McDONALD INSTITUTE CONVERSATIONS

Authenticity and cultural heritage in the age of 3D digital reproductions

Edited by Paola Di Giuseppantonio Di Franco, Fabrizio Galeazzi and Valentina Vassallo

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Star Carr
head dress

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with contributions from
Nicola Amico, Frederick Baker, Gareth Beale, Eleni Bozia, Mark Elliott, Kevin Garstki, Sorin Hermon, Stuart Jeffrey, Peter Jensen, Jody Joy, Sarah Kenderdine, Nicoletta Miltiadous, Franco Niccolucci, Paola Ronzino and Lola Vico

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Figures

Chapter 6

Virtual authority and the expanding role of 3D digital artefacts

Kevin Garstki

The technology used to create digital 3D models of archaeological material has proliferated in the discipline in recent years. There are now myriad types of technologies used to create digital artefact models that range in resolution, accuracy, and cost, depending on the type of research questions asked by the archaeologist. As these technologies expand in the discipline, the number of users of the final product (the digital model) is growing rapidly. Additionally, as the techniques and digital interfaces become easier to use, the number of producers is also growing. The benefits that these digital 3D artefact models present to research remain vast: access to otherwise remote collections, scalable models for comparative analysis, detailed morphometric analysis, and increased engagement with the public, are all potentials that these models bring to the discipline. However, as we keep these overwhelming benefits in mind, it is also necessary to consider the place that these new digital forms take in the discipline. The process of creating a digital model of an artefact requires significant input by the producer that includes choices about what technology to use, the capturing strategy, the lighting conditions and settings, the post-processing, and the software used to view or edit the model. Any number of these factors can, and do, influence the attributes of the final model. In turn, the way that we take into account or ignore these processes will impact how we use these digital models in archaeological research.

In this chapter I will begin by outlining the similar trajectories of photographic technology in archaeology in the nineteenth century and 3D scanning technology of the twenty-first century. This comparison will serve to establish the argument that 3D models of artefacts, just like artefact photographs, should be considered representations of the original object – establishing the terminology allows us to then acknowledge the biases inherent in the creation of a representation. I contend that the creation of any representation, be it photograph or 3D model, is accompanied by a perceived authority attributed to the producer. This implicit attribution of authority is in part based on the perception of a producer as a documentary witness to the original (Shanks 1997). In displaying a photograph or 3D model, the producer is saying 'I was there and this is what the artefact looks like.' This authority is also attributed to the producer as someone who knows how to use a 'black box' technology to create a representation. As the process by which data is manipulated in representations becomes more opaque, the authority attributed to the producer increases. I argue that this authority attributed to the producer of a 3D artefact model can be misappropriated in the argument for or against authenticity of a 3D model. The way in which authenticity can be defined, for digital models or otherwise, is extremely variable (Jones 2010; Jones & Yarrow 2013; Holtorf 2013; 2010; Garstki 2016). Yet I argue that any discourse surrounding the authenticity of a 3D digital representation of an artefact should include an understanding of the full production process – all of the choices, inputs, and data manipulation that affect the final model.

Photography and its similarities to 3D scanning

The discipline of archaeology has a long history of co-opting and subsuming outside technologies that are found to benefit the study of the human past. One of the earliest and most widespread examples of this is the development of photography in archaeology in the second half of the nineteenth century. I have argued elsewhere (Garstki 2016) that the development and use of photography in archaeology closely parallels the more recent development of 3D scanning and modelling techniques. One technology for capturing photographic images, the daguerreotype process,

was quickly adopted by archaeological expeditions following its development by Jacques-Louis-Mande Daguerre (Bohrer 2011; Dorrell 1994; Lyons 2005; Olsen et al. 2012). And while the daguerreotype was utilized to document monuments throughout the Mediterranean, the problem of reproducibility quickly came to the fore. The dissemination of visual archaeological data in publication is a key facet for the study of archaeology, yet the image produced by the daguerreotype process was not easily reproduced in print. This historical problem is paralleled by the techniques used in the early twenty-first century to produce 3D models of artefacts, and the hardware and software used to showcase them. If a 3D model can only 'live' on one computer or on a single server with limited access, then its utility to the discipline is also limited. It has only been with the increased capabilities of online digital repositories, 3D supplements in many major journals, or the capabilities to embed 3D representations into PDFs that the usefulness of 3D digital artefact models has been really felt. The reproducibility issue in the nineteenth century was also helped by an alternative photographic technology: Henry Fox Talbot's negative-positive procedure for capturing images, the calotype (Hamilakis & Ifantidis 2015). Although photography had been used in archaeology for a few decades, it was only with Conze's 1875 publication, *Archäologische Untersuchungen auf Samothrake*, that photographic documentation was used in a publication (Dorrell 1994).

By the later part of the nineteenth century, however, there were many techniques available to archaeologists to reproduce still images of excavations or artefacts – collotypes, chromolithography, autotypes, platinotypes, and heliogravures (Olsen et al. 2012, 53). This trajectory is once again mirrored by the development of 3D scanning techniques during this century. Archaeologists currently use a number of file types (OBJ, 3D pdf, PLY, STL, COLLADA, etc.) and digital interfaces (e.g. online journal supplements, embedded pdfs, Sketchfab,[1] Ariadne,[2] dedicated websites[3]) to reproduce and share digital 3D artefact models. Similarly, just as there were a number of technologies used to create photographic images in the early years, archaeologists are utilizing a number of types of surface capture technology to create digital 3D models of artefacts: laser scanning (e.g. McPherron et al. 2009; Pires et al. 2006), structured light scanners (e.g. Acka et al. 2006; Counts et al. 2016; Grosman et al. 2014), or photogrammetry (e.g. Kersten & Lindstaedt 2012; Heath 2015; Miles et al. 2014; Olson & Caraher 2015). Each type of technology utilizes different physical properties to capture the surface geometry (and visual appearance) of an object, just as the different types of photographic technologies differently captured the scene in front of the camera.

In addition to their historical development in the discipline, the way in which each image or 3D model seeks to present some visual and spatial data to the user is strikingly similar. The presentation of data to a user is partially based on the perception of source reliability and the authority to convey information from the original artefact to the user of the representation. The *perception* of photographic images is one of objective representation (Garstki 2016). There often exists a presumption of mechanical reproduction in the creation of an artefact photo – that there is little or nothing that influences the creation of the final representation. Photographs provide a static medium to interact with the original subject (i.e. artefact). In the nineteenth century, illustrations and later photographs were able to standardize experience and steer intellectual thought to a rigid framework by presenting standardized visual representations in scientific inquiry (Daston & Gailson 2007; 1992). This perception of objectivity is maintained in our modern interaction with photography (Bourdieu 1996, 77; Bohrer 2011, 28; Shanks 1997). Yet despite this perception of objectivity, Van Dyke (2006, 372) notes that '…there is always an eye behind the camera, and a hand on the development process, that directs what a viewer sees.' We cannot think of photography as a completely mechanical process, automated beyond human influence, or we remove any human determinism in the final product (Shanks 1997). The perception of photography as a 'camera automaton' is in danger of being mirrored in the use 3D scanning systems.

I would argue that despite its growth in the field, 3D scanning still maintains a *perception* of objective creation, resting on a mistaken assumption of mechanical reproduction (from original artefact to 3D model). As he traces the parallels between a conception of mechanical reproduction in plaster casts, squeezes, and digital 3D models, Adam Rabinowitz very correctly notes that 'the digital 3D model is not a true surrogate for the original, even when derived from photographs' (2015, 34). Rabinowitz (2015) identifies that there is a significant amount of input from the creator of any 3D model, which is not accounted for when the product is presented as being mechanically reproduced. In presuming a process of mechanical reproduction in the creation of a representation, the significant influence that the producer has over of the final product is ignored. By not addressing or understanding the producer's influence over the final product, a level of technological authority is attributed to them. This authority mistakenly assumes an objective translation of data, from the original artefact to the new 3D

model. As such, notions of an objective, mechanical technique are combined with a documentary aspect of photography. The user of a photograph attributes a level of authority to the producer of said photograph, which rests on a perception of the photographer as a documentary witness (Shanks 1997, 74). Shanks notes that 'a photograph may be used to provide authority based upon the notions of presence and seeing' (1997, 74). Authority rests with the producer of the digital 3D artefact model – as one who 'sees' the original artefact and is simply reproducing it in digital form through a mechanical process.

The argument made for authenticity of a representational object is tied strongly to the perception of authority surrounding the producer. Technological authority masks the productive process and creates a false sense of an objective reproduction of an original – justifying a perception of authenticity. A photograph or 3D model may be argued to be authentic to itself, as a thing produced with a specific set of goals in mind. In this way, Stuart Jeffery argues that due to the expertise, intentionality, and resources used to create a digital visualization, the aura (*sensu* Benjamin 1968) and authenticity of the original can be passed on to the digital replica (2015) (Jones and Yarrow [2013] have also argued for this in a physical form). On the other side, while these representations may be able to translate many visual aspects of the original that constitute our perception of pastness (Holtorf 2013; 2010), the creation of a visual representation of an artefact, be it photograph or digital model, gives the representation a separate narrative from the original (Garstki 2016). So, an argument may be made that a digital 3D artefact model is authentic because it has been created with the intention to create this new digital object, and also that it is inauthentic because an object's properties and relations are irreducible to a representation of it (Olsen et al. 2012). However, any argument for authenticity that equates representation with original negates the productive act, and all of the input that goes into the creation of the final product.

I would therefore argue that regardless of how one defines or attributes authenticity to a representational object, the technological authority to create the object should be interrogated. Would that authority still exist if the entire process of production (i.e. scanning, processing, modelling, etc.) becomes completely transparent, if the individual choices and inputs made by the producer became visible? The need for transparency has also been well articulated by Rabinowitz (2015, 34–6), as the production of digital 3D models of archaeological material is filled with choices in technology and technique. To emphasize the biases and myriad inputs that exist in the productive process of 3D artefact scanning, I present here two short case studies; one that examines how the influence of photography impacts the final digital 3D artefact model, and one that demonstrates how post-scanning input can also alter the final product.

Case study 1

In summer 2016, the Athienou Archaeological Project (AAP) began a project that attempts to integrate digital artefact models more seamlessly with a traditional publication framework. Following a pilot project in 2014 (Counts et al. 2016), a structured light scanning system was used to create a select corpus of digital 3D models of limestone and terracotta statuary recovered from the site of Athienou-*Malloura*. AAP has been examining the long-term cultural change at Athienou-*Malloura* and the surrounding region since 1990, which has evidence for domestic, religious, and funerary activity dating back to the first millennium BC (Toumazou et al. 2015; 2011). The focus during the last two decades has been on the rural sanctuary at Athienou-*Malloura*, which has brought to light significant activity from as early as the eighth century BC to the fourth century AD (Toumazou & Counts 2011). Due to being one of the few inland, rural sites in Cyprus to be excavated scientifically, the over 3,000 fragments of votive limestone and terracotta sculpture provide a useful corpus to reconstruct Cypriot religious practices during this period (Averett 2011; Counts et al. 2016; Counts 2011; 1998). A selection of these artefacts were scanned during the 2016 season and these models will be used in a digital open-access artefact catalogue.

The system used in the creation of these digital models was the HDI Advanced R1X Scanner from GoMeaure3D. As with many structured light systems, the scanner utilizes a projector, two point-grey cameras to capture the surface data, and a separate DSLR camera to capture the photo texture. And while much can be said regarding the type of surface capture technology, and its accuracy and resolution, the focus here will be on the impact that the DSLR camera had on the production of the final digital 3D model. The DSLR camera, a Canon Rebel T5 EOS 1200D (18 megapixels), was integrated with the scanning software so that all the camera settings were manually adjusted through the software (shutter speed, aperture, white balance, focus, etc.). Each of these aspects of photography that can be adjusted during a scan of an artefact impact the final 'look' of the resultant digital artefact model, and therefore, the individual operating the structure light system has significant productive influence. For example, the colour balance settings on the Canon can be adjusted to suit specific lighting conditions.

Figure 6.1. *Three digital 3D models of a Herakles head (AAP-AM 851; Larnaka District Museum, Cyprus) from Athienou-Malloura (© Athienou Archaeological Project), using different white balance settings.*

Adjusting this setting will result in drastically different colours of the artefact represented by the photo texture. Figure 6.1 shows the same artefact (a limestone head of the so-called Cypriot-Herakles type from Athienou-*Malloura*; see Counts 1998, 122–7) scanned in identical lighting conditions but with the white balance settings slightly adjusted. This example is at the extreme end of variations in photo-texture that can result from altering the photographic technique, yet it demonstrates that the process of scanning and modelling is far from mechanically automated. It is not a new idea that the location where we view an artefact can alter our perception of it; studying a limestone sculptural fragment will look slightly different in a well-lit gallery than it would outside on a sunny day, or in the attic of a museum under florescent lights. However, when one creates a 3D model of an artefact, with specific light and colour conditions, the appearance becomes fixed to the artefact; a static aspect of an otherwise dynamic representation.

Case study 2

The input that is required to complete a digital 3D model of an artefact does not end with the data capturing process. After each scan is taken (in range-based modelling systems) or image captured (in image-based systems), there may be significant processing involved in turning the initial data into a final model. This may take the form of manually aligning multiple scans to create a complete model of the artefact, or editing individual images to only highlight parts of the photographed artefact. 'Noise' is often captured by the 3D scanning technique, whether it is part of the platform that the artefact was resting on when scanned or simply a misalignment of one or two scans. This noise is manually deleted from the model within the modelling software – another input from the producer.

Once the final mesh is completed and the photo-texture is processed, it is not uncommon to notice areas of the artefact model that seem 'wrong' in their colour or shade. Figure 6.2 shows a 3D digital model made of a Roman lamp reproduction using close-range photogrammetry. A Fujifilm FinePix HS30EXR and Agisoft's Photoscan Professional version 1.2.5 were used to produce the model from a total of 74 images. After the final processing of the model, a discoloration was noted from where the lamp had rested on its side during much of the photo capture. This colouring does not represent the original colour on that part of the lamp (Fig. 6.2). How should a misrepresentation like this discoloration be handled by the producer of the model? This digital model is not 'accurate' to the original in that area of the lamp, and if someone were to interact with the new digital 3D model only, they would not be aware that this discoloration was not original to the piece. Yet, would additional input by the producer in the form of 'photoshopping' the discolored area of the model add to the misrepresentation or mitigate the issue? The photo texture of the

Figure 6.2. *A digital 3D model of a Roman lamp reproduction using photogrammetry. Discoloration on the bottom-centre of the model.*

model can be edited in Adobe Photoshop (or other illustration software) to better represent what is visible on the surface of the lamp in life (Fig. 6.3).

While this example may seem inconsequential to the production of archaeological knowledge through the interaction with 3D artefact models, it in fact illustrates the minute inputs from the producer that can all add up to greatly alter the final digital artefact model, and therefore alter our interaction with material culture. If we were to leave each 'imperfection' or discoloration created during the production of a digital artefact model, then these visual aspects of the model would become part of the object's narrative – a researcher will see a discoloration on a 3D digital model of a lamp and presume there was some process (in the past) that caused it. However, if we were to photoshop each 3D model to better suit what we 'see' in person, then we may as well create the photo-texture from scratch just as an illustrator would do.

Discussion

It is easy to understand why we can view photography as a mechanical process; early in the discipline, standards for capturing artefact images were developed (Flinders Petrie 1904), and today we continue a largely standardized practice of object photography. By standardized, I do not mean the practice is without

Figure 6.3. *(Left) The initial digital 3D model of a Roman lamp reproduction; (right) The altered digital 3D model using Adobe Photoshop.*

bias or individual choice, but merely there is a general set of guidelines used in the creation of artefact photos. Because of the perception of standardization, we do not as often consider the impact the photographer has on the creation of the image. The ability to manipulate an image while it is being created has always been present, but with the rise of digital images, manipulation of an image after it was captured can occur very easily and with little training (Shanks 1997, 81). The process of 3D scanning is far from standardized. To begin, there are still a number of technologies used in the process. Not only will a structured light scanner create a very different digital model than structure from motion, but even within a particular technology there are many types of commercial scanners, cameras, and software that can be used to create an artefact model. Moving beyond the technology itself, the locations where 3D artefact scanning can take place may be limited. It may be the case that when working in a museum, the artefacts may only be viewed in certain study rooms, which may or may not be well lit. And while it may be argued that there should be a standardized light box and lighting system used during each scan, this has yet to take place.

The two above examples demonstrate that digital 3D artefact models, just like photographs, are representations of an original object, each produced as part of archaeological practice with a series of choices and techniques. The aesthetic of the final model is largely dependent on the choices made during the production process (such as lighting and other camera settings) or during the processing of the model (such as manually manipulating the photo-texture). Archaeologists invest significant time and resources into the creation of media used to convey archaeological data, and yet the focus is rarely on the production process but only on the final product (Shanks & Webmoor 2013). Regardless of whether we consciously acknowledge it, the time and resources we put into creating archaeological representations significantly impacts the way in which archaeological knowledge is transferred, communicated, and created. It is important to discuss these otherwise innocuous steps and make these processes transparent so that by identifying the biases or choices involved in the creation of a representation, the authority of production is more strongly considered.

Without incorporating the ways in which a producer impacts the creation of a 3D model, the authority attributed to the producer presents a representation as being equivalent to the original, unintentionally reifying the information that is created in the process as being 'real' to the original. Through this reification, a colour inconsistency on the surface of a model becomes part of the artefact narrative. In the end, the creation of any visual representation in archaeology, photograph or 3D model, is an attempt to convey visual data to another person who may not be in direct contact with the original (Shanks & Webmoor 2013). The authority to create these representations is accompanied by the assumption that the data presented will be accurate to the original, in colour, shape, size, scale, etc. In order to more accurately convey the visual data to one another, and avoid the assumptions of objectivity that often accompany the attribution of technological authority, we need to be as explicit as we can in how we produce these digital representations – from the decision of what 3D scanning technology to utilize to the edits we make of the final product.

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Notes

1 https://sketchfab.com/
2 http://visual.ariadne-infrastructure.eu/
3 http://sites.museum.upenn.edu/monrepos/index.html

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