication. Thinking about what he defines as the "Fortress of Solitude," the full-scale reproduction of the Oval Office at the Lyndon B. Johnson Library, he affirms that

> to speak of things that one wants to connote as real, these things must seem real. The "completely real" becomes identified with the "completely fake." Absolute unreality is offered as real presence. The aim of the reconstructed Oval Office is to supply a "sign" that will then be forgotten as such: the sign aims to be the thing, to abolish the distinction of the reference, the mechanism of replacement. Not the image of the thing, but its plaster cast. Its double, in other words. (Eco 1986:6–7)

Before writing the essays collected in *Travels in Hyper Reality*, Eco made a journey throughout the United States, which he defines as a "hyper reality journey," during which he underlines how the North Americans' imagination "demands the real thing and, to attain it, must fabricate the absolute fake; where the boundaries between game and illusion are blurred, the art museum is contaminated by the freak show, and falsehood is enjoyed in a situation of 'fullness', of *horror vacui*" (Eco 1986:8). The examples range from the Johnson Oval Office to the reproduction of the drawing room of Mr. and Mrs. Harkness Flagler in the Museum of the City of New York—where the living room was inspired by the *Sala dello Zodiaco* in the Ducal Palace of Mantua, the ceiling was copied from a Venetian ecclesiastical building's dome, and the wall panels are in Pompeian Pre-Raphaelite style—to the Las Vegas copies of European cultural heritage and the incredible numbers of wax museums spread all over the United States (Eco 1986:10–21).

One of the most incredible representations of Eco's "Fortress of Solitude" can be found in central California, where

William Randolph Hearst built his own "castle." In 1865, having purchased 40,000 acres of ranchland, he then bought palaces, abbeys, and convents in Europe and had them dismantled, packaged, and shipped across the ocean to be reconstructed on his hill in California. The core of his residence was the "Casa Grande," a Spanish-style cathedral with two towers whose portal frames an iron gate brought from a sixteenth-century Spanish convent (fig. 3).

The floor of the vestibule encloses a Pompeian mosaic, the door into the meeting hall is by Sansovino, and the great hall is fake Renaissance style presented as Italo-French. The refectory has a 400-year-old Italian ceiling, and on the wall there are the banners of an old Sienese family. The authentic Richelieu bedroom forms the master bedroom, and a Gothic tapestry adorns the billiard room. This is only a small part of the long list of furniture and architectural elements that decorate the Hearst house. Today the "castle" is a state park and is presented to the general public with the slogan "Hearst Castle: Building the Dream." Hearst's guests could enjoy an outdoor "Neptune pool" (fig. 4*a*) and an indoor "Roman pool" (fig. 4*b*), wonderful gardens, and the "Casa del Sol," an eighteen-room guesthouse facing the majestic Pacific coastline.

But what was really the original nature of this project? This is not an example of a copy of the real. In Hearst's mind, there was not the idea to perfectly reproduce European monuments but an egocentric desire to build his own simulacrum of success by using, in a discretionary way, different artifacts and bricks from the European past. According to Eco, the place is characterized by "the obsessive determination not to leave a single space that doesn't suggest something, and hence the masterpiece of bricolage, haunted by *horror vacui*, which is here achieved" (1986:23). Even more than Hearst's nineteenth-century aspiration to monumentality, the actual musealization and presentation of this monumental residence is objectionable. The state park guided tour and website emphasize an old-style, colonial idea of power. As underlined by the slogan "Hearst Castle: Building the Dream," everything is possible with the right motivation, including the indiscriminate destruction of monuments to build your own residence, following the example of the magnate and great man, William Randolph Hearst. This kind of colonialist approach to the communication of heritage could be extremely dangerous in the formation of the social consciousness of future generations, favoring the diffusion of fake models and simulacra over more complex reconstructions of cultural heritage based on scientific data.

Figure 3. Hearst Castle, Casa Grande. A color version of this figure is available online.

The risk of creating simulated landscapes deprived of any scientific interpretation models can be misleading when trying to interpret and analyze our physical and cultural environment. Taking Daniels and Cosgrove's statement that "a landscape is a cultural image, a pictorial way of representing or symbolising surroundings" (1988:1) and Ingold's assumption that "there is nothing that is not socially and culturally constructed" (2000:2), people's bodily experiences in a physical and cultural environment could be considered the starting point of any imitative and creative process. We are the consequence of physical and emotional interaction with an environment composed of both individuals and objects. This relationship is the origin of our ideas, our feelings, and our being, and the way in which it affects our reactions determines our life path, establishing who we are. For this reason, when we develop and propose new communication systems for the public, we should carefully evaluate the scientific soundness of the process that led to their creation. Considering the Hearst Castle experience, the accuracy of the information conveyed and the transparency of the reconstruction process should be prioritized over the more attractive and cost-effective "wow factor."

"Fake" versus Original: From the Physical to the Digital

After discussing the implications inherent in the creation of physical simulacra, such as the Hearst Castle, this paper now looks at another case study, Luigi Canina's nineteenth-century etchings, to show how the authenticity discourse takes on different connotations when moving from the physical to the digital replica. In the 1850s, Luigi Canina interpreted the ancient Appian Way, creating "before" and "after" drawings of the ruins and reconstructions. He not only drew the surviving remains of ancient Rome but also turned them into fantastic and visionary spaces, populated with fragments of disparate elements from many archaeological sites. Canina's etchings are

Figure 4. Hearst Castle. *a*, Neptune pool. *b*, Roman pool. A color version of this figure is available online.

the result of his mental recollection of elements that he reinterpreted and recreated in his own vision of Italian heritage.

Canina etchings are a perfect example of Lowenthal's idea of the past: "the benefits the past confers vary with each epoch, culture, individual, and stage of life" (Lowenthal 1985). Tangible cultural heritage is the physical representation of the past, and its interpretation depends on the perspectives through which it is viewed. The symbolic meaning of heritage mutates when epoch, culture, and individual change, but it also appears differently each time we visit it (Dave 2008:41). For this reason, it is fundamentally important to create different interpretations of heritage not only to communicate its shape and texture but also to allow the different relations that people who come from different cultural backgrounds may have with it. This polysemy can be achieved today through the interactivity provided by virtual reconstructions. While with the "old technology" only one interpretation, one reconstruction, or one visualization was possible at a time, with the new technology it is possible to create, analyze, and interact with multiple 3-D reconstructed environments. Indeed, it is possible, after having built a personal reconstructive model that is charged with all of one's particular knowledge, to compare it with other simulations of the same past environment.

The creation of different possible interpretations and virtual simulations of the monument and its context can activate a process of multivocality in the process of interpreting our cultural heritage. Multivocality is one of the most important aspects of our understanding of the past's cultural and social dynamics and of attempts to increase the objectivity of interpretation (Hodder 1997:694). Multivocality allows us to improve our knowledge of the landscape or site and increase the objectivity of the scientific interpretative act (Hodder 1997: 694). In this sense, 3-D reconstructions and virtual environments can be challenging in their simulation of the original context of ancient remains, but these innovative tools can, through the creation of as many interpretations as possible, increase objectivity in the interpretation and reconstruction process.

One example of this is the 3-D reconstruction of Canina's etchings. Canina's interpretation of the ancient Roman road was first recreated and reinterpreted in 3-D. It was then visualized in an immersive virtual reality system together with other visual interpretations of the same heritage: the 2-D Canina representation, the 3-D immersive environment reproducing the 2-D Canina etching, the contemporary landscape, and the 3-D simulation of the contemporary landscape surveyed using 3-D technologies (Forte et al. 2004; fig. 5).

The use of 3-D technologies allows archaeological sites to be recorded and reconstructed through a simulation process that does not provide the absolute representation of the ancient remains but rather just one possible interpretation. However, 3-D reconstructions and immersive environments allow the simulation of different pasts rather than just one, which gives users the opportunity to navigate within this interpreted reality and have an embodied experience. But a fundamental question arises from these considerations: How should we consider these digital and virtual simulations? Are they original digital representations of our cultural heritage or just virtual "fakes"?

Finding an answer to this challenging question appears to be essential, since in the past 20 years the phenomenon of fake reconstruction has become digital as well as physical. With the development of new technologies, the physical fakes, such as Hearst Castle, have been replaced by digital fakes. The number of 3-D digital simulacra is continuously increasing, resulting in the first example in the history of new technologies in which the aesthetics of models, rather than their scientific accuracy, has become the most important aspect. For this reason, a large number of 3-D reconstructions of ancient monuments and archaeological sites are spectacular but incorrect. According to Maurizio Forte, this "wow factor" should give way to a methodological advancement that considers the accuracy and information conveyed by the 3-D models (2008:24). Thus the

Figure 5. Ancient Via Appia. *a*, Canina's etchings. *b*, 3-D reconstruction realized using Canina's etchings. *c*, Contemporary landscape. *d*, 3-D simulation of the contemporary landscape. A color version of this figure is available online.

"transparency" of the analytical process of study is a fundamental aspect in creating the ontology of this simulation process (Forte 2008:7; Forte and Pietroni 2009:58).

Both of the examples analyzed—Canina's etchings and Hearst Castle—are fakes and incorrect representations of the original context of these monuments and material culture. But the difference between these two case studies rests in the "transparency" of the reconstruction process. While the 3-D reconstruction of the Canina etchings simulates a possible original context—the artist's mental interpretation of the ancient Appian Way—Hearst Castle is just a collection of decontextualized objects that does not allow any understanding of their possible original environment.

Baudrillard describes the contemporary world as a simulation that does not admit originals, origins, or "real" referents but just the "metaphysic of the code" (Baudrillard 1983:116). Similarly, in his writing on hyperreality, Umberto Eco destructures the boundaries between the copy and the original, or between sign and reality, to deconstruct the conception of authenticity.

The Canina etchings described in this paper are a perfect example of how mental interpretations can be brought to the creation of new worlds. Considering Eco's statement (1986:8), these etchings cannot be considered originals, but neither are they fakes, since they are the result of an original process: Canina's interpretation. In this sense, the etchings can be likened to Baudrillard's definition of simulacra, something "not unreal . . . never exchanged for the real, but exchanged for itself, in an uninterrupted circuit without reference or circumference" (Baudrillard 1994:6).

So should we consider the Canina etchings "original fakes"? There is scope, in fact, for a double interpretation of the Canina etchings. If we consider the etchings in relation to the original context, we can state that they are "fakes," since they are not a good scientific simulation of the original. But what happens when we consider the third element, Canina's mental interpretation? Canina's mental interpretation cannot be considered hyperreal in Baudrillard's sense, "a real without origin or reality" (Baudrillard 1994:1), since it is possible to find its origin and reality in Canina's mind, based on his cultural back-

ground and personal experience. Therefore, the etchings can be considered "original" to Canina's mental interpretation and "fake" in relation to the original context.

Scholars have been debating the authenticity of 3-D digital reproductions in heritage and archaeology for many years (Bendix 1997; Benjamin 1969 [1936]; Orvell 1989; Trilling 1981), but there are no clear guidelines for the definition of "authentic" cultural heritage. This is because it is not possible to create universal predetermined categories when defining what is "authentic." The concept of authenticity changes with individuals, cultures, and time. Rather than defining the absolute "authentic," we should probably consider the relative "authentic." This is the "authentic" that results from our subjective mental interpretation of cultural heritage, stressing and underlining the process that allowed this interpretation through analysis of the scientific data. So the transparency in the interpretation process can help us to define the "authentic" more in a subjective and relative way than in an objective and absolute sense.

The mural paintings of the Western Han tomb M27 represent a clear example in this sense. The 3-D data collection and the interpretation process for this tomb are part of the "Virtual Museum of the Western Han Dynasty Project," a joint research project between the University of California, Merced, and Xi'an Jiaotong University (Di Giuseppantonio Di Franco et al. 2013:345). The frescos contain a very complex interpretation code that shows the symbolic relations between life and death during the Western Han dynasty. Both the simple description of the subjects and the 3-D virtual reconstruction of the tomb are insufficient for approaching its correct cultural interpretation. For this reason, a 3-D virtual cybermap was created. The cybermap (or hypertextual map in three dimensions) is the graphic layout of a set of relations between each scene and its context (fig. 6). Interacting with it, users are able to acquire as much information as possible on the tomb's iconographic apparatus (Galeazzi, Di Giuseppantonio Di Franco, and Dell'Unto 2010:97–108).

The main goal in this kind of virtual reality system is to build a cybermap of affordances that involve the users to such an extent that it reduces their perception of being in an artificial world. James Gibson defined affordances as "all the action possibilities latent in the environment, objectively measurable and independent of the individual's ability to recognize them, but always in relation to the actor and therefore dependent on their capabilities" (1979:128).

In this kind of approach, the user is no longer an external observer; he is not passively in front of the archeological material culture. Instead, he or she is a protagonist in the cultural process and participates in an active way in the knowledge system.

Rigorous analysis of the scientific data allowed the subjective interpretation of the frescos and the definition of the narrative described in the mural tomb's iconographic apparatus through four main themes: daily life, ascension to heaven, five phases, and Yin and Yang (figs. 7, 8; Galeazzi, Di Giuseppantonio Di Franco, and Dell'Unto 2010; Hardy and Kinney 2005:5–6; Loewe 2005:38–43).

The interpretation of the narrative described in the frescos cannot be considered "authentic" in an absolute sense, since we do not have enough elements to reconstruct the motives of those who created the frescos (absolute "authentic"), but it can be considered authentic in a relative sense, since the presentation is based on a subjective scientific interpretation of the painter's mind (relative "authentic"). Digital projects such as those described in this paper show how digital technologies can be powerful tools to increase our understanding of tangible heritage, both when integrated with the "real" site and when used for the preservation of information in the absence of the original site.

Conclusions

When we try to preserve and protect monuments, in part we modify them. When we attempt to reconstruct their shape, we

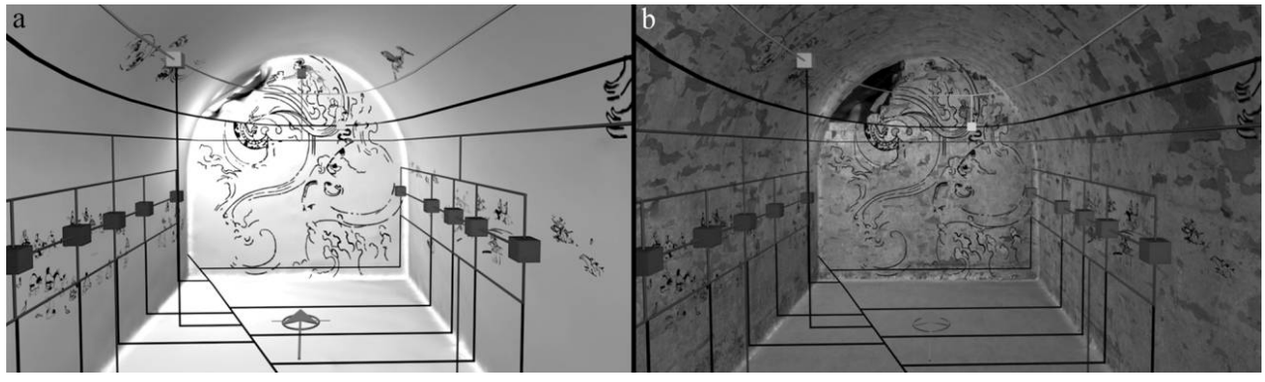

Figure 6. Cybermap of the Western Han mural tomb M27 (Xi'an, China). *a*, 3-D model mapped with the drawings made by archaeologists. *b*, 3-D model mapped with the drawings made by archaeologists superimposed with the tomb images. A color version of this figure is available online.

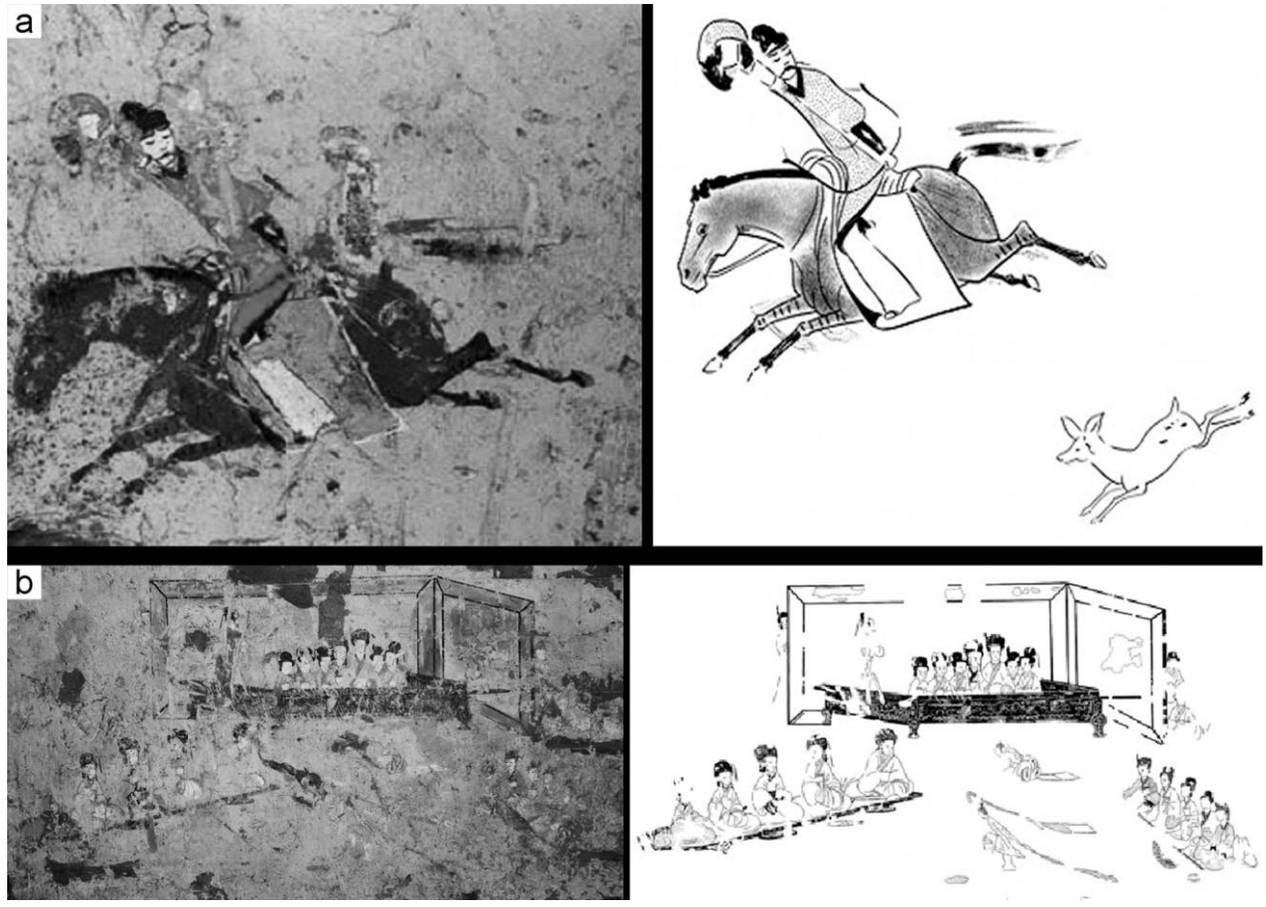

Figure 7. Xi'an University of Technologies mural tomb (M27) depicting scenes of daily life. *a*, Hunting scene in which a hunter is pulling his bow to shoot a deer (east wall; *left*, photograph; *right*, drawing). *b*, Banquet scene with dancers (west wall; *left*, photograph; *right*, drawing). A color version of this figure is available online.

often damage their essence. But at the same time, it is impossible to contemplate a disinterested abandonment of heritage due to its material decay. We need to preserve not just the physicality of our material culture but also all of the information connected with its cultural and historical background. In this sense, 3-D replicas, reconstructions, and virtual environments can be challenging in their simulation of the original context of ancient remains. Through the creation of as many interpretations as possible, these innovative tools make it possible to increase the objectivity of the interpretation and reconstruction process.

Using digital technologies, we can avoid the alteration of our physical heritage sites and artifacts by creating another level of perception of the monument that is completely virtual. In this way, the shape that we modify and interpret is not real but a 3-D digital reproduction. Moreover, thanks to these tools, it is possible to create metric reproductions of the monument, preserving it in the process, so as to have the possibility of analyzing its decay over time.

There is an ongoing dispute between different schools of thought on the preservation and reconstruction process. Is it really necessary to preserve and reconstruct our heritage in an invasive way, or is it possible and desirable to start thinking of a new approach that, through the use of new technologies, could digitally record it and simulate its original nature and cultural context, thus avoiding an intervention that might be destructive to the monument? Indeed, is it possible to preserve not just the heritage site's physical (tangible) aspects but also its (intangible) meaning thanks to the use of new technologies?

According to Svetlana Boym, "we don't need a computer to get access to the virtualities of our imagination: reflective nostalgia has a capacity to awaken multiple planes of consciousness" (2002:49), because machines are just tools. They have to be used as containers and displays of the virtualities created from our imagination. The computer cannot substitute for the human brain, but at the same time virtual reconstructions and new technologies in general are powerful visualization tools for our mental interpretations of the past. Using very different examples, this paper has attempted to clarify how the authenticity discourse changes not only when comparing replicas and reconstructions but also when the materiality or physicality of the reproduced or reconstructed object mutates. As has been shown,

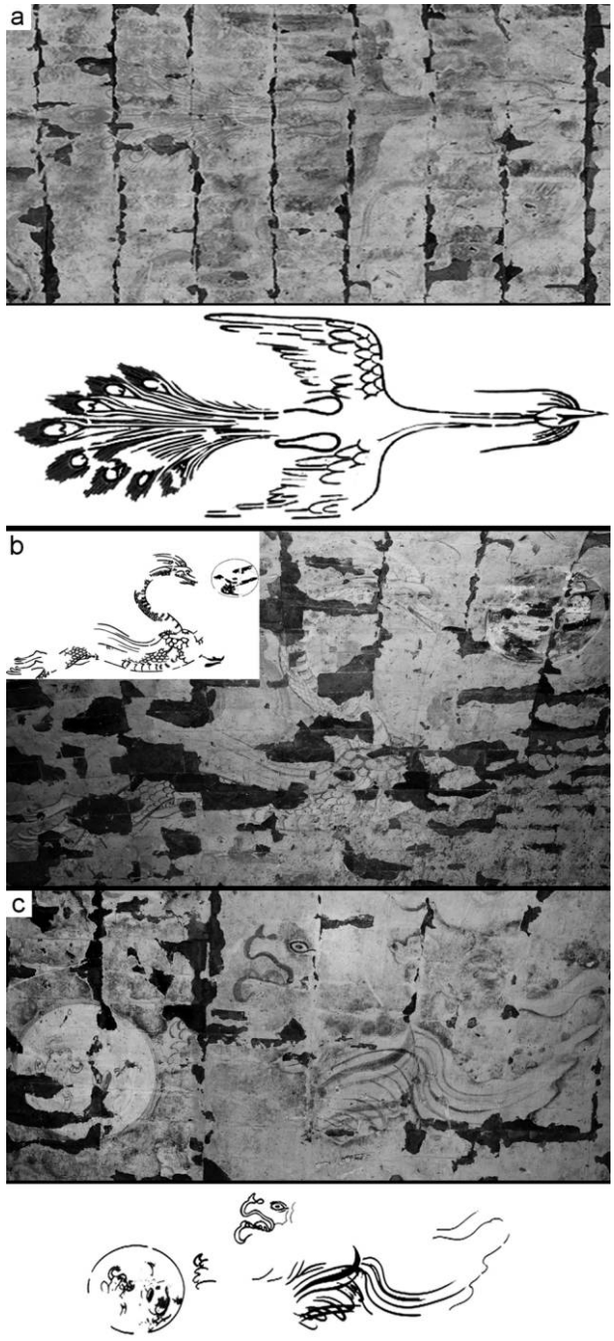

Figure 8. Xi'an University of Technologies mural tomb (M27). *a*, Red bird, symbol of the South (ceiling; *top*, photograph; *bottom*, drawing). *b*, Green dragon, symbol of the East (ceiling; photograph and drawing [*inset*]). *c*, White tiger, symbol of the West (ceiling; *top*, photograph; *bottom*, drawing). A color version of this figure is available online.

physical simulacra and "old" technologies allow the user to reconstruct and interact with only one interpretation at a time, which makes it extremely difficult, time consuming, and expensive to change the reconstruction and/or create alternative simulated environments. By exploring the different nature of physical and digital simulations, the ontological value of 3-D digital representations of the past has been explained. The possibility of interacting with multiple reconstructions at the same time and, more importantly, the fact that it is easier in terms of time and costs to make changes to these simulated environments, when compared with the physical one, gives an unprecedented ability to create "open" and "editable" simulations. This flexibility allows the development of "open" and "dynamic" ontologies that change every time they are subject to modifications and improvements starting from new interpretations. Today, digital tools allow us to keep track of all the changes that different users make to the simulated environments, which encourages a more transparent use of the data and description of the procedures that led to the reconstruction.

The discussion about the value of virtual reconstruction for the preservation and interpretation of cultural heritage has only just started. Should these virtual simulations be considered original digital representations of our cultural heritage or just virtual "fakes"?

They can probably be considered subjective virtual interpretations (a relative "authentic") that aim to get as close as possible to the absolute "authentic" thanks to the activation of a multisimulation process and the creation of "open" and "dynamic" ontologies. This kind of process can allow users to compare, virtually and in real time, different reconstructed worlds that result from diverse interpretations of the same cultural heritage and to then change them and create new interpretations. New digital methodologies can facilitate the preservation of our material memory and, at the same time, help to remove the barriers between past and present through innovative and open communication systems.

Comments

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Fabrizio Galeazzi rightly points out that "the discussion about the value of virtual reconstruction for the preservation and interpretation of cultural heritage has only just started." And for a discipline that has only just started, it is key to get its name right. Key problems can be avoided if the word "virtual" is replaced with the word "digital." The problem is that the word virtual suggests a dichotomy between a virtual archaeology and a real archaeology. Total stations and digitized data sets have now joined the spade, trowel, and spirit level as key archaeological tools in the twenty-first century.

Anthropology has had a similar dilemma. Daniel Miller and Barbara Horst rejected the name "virtual anthropology" in fa-

vor of "digital anthropology" on the following grounds: "Materiality is the bedrock of digital anthropology, and this is true in several distinct ways of which three are of prime importance. First, there is the materiality of digital infrastructure and technology. Second, there is the materiality of digital content, and, third, there is the materiality of digital context" (Miller and Horst 2012).

In his analysis of the Turin shroud, the art historian Hans Belting (2006) describes the material upon which an image of Christ has been scorched as the "contact medium." Electronic digits are the "contact medium" in digital archaeology. These digits are not virtual but real within their own realm. In fact, like the Turin shroud, the digits are both a contact medium and a display medium, very similar to the 3-D Valcamonica rock art scans produced by the Technical University of Graz's rock art scanner or Fabrizio Galeazzi's excellent reproductions of the Western Han dynasty tomb paintings in China. The contact with the original Camunian rock art in Valcamonica makes these digital copies, but they are not virtual copies. The flow of electrons is real according to the rules of the digital medium.

The key question is, What is the "digital difference" (Baker 2015)? One key area of opportunity is the new quality or precision it brings to the reconstruction of material culture destroyed by war.

Here, as in other cases, the problem with the term virtual is its ambiguity. In areas that are contested, the label of the virtual can leave work open to dismissal and diminution. This is especially important in contexts where the cultural heritage in question means that there is more at stake than issues of taste and academic classification. A prime example is Palmyra and the work of the Institute of Digital Archaeology (IDA).

On the April 19, 2016, the *New York Times* reported that "a landmark Roman arch that was destroyed by Islamic State fighters in Palmyra, Syria, stood proudly once again on Tuesday, this time as a replica built from digital models that was installed in Trafalgar Square in London. To create the roughly 20-foot-tall marble replica, which weighs around 11 tons, researchers built a 3-D computer model of the arch by compiling dozens of photographs taken by archaeologists and tourists in Palmyra before the Islamic State moved in. Robots in Italy then used the computer model to carve the marble replica" (Shea 2016).

Even when the plan for the arch was first announced, a photograph of Palmyra made it to the cover of *Newsweek* magazine, where the IDA's founder, Roger Michel, was hailed as a successor to the "Monuments Men" of World War II (Karmelek 2015). The digitally guaranteed accuracy of the reconstructed arch formed a key part in making the work's message so powerful. It demonstrated the ability of digitally driven archaeology to replicate and therefore restore the original monuments not just as physical objects but also as the carriers of perceived values—values that had made them the target of Islamic State detonations in the first place. The term "triumphal arch" therefore took on a double meaning, evoking not just the Roman triumph of the original but also the modern triumph that digital technology could demonstrably provide.

The IDA's strategy of having a copy carved in the world-famous Carrara quarry by computer-driven masonry tools allowed the copy to be reproduced from the 3-D digital files to a level of accuracy that compensated for the fact that the copy was not exactly the full size of the original. Yet it was not about size but about physical accuracy and another kind of aura, as Roger Michel told the IDA in his yearly round-up letter.

> While recreated objects certainly need to be high quality—and ours are—they also must incorporate the efforts and aspirations of the stakeholders for whom they hold significance. Local stakeholders must stand behind and participate in the reconstructions for a finished object to be anything more than a cold piece of stone. People who care about the objects that capture their cultural identity are the only ones who can confer an aura of authenticity on them, and so we always try and work on their behalf. (Michel 2016)

These could be local Syrian stonemasons, who could one day help to rebuild the ruins in Palmyra itself, because however perfect the Carrara copies are, their makers recommend a final human touch before they are deemed finished.

The digital files work as another form of "contact medium," but this time they establish contact between the past, present, and future. In this case, the present forms a place of storage for building data, but also values, that should one day be repatriated, a form of preservation through relocation. This is a case of recontextualization not as destruction or falsification but conservation.

In the meantime, the act of reconstruction and relocation of the arch to central locations in the West has created another totally new trajectory, since the IDA's defiant act of memory has found a group of "people who care about the objects." After being displayed in London, the arch toured from City Hall Park in New York to the world government summit in Dubai. Michel proudly quotes "one visitor to the Trafalgar Square Installation who observed: 'the new arch is not a recreation, but a new monument in its own right—a symbol of courage and tolerance.'" The story of the arch shows that the digital difference is not virtual but actual. The tag virtual is too weak to describe the essence, the potential, and the power of digital archaeology in the twenty-first century.

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"The ontology of 3-D replicas and simulations," the question of authenticity and aura, and the challenge of disproving the possibility of "universal predetermined categories for the definition of 'authentic' in the digital domain." Can a single jour-

nal article hope to cover such far-reaching but interrelated and fascinating topics? There have been quite a few papers on the authentic (e.g., Dueholm and Smed 2014) and some on the role of 3-D models in relation to cultural heritage, but there are few robust and accessible outlets for scholarly discussions on these topics, so I am very happy to see articles like this one in press.

Ontology has a myriad of meanings to varying disciplines. In computer science, as opposed to philosophy, it typically refers to domain ontology (cf. https://protege.stanford.edu/publications/ontology_development/ontology101-noy-mcguinness.htm and https://plato.stanford.edu/entries/logic-ontology/). The article by Dr. Galeazzi initially appeared to propose a domain ontology of 3-D models and simulations, due to the reference to Forte et al. 2004, but as the word only appeared twice, I now wonder whether the term was meant to refer to ontology as in essence or existence (of aesthetic objects), because that seems to be the guiding motivation of the key Latour and Lowe reference (2011).

Why is the Latour and Lowe article a key reference? Because it is both very recent and a blend of aesthetic theory, a critique of the famous Walter Benjamin essay "The Work of Art in the Age of Mechanical Reproduction" (1969 [1936]), and an investigation of both audience reception and the role and nature of digital copies in a digital age (an age Benjamin predated). I do have some serious questions for that paper, but I commend Dr. Galeazzi for citing it. I suggest that it offers serious critical fuel for thought in digital cultural heritage, even if it focuses on painting. And this is a shame, because the role of art and the artist versus the scientist and narrator in 3-D digital heritage is a complex and demanding issue.

The roles of aura and place in simulations are seldom explored but are also mentioned in the Latour and Lowe article; unfortunately, they are not woven into the overall argument. Even with augmented reality, can we place a simulation, given that the real-world place is not the past-world place? Likewise, how is the view from nowhere (Nagel 1986) used in the overall argument? There is a practical problem tied to this concept. For designers of virtual environments, where should or could a visitor appear?

As for 3-D heritage, as mentioned in this paper, there is also a bold (but on the face of it plausible) claim: "In the past 20 years, the use of new technologies for the 3-D documentation and reconstruction of cultural heritage has altered approaches to the analysis and interpretation of tangible heritage." For interpretation, I respectfully disagree. Not only do I not think we have successfully leveraged digital technology to provide new and effective ways of interpreting the past, I am also not convinced that the emerging technologies of capture and reproduction have (yet) fully explored the ways in which 3-D digital heritage can be analyzed. Reasons could include the fragmentation of the research field, the paucity of sustained and focused scholarly areas of debate, or simply the speed at which technology is advancing. Such factors also lead me to doubt the effectiveness of the documentation of 3-D heritage objects. For example, as far as I can tell, the projects illustrated in this article do not clearly say how and where the models can be accessed. I and others have even argued that virtual heritage models are in danger of disappearing even faster than the heritage sites and objects they simulate (see Thwaites 2013).

Can digital representations of cultural heritage be original, or are they just virtual "fakes"? I wonder if a virtual fake is an oxymoron. For the virtual implies not quite real, or not quite the real thing in itself. In the field of cultural heritage and virtual reality (virtual heritage), the virtual has been conflated with the digital, and fakery implies an attempt to deceive, not an attempt to complicitly imagine.

Regarding the illustrations, I find figures 1, 2, and 6 to be the most interesting, but as with many virtual heritage projects, it is not clear to me how the general public will understand the expert's view and related scholarly information without having access to a real-world expert guide or to in-world textual information that carefully and clearly points out what has been added or deleted and why. Perhaps that is both the point of and the problem with 3-D digital heritage projects: their meaning. Value and significance cannot be fully verified on a page, but I would prefer to be able to instantly and clearly understand what digital models add to an experience of the past.

As to what is a 3-D virtual cybermap, I am still not sure after reading this article. Publications on cyberarchaeology make sense to me, for navigation through space, time, and interpretation is not trivial, but what is a 3-D virtual cybermap? Cyber implies steering, a map is a diagrammatic representation, and yet this article defines cybermap as a "hypertextual map in three dimensions." How do these terms interact and what do they define? In what way can and does 3-D hypertext define 3-D digital artefacts? Or does a cybermap describe the experience of the participant? This is an intriguing concept but sadly, for me, still elusive.

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Representation versus Reproduction, Recording versus Interpretation

Galeazzi's article offers a timely argument about the nature of 3-D virtual tools in the reconstruction of archaeological contexts and cultural heritage. His focus on the analytical significance of these techniques, and particularly his assertion that the models generated are not substitutes for the "real" thing, is an important position to take in a moment when 3-D technologies are gaining a significant foothold in archaeology. The explicit statement that there is significant input from the producer of such models at all stages of their creation is an essential point in the context of broader discussions of the role of

3-D models in cultural heritage. Galeazzi rightly notes that 3-D models are not objective representations of artifacts or monuments; instead, he highlights that an "operator" is responsible for making 3-D models, which is a highly subjective exercise.

Galeazzi's title and discussion raise an issue that deserves more explicit discussion by those working in the area of 3-D modeling. That is, not all digital 3-D models are equivalent, and it can be misleading to attempt to theorize the epistemology, authenticity, or realness of all digital models of cultural heritage. Galeazzi does not conflate what he calls 3-D metrical reproductions (replicas, digital copies, and facsimiles) and 3-D reconstructions or simulations; however, grouping them in his central question of whether both categories are "real" or "fake" does presume that they are created under the same epistemic conditions. We risk misrepresenting the knowledge that is enabled by the use of different models by making the mistaken assumption that all digital forms are created equal.

I see significant methodological and motivational differences in digital 3-D representations versus digital 3-D reconstructions or simulations. In the first category, I would place digital photogrammetric models of artifacts and excavations and models of artifacts and sites created from structured-light systems and laser-scanning techniques. These tools are used to create representations of extant physical things, and a primary motivation for their creation is to record data. The term representation seems most apt for these types of digital objects, because they stand as depictions of artifacts or sites with an implicit statement from the producer that "this is what it looked like, because I was there" (Garstki 2016). This process is fraught with the individual biases and subjectivities of the producer(s), but this is the case with any type of archaeological recording. Photographs have long skirted the line between perceived objectivity and subjectivity in archaeological recording (Shanks 1997; Van Dyke 2006), and archaeological maps still significantly influence our conceptual framework for excavation and reconstruction (Webmoor 2005; Witmore 2013).

In contrast, digital 3-D reconstructions or simulations are created with a different motivation: interpretation. Galeazzi, I think rightly, calls these virtual worlds "subjective virtual interpretations." The subjectivities inherent in these virtual environments are also different than those in the creation of digital representations. This interpretive exercise is not derived from a fully physical basis, and it therefore cannot be "real" or "fake" but only accurate in relation to a mental conception. I would disagree with Galeazzi's argument that multiple interpretations or simulations necessarily come closer to an "absolute authentic." It is true that a model of openness provides greater possibilities for interpretation and reconstruction, but there is no guarantee that any of these is closer to a "real" past; all interpretations suffer from the same inherent flaw that, as informed as they may be, their basis is mental rather than physical. 3-D simulations fix interpretations and preserve them, but creating a fixed form of one's mental landscape is not the same as recreating the original context; it is creating an entirely new one. The motivation and basis for creating these two digital forms differ, and so should the way we view metrical reproductions versus virtual reconstructions.

I think Galeazzi is correct in highlighting the interpretive work that virtual reconstructions do for past contexts and that interpretations are projected through a set of individual subjectivities that can be somewhat mitigated by the "openness" and "editability" of simulations. To his initial question of whether virtual reproductions are digital representations of our cultural heritage or just virtual "fakes," I would have to answer neither. To refer to a fixed mental landscape as a representation suggests that it is equivalent to other representations, which have an extant physical form that they are depicting. To refer to them as "fakes" suggests that they are counterfeits and assumes an intention to mislead. While some may be intended to "trick" the consumer, this is mostly not the case. Subjective virtual interpretation fits quite well as a description, I think.

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Galeazzi's article on the ontology of 3-D replicas and simulations highlights a number of significant areas of discussion in the field of digital cultural heritage, not least the difficulties of defining terms and meanings in a field where the material differences between an original and its digital representation are so great. While I am not convinced that "fake" is a useful term in this context, with its implication of deliberate deception, it is certainly true that 3-D copies, replicas, and reconstructions are often received as inauthentic, sanitized, and outwith the biographical narrative of the original (Jeffrey 2015).

Galeazzi's paper presents an overview of the debates around these topics over the past decade or so and, in particular, the more recent intervention by Bruno Latour and Adam Lowe (2011). In addition to the important aspects of replication identified by Latour and Lowe, other factors deserve consideration, such as the intention of the replica (Cameron 2007) and the network of relations involved in the production process (Jones 2010); both have been demonstrated as highly pertinent through recent research projects (Jeffrey et al. 2015; Jones et al. 2017). These additional perspectives are also worth considering, as they go a long way to disentangling the conception of authenticity as being intrinsic to the model (i.e., being critically contingent on accuracy and/or objectivity in production). Galeazzi himself notes that total accuracy in replication is not currently possible. In fact, it is a philosophical impossibility, irrespective of the subjective nature of operator intervention that he notes in his paper. Galeazzi states that the true value of 3-D replicas resides not in the creation of perfect copies but in what these copies allow us to do. Galeazzi is somewhat contradictory on this point, though, as he later states that "it is crucial to be able to discriminate between good and bad reproductions through

accuracy, understanding, and respect." While this statement seems hard to argue against, perhaps the accuracy of a digital record is most relevant to its value only when considered in light of the intention of the record. What is the 3-D digital copy or record intended to do? These digital objects have multiple audiences and multiple purposes. On the one hand, there is the specialist world of management, curation, and academic analysis, and on the other hand, there are broad audiences who wish to engage with the past, perhaps through an immersive environment as a way of stimulating their imagination. In this case, these technologies act, as Galeazzi puts it, to "bridge the gap that exists between past and present, guiding people in emotional immersive experiences that can improve their consciousness of the past."

The criticism that Galeazzi goes on to make, that many models are spectacular but incorrect, is expanded using Forte and Pietroni's (2009) plea that the aesthetics of digital models should be deprecated in favor of accuracy and the levels of information conveyed (i.e., the transparency of the interpretative process). I would argue that this position is meaningful if the purpose of the model is to act as a scientific tool for analysis rather than a mode of "emotional immersive experience." This confusion over intention is also notable in Galeazzi's first case study, Hearst Castle. This castle represents an unusual (but not unique) case, originally a private building and a fanciful reconstruction of an imagined past incorporating actual physical elements of historic buildings from around the world. Galeazzi states that this approach is "extremely dangerous in the formation of the social consciousness of future generations, favoring the diffusion of fake models and simulacra over more complex reconstructions of cultural heritage based on scientific data." But was Hearst's intention to reconstruct and deceive, while ignoring scientific data? This seems unlikely given that the building is in California. Self-aggrandisement and an ostentatious display of wealth are more likely motives. If anything, the castle could be considered a creative endeavour, however distasteful, rather than an attempt to recreate or mislead. In a digital context, a similar approach to representing the past is now commonplace; numerous computer games create digital capriccio, versions of past worlds that take pride in incorporating elements modeled on the real world (often with high degrees of accuracy). For an example, see the cityscapes of the *Assassin's Creed* game series (Ubisoft). Such games are generally held up as an example of how broader audiences can be engaged with the past, and critiques are directed at the unrealistic behavior of the virtual world's inhabitants rather than the space and geometry of the virtual world itself. For history-based games, the primary intention is clearly to entertain rather than to inform; these two things are not mutually exclusive, of course, and for many people, such games demonstrate a way to create emotionally immersive experiences where engagement and understanding are not contingent on metric accuracy or an exposition of the interpretative process.

In trying to clarify conceptions of authenticity, I am not sure that Galeazzi's introduction of the concept of "absolute and relative authenticity" is entirely helpful; the key to a digital representation's relative authenticity is defined as an informed and transparent interpretation derived from scientific data. However, like Latour and Lowe, Galeazzi acknowledges the importance of aura to authenticity, but this is a quality that essentially defies scientific quantification. Despite this, I agree with Galeazzi's observation that integrating multiple and dynamic (real-time) visualizations of competing interpretations (each transparent about its own analytical genesis) creates a new type of digital object with affordances distinct from the original. This is an approach that, while long posited, is now becoming more technically feasible. I would also agree that, if done well, such representations could become imbued with their own form of authenticity. The notion of an open and editable simulation, particularly one that acknowledges the networks of individuals and the authorship of those behind the representation rather than simply citing data sources, could indeed be received as an authentic representation.

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6 III 17

In this article, the author explores the use of 3-D imaging to create digital replicas and simulations that can be applied to cultural heritage and archaeological research projects. The article is timely because several countries have implemented regulations that preclude the excavation and documentation of sites and/or the removal of prehistoric artifacts and burials, thus making 3-D imaging an essential tool in archaeological research, salvage excavations, and cultural heritage projects. Although the accuracy and ease of using 3-D imaging equipment has improved over the past several years, the author aptly notes that there are few standards in place to automate scanning in the field, many of which depend on user experience, equipment, and the software designed for data processing. 3-D imaging is still a relatively new tool for the anthropologist, so researchers have largely addressed technical questions about the accuracy and feasibility of using 3-D methods to replace traditional ones within archaeology, paleoanthropology, and bioarchaeology. For example, rendered 3-D models of dense stone tools or bones enable the researcher to rotate an object in the same way as the original, but they can also make volumetric computations or analyze the geometry of an object, which can be difficult to do without computer software designed to perform the computations (Weber 2015).

While there is a growing body of literature on how 3-D imaging can replace traditional methods, this article moves in a new direction by tackling theoretical issues that arise when digital methods are incorporated into archaeological research and cultural heritage projects. I commend the author for con-

tributing to questions related to authenticity, replication, and "virtual fakes," especially for the simulation of prehistoric or historic-period sites. The case studies presented (physical, digital, and a combination of physical and digital) offer new insights into how we utilize 3-D imaging together with the study of places as well as how these images are only as good as the "real." Objects or sites could either be scanned in their unaltered state as they were discovered by the archaeologist or scanned after a reconstruction in a laboratory or on site. In some cases, simulations have the potential to present the researcher with a new interpretation of the site through visualizing landscapes and experiences outside of their original context, as demonstrated with the case of Canina's interpretation of the Roman roads and their place within a contemporary landscape. The example of the 3-D collection of the Western Han tomb M27 provides a useful illustration of how 3-D rendering, despite its technical accuracy, would not serve as an accurate copy of the original site. Instead, the author explains that researchers created a 3-D virtual map based on a variety of criteria to better understand its context as a virtual object. The tomb example raises another important point, which is that humans are not well adapted to visualizing 3-D data on screens (see Weber 2015), and it will require the researcher to be cognizant of this issue when designing simulations and/or object replicas in 3-D space.

This is not necessarily a criticism, but I was somewhat unclear about the section "3-D Replicas of the 'Real,'" the examples presented in this section, and the author's distinction between "3-D metrical reproduction of contemporary sites" and "simulation of past landscapes." I interpreted this to mean that there is a distinction between 3-D scanning as a tool (the "metrical reproduction") and 3-D scanning used in the process of creating a simulated site or object. I do not necessarily view these two as distinct but rather see "3-D metrical reproduction" as the first step of a digital project, whether the goal is to produce a highly accurate replica that can be used to measure site features or to create a site simulation to be used for museum display, for analysis, or as a novel exploration of the object or site within its surrounding landscape. The author does later clarify this, albeit briefly, stating that 3-D methods are used as a starting point for the different interpretations that could be made of a site.

In summary, the author has written a thought-provoking article highlighting issues that arise with 3-D imaging in archaeological fieldwork or the digital preservation of objects. The article makes a substantial contribution to the ways in which individual human experiences and perceptions may impact the creation of digital replicas of a site, objects, or virtual simulations used to explore new interpretations of the "real." These are considerable issues for archaeologists, and while they differ in some respects from other areas of virtual anthropology that have utilized computed tomography and surface scanners, which produce standardized and highly accurate models for morphological analyses, the article makes a solid argument for how we define digital renderings in archaeology and establishing new protocols that aid in the digital reproduction and interpretation of the past.

Reply

The intention of this article is to ignite discussion around the role that 3-D digital technologies play in archaeology and heritage today. Is it possible to assign to 3-D archaeology and heritage their own body of theoretical sources and culture of discourse and the production of unique classes of cultural content? Also, how can we produce a serious and complete evaluation of the potential and limitations of using 3-D? Frederick Baker's observations on the use of "virtual" versus "digital" when referring to cultural heritage provide an opportunity to elaborate in reply to the above comments. Since the introduction of the term "virtual" in archaeology in the early 1990s (Reilly 1991), the use of the word "virtual" in heritage and archaeology has often been associated with "virtual reality" and the possibility of reproducing cultural heritage in three dimensions and reconstructing or simulating its potential aspects in a photorealistic way (Champion 2006; Forte and Siliotti 1997). This particular focus on producing and providing a 3-D immersive experience with tangible heritage is the reason why the term "virtual" is often preferred to the broader "digital" when referring to 3-D photorealistic and immersive experiences with the past. Nonetheless, I believe that the use of the term virtual might be misleading, as it is often associated primarily with the concept of immersivity and does not consider other forms of interaction and engagement with 3-D data, as is also pointed out by Baker. I agree that we should really consider the different trajectories of the 3-D digitally reproduced and/or reconstructed artefact, but at the same time, we should not lose sight of the different meanings that the terms virtual and digital convey when referring to cultural heritage. The term "virtual fake" and the dichotomy between "real" and "fake" when referring to 3-D digital representations of tangible heritage (both replicas and reconstructions) were used on purpose in my article to provoke discussion. The comments received demonstrate that I achieved this goal. In this respect, I would like to thank the commentators, who brought new and stimulating aspects of the use of 3-D in archaeology and heritage to the table. I agree with Erik Champion that "virtual fake" might be an oxymoron and, as stated by Stuart Jeffrey, probably not the best word to be used in this context due to "its implication of deliberate deception." I deliberately used this provocative and contradictory term to reignite discussion on 3-D in archaeology and heritage, starting from the assumption that we should change the way we approach and consider the use of 3-D in our field and overcome the limited dualistic distinction between "real" and "fake." Jeffrey has pointed out how "3-D copies, replicas, and reconstructions are often received

as inauthentic, sanitized, and outwith the biographical narrative of the original." I think that most of the commentators would agree that we should consider these digital counterparts of the physical object different "realities," which lead to new ideas and research questions.

Two issues brought up in the comments concern the nature of the 3-D object and the intention behind the replica or reconstruction. Regarding the nature of the 3-D artefact, I agree with Kevin Garstki that not all digital 3-D models are equivalent. As he clarifies in his comments, I do not conflate what I call 3-D metrical reproductions and 3-D simulations, and I am not convinced by Kevin's argument that, by grouping them in my central question of whether both categories are real or fake, there is the risk of "misrepresenting the knowledge that is enabled by the use of different models by making the mistaken assumption that all digital forms are created equal." In fact, the aim of this contribution was to highlight "issues that arise with 3-D imaging in archaeological fieldwork or the digital preservation of objects" (as noted by Susan C. Kuzminsky) and to illustrate, starting from the provocative title, the different 3-D tools and forms of data available for visualizing, analyzing, and interpreting the past. By using very different examples in this article, I wanted to clarify how the nature of the digital object and the authenticity discourse changes when comparing 3-D metrical replicas and 3-D reconstructions and simulations but also when examining the intention behind their production. I believe in the importance of considering the final audience and purpose of the digital object at the beginning of any project and what that brings to the production of 3-D data. While I find some common ground with Jeffrey when he argues that the accuracy of a digital model is more relevant for a specialist who is attempting to unveil the story of the object, I am not convinced it is of less significance when trying to trigger emotions. Are we sure, as stated by Jeffrey, that accuracy is less important when the digital model is used as a mode of "emotional immersive experience"? Or should we consider how the perception and experience of a broader audience changes when interacting with an inaccurate instead of an accurate reproduction or simulation of past material culture? On the basis of my experience interviewing people interacting with 3-D replicas of artefacts in schools and museum settings, I can certainly argue that accurate 3-D replicas of objects increase engagement and understanding, offering new learning possibilities that are built on both object-based and inquiry learning (Chapman 2016, 2017; Magnussen, Ishida, and Itano 2000). We should also avoid the meaningless "wow effect" in the virtual as well as the physical (e.g., Hearst Castle)—it is not sufficient simply to clarify the intention; we should also consider the messages that the public receives from the organizations and museums that manage heritage sites to avoid the amusement park, Disneyland effect described by Umberto Eco in his *Travels in Hyper Reality* (Eco 1986). For this reason, while I agree with Stuart that it was not Hearst's intention to reconstruct and deceive while ignoring scientific data, the narratives created for the visitor are misleading, as they suggest Hearst's intention was to reproduce the sense of authenticity of European culture and architectural taste.

Erik Champion is right in pointing out that the Latour and Lowe (2011) article is a key reference that is "very recent and [provides] a blend of aesthetic theory . . . and an investigation of both audience reception and the role and nature of digital copies in a digital age." I share with Champion the belief that we should extend Latour and Lowe's work on painting to a thorough discussion of the role the scientist and the narrator play in relation to art and the artist and how these relationships change with 3-D digital heritage. In this context, it might be worth clarifying my discussion on the ontology of 3-D models and simulation. Starting from a domain ontology of 3-D replicas and simulations, which considers the most general features and relations of the entities that characterize the 3-D object, my article aims at opening up a conversation on the nature and value of 3-D and whether the 3-D digital counterpart of the physical object exists as an entity and aesthetic object (https://plato.stanford.edu/entries/logic-ontology/). I do believe that 3-D digital replicas and reproductions have their own entities and story to tell. I am also convinced of the importance of recording the trajectories of the flow of copies described by Latour and Lowe (2011:283) and the network of relations involved in the production process (Jones 2010; Jones et al. 2017). For this reason, I disagree with Kevin Garstki, who criticizes my argument that multiple interpretations and simulations necessarily come closer to an "absolute authentic," because I firmly believe, as stated by Jeffrey, "that integrating multiple and dynamic (real-time) visualizations of competing interpretations (each transparent about its own analytical genesis) creates a new type of digital object with affordances distinct from the original" and that "if done well, such representations could become imbued with their own form of authenticity." I believe the development of collaborative platforms that would allow both accessibility and editability of the flow of the copies to be a crucial element for the production of a simulation that could be received as an authentic representation. In this sense, I agree with Jeffrey that an "open and editable simulation, particularly one that acknowledges the networks of individuals and the authorship of those behind the representation rather than simply citing data sources, could indeed be received as an authentic representation."

I sympathize with Champion's argument that it is not yet clear what role digital technologies will play in the creation of new and effective ways of interpreting the past. This is especially true when dealing with 3-D. We still have to demonstrate if and how 3-D digital heritage changes the way we access, understand, and interpret the past, but I am also convinced that, with the advent of 3-D digital technologies, our perception and approach to cultural heritage has profoundly changed. How it has changed has been demonstrated in some works on cognition and perception (Di Giuseppantonio Di Franco et al. 2015; Kirsch 2010*a*, 2010*b*): we think differently when interacting with a 3-D virtual copy of the past, although it is very difficult to track how our thinking process changes with

3-D. With this statement, I am not trying to claim that we obtain a better interpretation of the past using digital tools, but I am convinced that, as digital archaeology and heritage specialists, we should aim at revealing those changes and measuring their impact on our interpretative processes.

The most rewarding result of this forum is the widespread acknowledgment that accessibility is one of the most important aspects when dealing with 3-D digital heritage. The models presented in this article are all available in offline virtual museums. For reasons of space and because of the nature of this paper, I did not provide a detailed description of the virtual museums, but I refer to the dedicated publications where it is possible to find more information on the different applications presented during my discussion (Forte et al. 2004; Galeazzi 2008; Galeazzi, Di Giuseppantonio Di Franco, and Dell'Unto 2010). Access and long-term preservation are crucial aspects when dealing with 3-D data. For this reason, I am currently working on the development of open infrastructures aimed at increasing access to and preservation of 3-D data (Galeazzi et al. 2016). Is it possible to develop open and collaborative online infrastructures that could change the way we use and interpret 3-D data pertaining to cultural heritage? How might this open and accessible online platform contribute to understanding the real nature or entity and the potential and limitations of 3-D for analyzing and interpreting the past? While digital archaeologists and heritage specialists have long used digital tools and applications as valuable methods for the preservation and recording of tangible heritage, it may be time to consider a new direction for digital archaeology and heritage, one in which we take 3-D itself as an object of inquiry. This would help us to understand whether it is possible to assign to 3-D archaeology and heritage its own body of theoretical sources and culture of discourse and the production of unique classes of archaeological content.

—Fabrizio Galeazzi

References Cited

Baker, Frederick. 2015. Rock-art and the digital difference. Paper presented at International Conference on Cultural Heritage and New Technologies 19, Vienna. [FB]

Baudrillard, Jean. 1983. *Simulations*. New York: Semiotext(e).

———. 1994. *Simulacra and simulation*. Ann Arbor: University of Michigan Press.

Belting, Hans. 2006. *Das Echte Bild: Bildfragen als Glaubens Fragen*. Munich, Germany: Beck. [FB]

Bendix, Regina. 1997. *In search of authenticity: the formation of folklore studies*. Madison: University of Wisconsin Press.

Benjamin, Walter. 1969 [1936]. The work of art in the age of mechanical reproduction. In *Illuminations*. Hannah Arendt, ed. Harry Zohn, trans. Pp. 217–251. New York: Schocken.

Boym, Svetlana. 2002. *The future of nostalgia*. New York: Basic.

Cameron, Fiona. 2007. Beyond the cult of the replicant: museums and historical digital objects—traditional concerns, new discourses. In *Theorizing digital heritage: a critical discourse*. Fiona Cameron and Sarah Kenderdine, eds. Pp. 49–75. Cambridge, MA: MIT Press. [SJ]

Champion, E. 2006. Enhancing learning via 3-D virtual environments. In *Enhancing learning through technology*. E. Korsgaard-Sorensen and D. O'Murchu, eds. Pp. 103–124. Hershey, PA: Information Science.

Chapman, A. J. 2016. Developing students' understanding of historical interpretations. London: Edxecel/Pearson. https://qualifications.pearson.com/content/dam/pdf/A%20Level/History/2015/teaching-and-learning-materials/A_level_History_interpretations_guidance_abridged.pdf.

———. 2017. Historical interpretations. In *Debates in history teaching*. Ian Davies, ed. Pp. 100–112. London: Routledge.

Daniels, Stephen, and Denis Cosgrove. 1988. Introduction: iconography and landscape. In *The iconography of landscape*. Denis Cosgrove and Stephen Daniels, eds. Pp. 1–10. Cambridge: Cambridge University Press.

Dave, Bharat. 2008. Virtual heritage: mediating space, time and perspectives. In *New heritage: new media and cultural heritage*. Yehuda E. Kalay, Thomas Kvan, and Janice Affleck, eds. Pp. 40–52. New York: Routledge.

Di Giuseppantonio Di Franco, P., C. Camporesi, F. Galeazzi, and M. Kallmann. 2015. 3D printing and immersive visualization for improved perception of ancient artifacts. In *Living virtual heritage*. Special issue, *Presence: Teleoperators and Virtual Environments* 24(3):243–264. doi:10.1162/PRES_a_00229.

Di Giuseppantonio Di Franco, Paola, and Fabrizio Galeazzi. 2013. Western Han Dynasty mural tombs: from the use of integrated technologies to the cybermap. In *CAA 2010 fusion of cultures: proceedings of the 38th Annual Conference on Computer Applications and Quantitative Methods in Archaeology, Granada, Spain, April 2010*. Francisco Contreras, Mercedes Farjas, and Francisco J. Melero, eds. Pp. 345–352. BAR International Series. Oxford: British Archaeological Reports.

Dueholm, Johanne, and Karina M. Smed. 2014. Heritage authenticities: a case study of authenticity perceptions at a Danish heritage site. *Journal of Heritage Tourism* 9(4):285–298. [EC]

Eco, U. 1986. *Travels in hyper reality: essays*. San Diego, CA: Harcourt Brace Jovanovich.

Entrikin, J. Nicholas. 1991. *The betweenness of place: towards a geography of modernity*. Baltimore: Johns Hopkins University Press.

Forte, Maurizio. 2008. Introduzione. In *La villa di Livia, un percorso di ricerca di archeologia virtuale*. Maurizio Forte, ed. Pp. 1–36. Rome: Erma di Bretschneider.

Forte, Maurizio, Sofia Pescarin, Eva Pietroni, and Nicoló Dell'Unto. 2004. An integrated approach to archaeology: from the fieldwork to virtual reality systems. In *Beyond the artifacts: digital interpretation of the past: proceedings of CAA 2004*. Franco Nicolucci and Sorin Hermon, eds. Pp. 325–334. Budapest, Hungary: Archeolingua.

Forte, Maurizio, and Eva Pietroni. 2009. 3-D collaborative environments in archaeology: experiencing the reconstruction of the past. *International Journal of Architectural Computing* 1(7):57–75.

Forte, M., and A. Siliotti. 1997. *Virtual archaeology: ER-creating ancient worlds*. New York: Abrams.

Galeazzi, Fabrizio. 2008. La modellazione architettonica: la modellazione. In *La villa di Livia, un percorso di ricerca di archeologia virtuale*. Maurizio Forte, ed. Pp. 129–133. Rome: Erma di Bretschneider.

Galeazzi, Fabrizio, M. Callieri, M. Dellepiane, M. Charno, R. Scopigno, and J. Richards. 2016. Web-based visualization for 3-D data in archaeology: the ADS 3-D viewer. *Journal of Archaeological Science: Reports* 9:1–11. doi:10.1016/j.jasrep.2016.06.045.

Galeazzi, Fabrizio, P. Di Giuseppantonio Di Franco, and N. Dell'Unto. 2010. 3-D cybermaps of Western Han mural tombs. In *Cyber-archaeology*. M. Forte, ed. Pp. 97–108. BAR International Series 2177. Oxford: Archeopress.

Garstki, K. 2016. Virtual representation: the production of 3-D digital artifacts. *Journal of Archaeological Method and Theory* 24(3):726–750. doi:10.1007/s10816-016-9285-z. [KG]

Gibson, James J. 1979. *The ecological approach to visual perception*. Boston: Houghton Mifflin.

Gruen, Armin, Fabio Remondino, and Li Zhang. 2002. Reconstruction of the Great Buddha of Bamiyan, Afghanistan. *International Archives of Photogrammetry, Remote Sensing Spatial Information Science* 34(5):363–368.

Hardy, Grant, and Anne Behnke Kinney. 2005. *The establishment of the Han Empire and imperial China*. London: Greenwood.

Hodder, Ian. 1997. "Always momentary, fluid and flexible": towards a reflexive excavation methodology. *Antiquity* 71:691–700.

Holtorf, Cornelius. 2002. Notes on the life history of a pot sherd. *Journal of Material Culture* 7(1):49–71.

Ingold, Tim. 2000. *The perception of the environment: essays on livelihood, dwelling and skill*. New York: Routledge.

Jeffrey, Stuart. 2015. Challenging heritage visualisation: beauty, aura and democratisation. *Open Archaeology* 1(1):144–152. doi:10.1515/opar-2015-0008.

Jeffrey, Stuart, Alex Hale, Cara Jones, Siân Jones, and Mhairi Maxwell. 2015. The ACCORD project: archaeological community co-production of research resources. In *Proceedings of the 42nd Annual Conference on Computer Applications and Quantitative Methods in Archaeology, CAA 2014*. Paris: CAA. [SJ]

Jones, Siân. 2010. Negotiating authentic objects and authentic selves: beyond the deconstruction of authenticity. *Journal of Material Culture* 15(2):181–203. doi:10.1177/1359183510364074.Jones.

Jones, Siân, Stuart Jeffrey, Alex Hale, Cara Jones, and Mhairi Maxwell. 2017. 3-D heritage visualisation and the negotiation of authenticity: the ACCORD project. *International Journal of Heritage Studies* 24(4):333–353. doi:10.1080/13527258.2017.1378905.

Karmelek, Mary. 2015. The new monument men outsmart ISIS. *Newsweek*, November 11. [FB]

Kirsh, D. 2010*a*. Thinking with external representations. *AI and Society: Knowledge, Culture and Communication* 25(4):441–454.

———. 2010*b*. Comparing tangible and virtual exploration of archaeological objects. In *Cyber-archaeology*. M. Forte, ed. Pp. 119–124. BAR International Series 2177. Oxford: Archeopress.

Knappett, Carl. 2002. Photographs, skeuomorphs and marionettes: some thoughts on mind, agency and object. *Journal of Material Culture* 7(1):97–117.

Kopytoff, Igor. 1986. The cultural biography of things: commoditization as process. In *The social life of things: commodities in cultural perspective*. Arjun Appadurai, ed. Pp. 64–91. Cambridge: Cambridge University Press.

Kuzminsky, Susan A., and Megan S. Gardiner. 2012. Three-dimensional laser scanning: potential uses for museum conservation and scientific research. *Journal of Archaeological Science* 39:2744–2751.

Lakoff, George, and Mark Johnson. 1999. *Philosophy in the flesh: the embodied mind and its challenge to Western thought*. New York: Basic.

Latour, Bruno, and Adam Lowe. 2011. The migration of the aura, or how to explore the original through its facsimiles. In *Switching codes: thinking through digital technology in the humanities and the arts*. Thomas Bartscherer and Roderick Coover, eds. Pp. 275–297. Chicago: University of Chicago Press.

Loewe, Michael. 2005. *Faith, myth and reason in Han China*. Indianapolis: Hackett.

Lowenthal, D. 1985. *The past is a foreign country*. Cambridge: Cambridge University Press.

Magnussen, L., D. Ishida, and J. Itano. 2000. The impact of the use of inquiry-based learning as a teaching methodology on the development of critical thinking. *Journal of Nursing Education* 39(8):360–364.

Michel, Roger. 2016. Reflecting on an extraordinary year—and looking ahead to 2017. Institute for Digital Archaeology website. http://digitalarchaeology.org.uk. [FB]

Miller, D., and H. A. Horst. 2012. The digital and the human: a prospectus for digital anthropology. In *Digital anthropology*. Heather A. Horst and Daniel Miller, eds. Pp. 13–25. London: Bloomsbury. [FB]

Nagel, Thomas. 1986. *The view from nowhere*. New York: Oxford University Press.

Orvell, M. 1989. *The real thing: imitation and authenticity in the American culture, 1880–1940*. Chapel Hill, NC: University of North Carolina Press.

Pred, Allan. 1984. Place as a historically contingent process: structuration and the time-geography of becoming places. *Annals of the Association of American Geographers* 74(2):279–297.

Reilly, P. 1991. Towards a virtual archaeology. In *CAA90 computer applications and quantitative methods in archaeology 1990*. S. Rahtz and K. Lockyear, eds. Pp. 132–139. BAR International Series 565. Oxford: Tempus Reparatum.

Ruggieri Tricoli, M. C. 2000. *I fantasmi e le cose*. Pavia, Italy: Lybra Immagine.

Sanz, Juan O., Maria de la Luz G. Docampo, Santiago M. Rodríguez, María T. R. Sanmartín, and Gonzalo M. Cameselle. 2010. A simple methodology for recording petroglyphs using low-cost digital image correlation photogrammetry and consumer-grade digital cameras. *Journal of Archaeological Science* 37(12):3158–3169.

Seremetakis, N. 1994. *The senses still: perception and memory as material culture in modernity*. Chicago: University of Chicago Press.

Shanks, M. 1997. Photography and archaeology. In *The cultural life of images: visual representation in archaeology*. B. L. Molyneaux, ed. Pp. 73–107. London: Routledge. [KG]

Shea, Christopher D. 2016. Palmyra arch replica is unveiled in Trafalgar Square in London. *New York Times*, April 19. [FB]

Spector, Janet. 1993. *What this awl means: feminist archaeology at a Wahpeton Dakota village*. St. Paul, MN: Historical Society.

Thwaites, Harold. 2013. Digital heritage: what happens when we digitize everything? In *Visual heritage in the digital age*. E. Ch'ng, V. Gaffney, and H. Chapman, eds. Pp. 327–348. London: Springer. [EC]

Trilling, L. 1981. *Sincerity and authenticity*. Cambridge, MA: Harvard University Press.

Tringham, Ruth. 1994. Engendered places in prehistory. *Gender, Place and Culture* 1(2):169–203.

Tuan, Yi-fu. 1977. *Space and place: the perspective of experience*. Minneapolis: University of Minnesota Press.

Tversky, Barbara. 2001. Multiplicity of mental space. *Schriftenreihe-Wittgenstein Gesellschaft* 29:370–378.

Van Dyke, R. M. 2006. Seeing the past: visual media in archaeology. *American Anthropologist* 108(2):370–375. [KG]

Varela, Francisco J., Evan Thompson, and Eleanor Rosch. 1999. *The embodied mind: cognitive science and human experience*. Cambridge, MA: MIT Press.

Weber, Gerhard W. 2015. Virtual anthropology. *Yearbook of Physical Anthropology* 156:22–42. [SCK]

Webmoor, T. 2005. Mediational techniques and conceptual frameworks in archaeology: a model in "mapwork" at Teotihuacán, Mexico. *Journal of Social Archaeology* 5(1):52–84. [KG]

Witmore, C. L. 2013. The world on a flat surface: maps from the archaeology of Greece and beyond. In *Re-presenting the past: archaeology through text and image*. S. Bonde and S. Houston, eds. Pp. 127–152. Oxford: Oxbow Books. [KG]