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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head dress

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with contributions from
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Figures

Chapter 9

Theorizing authenticity – practising reality: the 3D replica of the Kazaphani boat

Nicola Amico, Paola Ronzino, Valentina Vassallo, Nicoletta Miltiadous, Sorin Hermon and Franco Niccolucci

3D printing is considered the new revolution in the field of cultural heritage and archaeology, contributing to the definition of new horizons in the conservation and communication sector (Foster & Curtis 2016; Alemanno et al. 2014; Scopigno et al. 2014; Tucci & Bonora 2011). 3D physical replicas may replace original objects that cannot be moved, because of their value, or that are inaccessible, or not available, due to their conservation state or fragility, or because they are considered valid substitutes for lost museum artefacts.

Much has been written about authenticity. Concepts associated with authenticity such as truthfulness and integrity are discussed in the definition of the word given in the last version of the World Heritage Operational Guidelines published in 2015 (UNESCO 2015).

Furthermore, according to Adam (Adam 2010), the term authenticity has different definitions depending on the context of its use. If the term 'authentic' is used to define something original and unique, the authenticity of digital objects or their physical replicas, generated from a real object, cannot be applied because 'all digital object are copies' (Lynch 2000) and infinitely replicable and modifiable. In this case, the term 'faithful' seems to fit better. It can mean being original, but also being faithful to an original; it can mean accurate, with known provenance (Cullen et al. 2000).

The concept of authenticity in DH is often related to provenance (as widely discussed by Hermon and Niccolucci in Chapter 1), completeness, integrity, accuracy and context (Lynch 2000). These aspects are endorsed by various scholars (Amico et al. 2013; Damnjanovic, Hermon & Iannone 2013; Ronzino, Niccolucci & Hermon 2012; Niccolucci et al. 2010; Koller, Frischer & Humphreys 2009; Beacham, Denard & Niccolucci 2006) who address the importance of scientifically authenticated 3D data, by adopting effective metadata structures, to ensure long-term preservation and data interoperability.

The importance of documenting the digital provenance of data is largely a matter of intellectual transparency (Beacham, Denard & Niccolucci 2006); there is a chain of events and elements (including activities, actors, devices, parameters, contextual information, and so forth) that connects the 3D digital or physical replica to the real object (Amico et al. 2013). By preserving the integrity and the transparency of the chain of activities involved in the creation of the 3D digital or physical reproduction, we can ensure its authenticity.

As far as the authenticity discourse is concerned, how are replicas conceived? What does an observer looking at a 3D digital or physical replica perceive? These questions arose from our observations by applying 3D acquisition and 3D printing to a case study.

In the next section, we will describe the recreation of the so-called 'Kazaphani boat', a Late Bronze Age pottery artefact found in Cyprus and permanently exhibited at the Cyprus Museum. Recently, the boat was chosen to be part of a travelling exhibition hosted at the National Museum of Natural History, Smithsonian Institute, USA, but due to its fragility, it was decided that the artefact could not be moved.

In describing in detail the chain of activities involved in the production of the 3D physical replica of the Kazaphani model boat, we attempt to demonstrate how the 3D technologies can contribute to the work of conservators in understanding, analysing and interpreting the tangible heritage, and engage the public in an experience that, due to logistical issues, was not previously possible.

Size, shape, colours, surface markings, even evidence of the past damage and previous restorations were recorded. Then, an accurate physical replica of the boat was created with a 3D powder printer.

Besides the opportunity to show the replica in a travelling exhibition, the digital and physical reproduction enabled conservators to interact and analyse the replicated boat in detail, preventing any damage to the original.

The lessons learned through the case study in question, which involves not only the application of 3D technologies and the replica-making process, but also community engagement, will enable us to discuss the limits and the strengths of 3D replicas in archaeology, re-focusing the concept of authenticity by defining a new 'augmented authenticity'.

The 3D replica of the Kazaphani boat.
A case study of a fragile archaeological artefact

The Kazaphani model boat was found in a tomb in the locality of *Ayios Andronikos* in the village of Kazaphani, Kyrenia District, Cyprus. It is a clay model of a ship, the hull of which is canoe-shaped, deep and hollow, dating to the Late Bronze Age in Cyprus (between 1550 and 1200 BC). It is made of reddish clay and it is not decorated. The dimensions of the Kazaphani model boat are: length 45 cm, beam amidships 20.5 cm, height amidships 15 cm (Nicolaou & Nicolaou 1989; Karageorghis 2002; Pilides & Papadimitriou 2012). The model boat (inv. no. Kazaphani Tomb 2B/249+377) is currently on display at the Cyprus Museum in Nicosia. In 2010, the Kazaphani model boat was chosen to be part of a travelling exhibition titled 'Cyprus: Crossroads of Civilizations', which was on display at the National Museum of Natural History, Smithsonian Institute, USA, between October 2010 and April 2011 (Hadjisavvas 2010).

The model boat was in a fragile condition and was not intact, having been reassembled in a previous conservation effort. The surface was worn in some areas, mostly from flaking. The adhesive used in the initial conservation needed replacement to ensure the stability of the object. A number of minor and major scratches were visible on the boat's surface. Some old residues of silicon rubber were also visible from a previous casting process.

The conservators in charge, after examining the object and evaluating its fragile condition, recommended that a replica of the original be sent to the exhibition so as to avoid the risk of damage during transportation to the USA.

For many years, the Casting Laboratory at the Cyprus Museum had been replicating a variety of archaeological artefacts, such as small statues, heads, tools, etc., using the traditional silicon rubber method for creating a mould that is a 'negative' impression of the original. Incidentally, a cast is a 'positive' replica made from the mould, which has the exact shape and dimensions, surface markings, details and evidence of the original object. Casts are made of plaster of Paris (casting plaster) or polyester resin.

However, due to the fragile state of the model boat, coupled with the overhung and undercut parts of its interior, which would make the process of casting

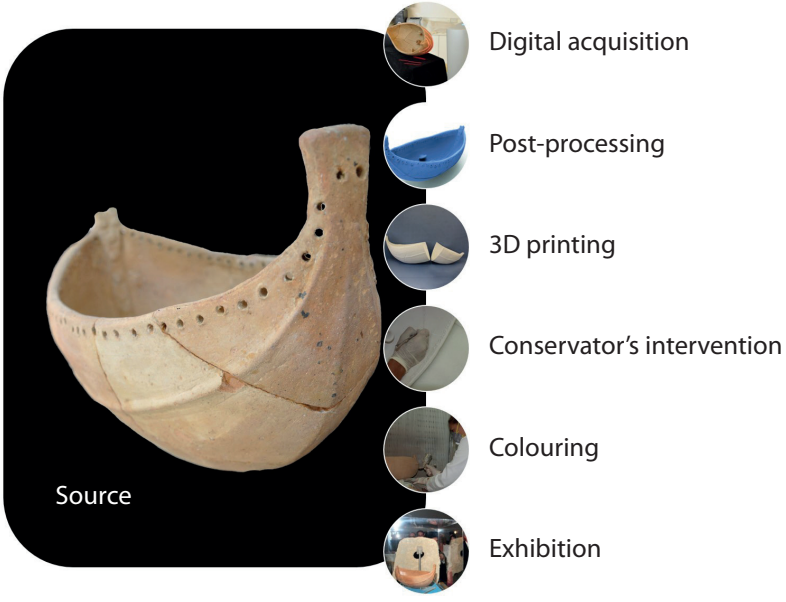

Figure 9.1. *From the real artefact to the 3D physical replica.*

Figure 9.2. *The 3D scanning of the Kazaphani model boat.*

more difficult and dangerous for the integrity of the object, the conservators decided to avoid using the traditional silicon rubber method of casting.

Given the difficulties, a proposal was put forward for collaboration between three institutions for the creation of a 3D replica of the model boat: the Cyprus Institute – STARC, the Department of Architecture at the University of Cyprus, and the Department of Antiquities Cyprus.

A pipeline was developed for the project. The workflow consisted of the 3D scanning phase; the post-processing of the digital data acquired and the final creation of the 3D model; the phase of rapid prototyping; the testing of the glue, stabilizers and colours to be used; the 3D printing of the replica; and, finally, the colouring of the replica. Figure 9.1 provides an overview of the entire process.

Creating the 3D digital model

A campaign of 3D data acquisition was planned to create an accurate digital replica of the artwork with the aim of making a physical replica to substitute the real object.

The original object was carefully scanned using a NextEngine laser scanner (Fig. 9.2), a low cost portable laser scanner that allows digital acquisition of small and medium objects. Beyond the digital acquisition of the object geometry, this laser scanner has an integrated camera that is able to record the texture of the object as well. However, the quality of the integrated camera was not good enough for the expected results; therefore, it was decided to integrate the results of the laser scanner with another technique.

The object was digitally acquired through a photogrammetric technique using ARC3D, a free online service.[1] Through a photographic campaign of high resolution images, a model with an accurate texture was created. After the digital acquisition phase, the data were post-processed in Meshlab[2] and a 3D model was created (Fig. 9.3). The results of the two digital acquisition campaigns have been successfully integrated and the model has been texturized. This created an accurate 3D digital copy of the boat, which reproduced the size, shape, colours, surface markings, and evidence of the past damage and the previous restoration of the real artefact.

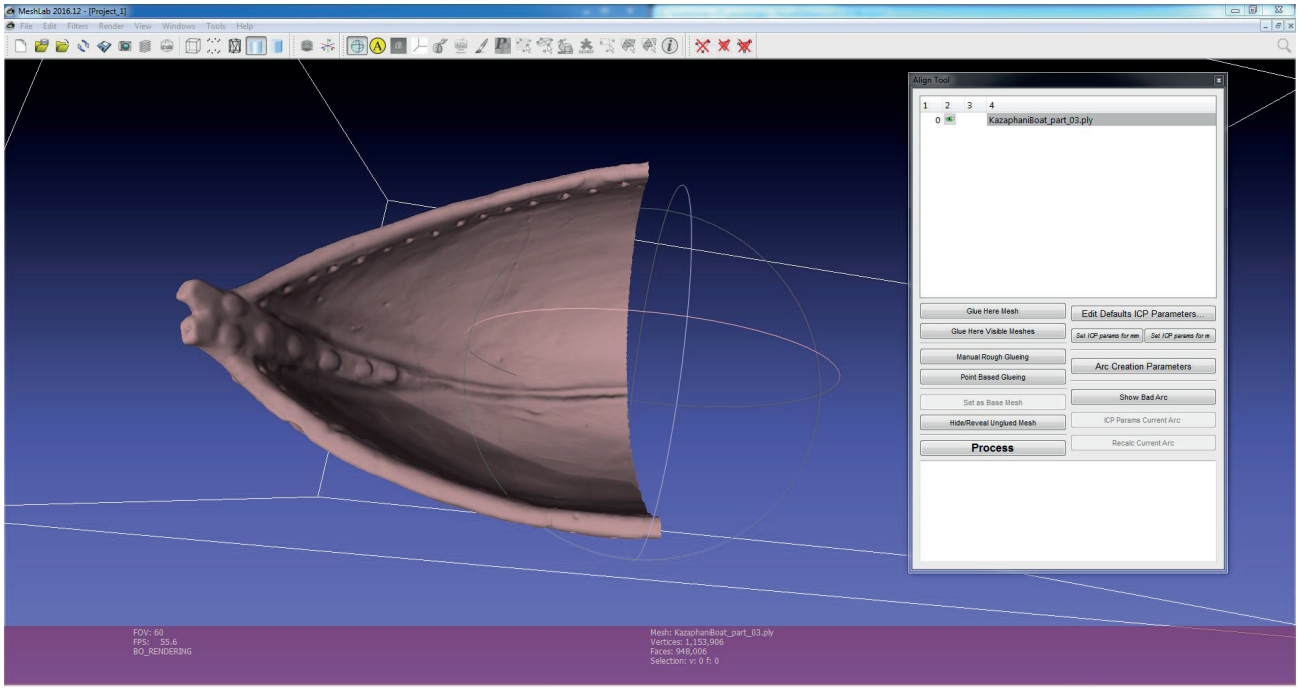

Figure 9.3. *Creation of the 3D digital model.*

From virtual to physical. The new identity of the object
The 3D digital model obtained was used for the creation of the replica. An accurate physical replica of the boat was created by the Department of Architecture at the University of Cyprus, using a 3D powder printer, whereby layers of powders are deposited with the use of photopolymer and UV laser to build up the model. The model was printed in 3D using a SPECTRUM Z510.

Once the 3D physical replica was created, it was delivered to the Casting Laboratory of the Cyprus Museum. Due to the limitations of the 3D printer, which could only produce items under 30 cm across – the length of the Kazaphani model boat was 45 cm – the replica was made in two pieces (Fig. 9.4). Furthermore, as the 3D printer was limited to a single colour only and, since the model would subsequently have to be painted, white was chosen.

The first step consisted of connecting the two pieces, something that worked out well, using the same materials with which the replica was produced. Powder ZP131 and Clear Binder ZB60 were mixed to produce a paste, which was used to fill the gaps created when the two units were put together. Once it was applied and left to dry, sandpaper of different grades was used to create a smooth area, eliminating the signs of the join (Fig. 9.5).

Following assembly, the next important step was mirroring the original artefact with the replica and dealing with the details. To achieve this, the original Kazaphani model boat was placed next to the replica. Even though the 3D printer produced an as-accurate-as-possible copy, it was noted that the replica lacked certain details, so it had to be manually treated in order to closely reflect the original. The recreation of the holes situated below the gunwale in the original model was done using a dentistry tool with edges of various sizes, drilling to imitate the original ones.

On both the exterior and interior sides, where the marks of the joins from previous conservations on the original were visible, those on the replica were less intense and had to be engraved with a pointed tool (Fig. 9.6).

Some additional minor corrections were made to the replica, such as gap-filling of small holes, smoothing and imitating specific areas. Once all the details were finalized, Zbond 101 binder agent (hardener) was applied to the surface of the replica to add stability (Fig. 9.7).

This is an integral part of the 3D process and generally takes place right after the production of the 3D item. The reason behind the timing of the delayed application of the binder agent in this case was to allow changes to be made to the model.

The final step was the reproduction of colour, which was carried out with the same method that was used by the Casting Laboratory of the Cyprus Museum to colour replicas. Paraloid B72 thermoplastic

Figure 9.4. *The replica of the Kazaphani model boat in two pieces.*

Figure 9.5. *The completed assembly of the two pieces.*

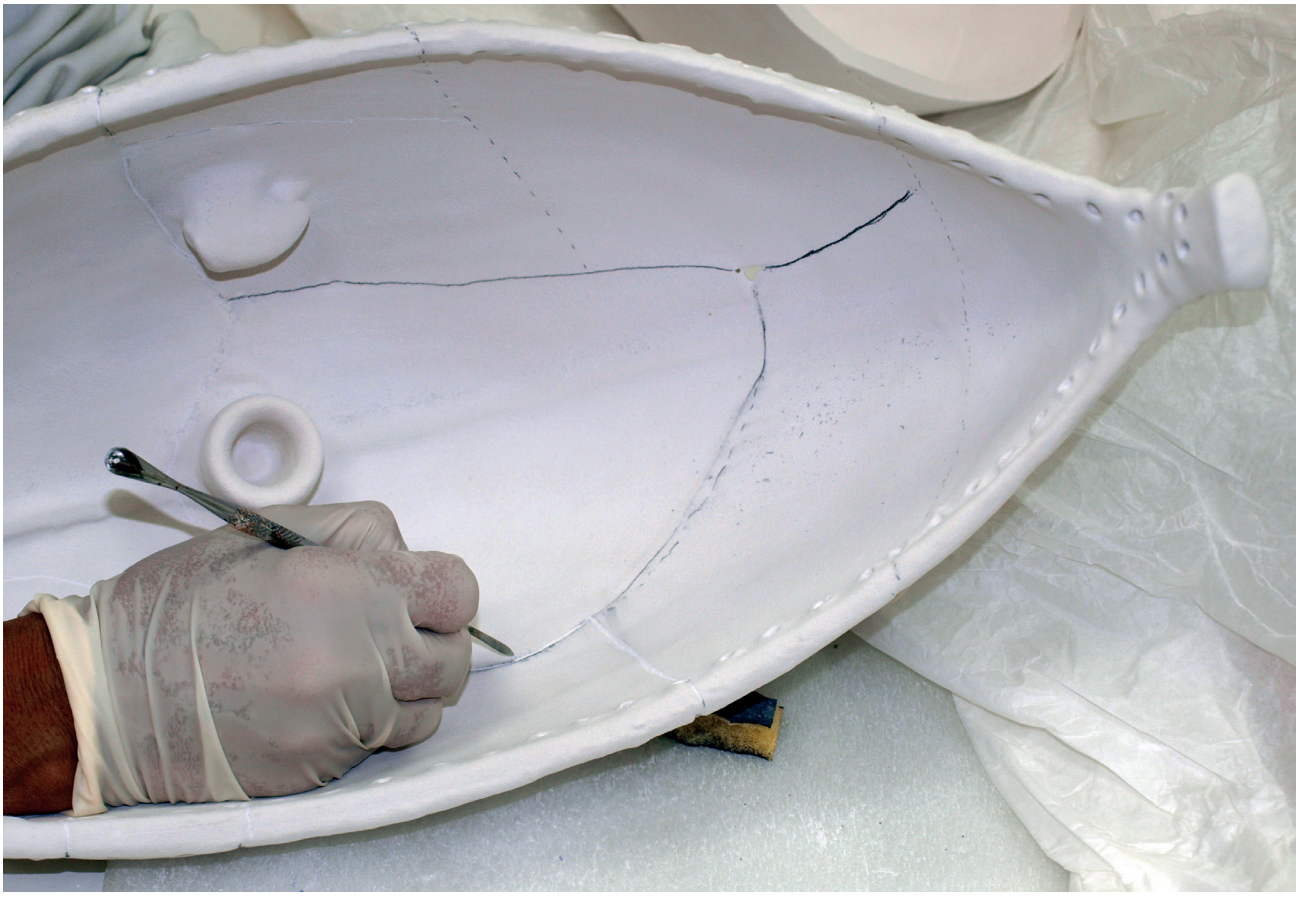

Figure 9.6. *Engraving the marks of the joints from previous conservation.*

Figure 9.7. *Application of the binder agent.*

Figure 9.8. *The colouring of the replica.*

resin was diluted in acetone at the proportion of 10 per cent of Paraloid B72 with respect to the total solution, along with colour pigments (mostly composed of iron oxide and earth colours). This solution is suitable for achieving high accuracy of different colour shades; it is easy to apply and ensures longevity. A paint gun was used to colour the replica using layers of different shades to reflect the original model boat colour (Fig. 9.8).

With the completion of this experimental project, the 3D version of the Kazaphani model boat successfully replicated the original artefact for the exhibition (Fig. 9.9).

Even though human intervention was needed, and several steps had to be followed for the 3D replica to resemble the original model boat, the result was encouraging and the original artefact was preserved in the Cyprus Museum. The 3D scanning process has enabled conservators to analyse the boat in greater detail without risking any damage to the original. The experiment has also shown how simple and cost effective this method of creating replicas can be, with obvious benefits for curators, education and merchandise.

Following the success of the project, it can be said that the 3D printing method can offer many opportunities in the field of conservation and is a particularly promising area of development. As regards the experimental project presented above, the 3D model substituted an original artefact, which was not in a good physical condition, and enabled it to be displayed in an exhibition, providing the opportunity to cast a difficult and fragile artefact, saving time, and avoiding direct contact with the original artefact.

Every time an object goes through a casting process with silicone rubber, it becomes increasingly more fragile and may eventually reach a stage where it can no longer be subjected to this process.

Although the 3D method has both advantages and limitations, the former outweighs the latter, and

Figure 9.9. *Details of the 3D replica.*

ensures the safety of the originals. Limitations can be overcome, manually for the present, and will hopefully be eliminated in the near future as the technology improves.

As we have experienced in our case study, the sub-millimetric errors added to the replica by the instrumental and operational errors (Beraldin 2004; Boehler, Bordas & Marbs 2003), did not affect the final aim of the project. Although one can think that the transformation of a virtual object diverts from the concept of topological authenticity, when the DH object is printed with the same material and texture, and then exhibited in a museum showcase, what does an observer perceive?

Visitor's experience: 'A wonderful deception!'

The 3D physical replica was used for the aim initially planned, allowing the Department of Antiquities to permit the object loan, and avoiding any problems of insurance costs and fragility issues. The replica of the boat was exhibited at the National Museum of Natural History, Smithsonian Institute, for the temporary exhibition. During this period the 3D replica was placed, as any other ancient object, behind glass and it was explained that the object was the replica of an original located somewhere else (Fig. 9.10). Interestingly, a journalist, while interviewing the museum curators regarding the exhibition, appeared surprised when he learned that the object was a replica, commenting that it was 'a wonderful deception!'. This might have been the same reaction most visitors had immediately after reading the label.

The misunderstanding could have been caused by the peculiar exhibition of the object. The replica was exhibited under glass, exactly as an original masterpiece. The use was completely different from the role usually attributed to 3D prints, such as giving a sensorial experience usually denied to the museum visitors for obvious security reasons. It would be interesting to understand what the motivation for this choice was.

Unfortunately, the choice made by the museum curators was not made explicit and there is no formal explanation for this approach instead of another one that would have allowed sensorial interaction with

the replica (Di Giuseppantonio Di Franco et al. 2016). Most probably this might be explained with the aura of an object. The aura and the expression of these intangible feelings are widely discussed in museum studies regarding exhibitions and use of technologies (Dorrian 2014; Hazan 2001; Battani 2011; Jones 2010). As Maxwell et al. write in their excerpt, the 3D replica created after their experiments, 'except for one specially organised handling event, as per typical museum rules of engagement the display was behind glass' (Maxwell, Gray & Goldberg 2015). In a way, the words 'as per typical museum rules of engagement' explain the reason for such a choice. This can be further explained as a *semiophore* ('that

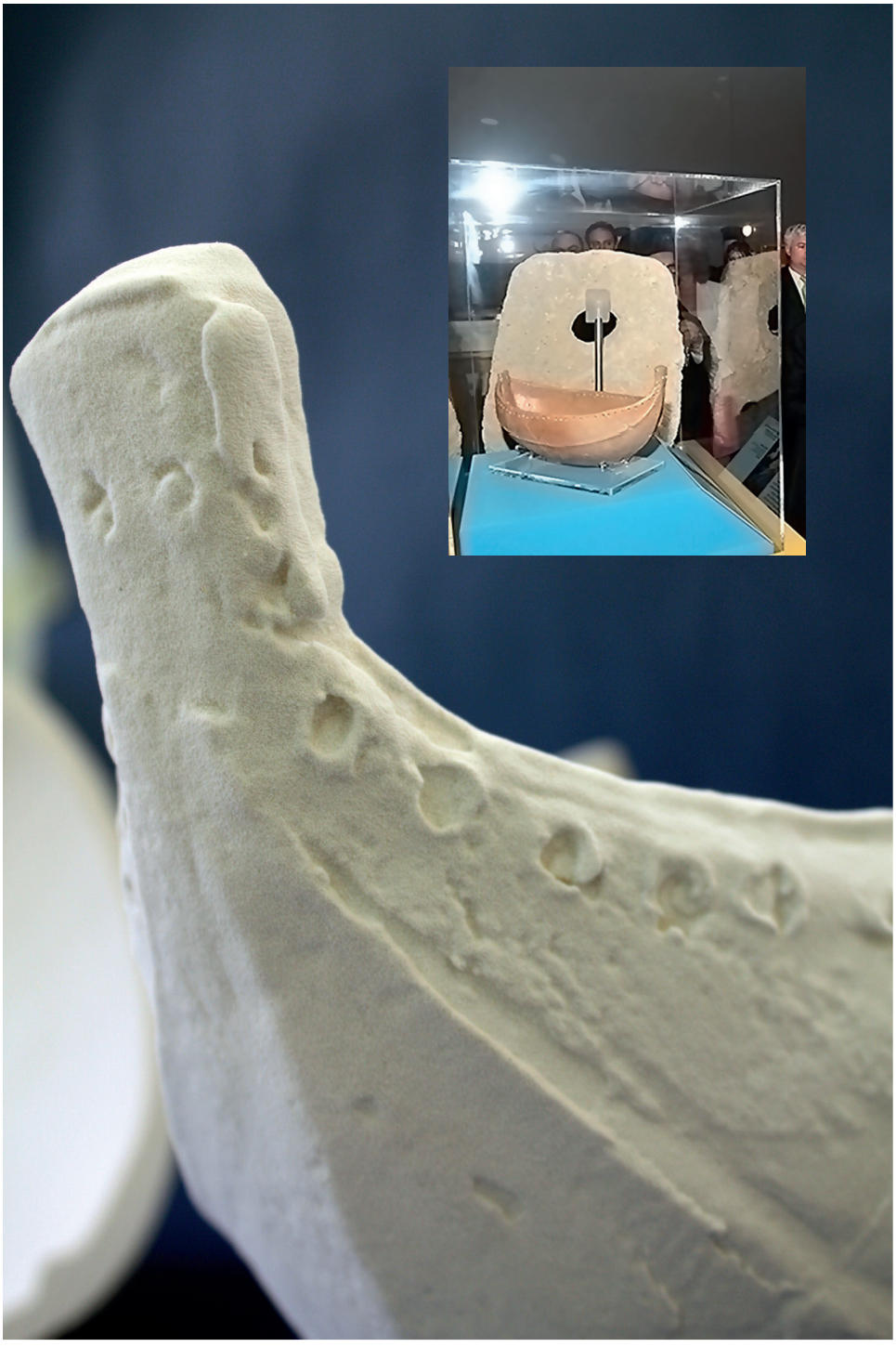

Figure 9.10. *The 3D replica exhibited at the Smithsonian behind glass.*

brings along a meaning') (Pomian 1987): the object, as soon as it loses its utilities, assumes a pure semantic function. The *semiophore* is in front of the observer and acts as an intermediary between the visible and the invisible, the observer and the hidden meaning (or what is now far or absent). Differently from a common object that has its meaning in the present and in its daily use, the *semiophore* reveals its meaning only when it is exhibited in front of the observer, and therefore when it becomes a piece of a collection. In this way, the object that lost its utility, takes the role of representing something now invisible. The curator gives the 3D replica the importance of a *semiophore*: s/he puts the copy at the same level of the original, since it brings along a meaning that connects the visible with the hidden meaning, in the same way as the original objects in the exhibition cases do. Therefore, only when the objects are seen by the observer and are under the care of the curator, they assume meaning and significance. These circumstances put the replicas at the same level of the originals, assuming the same value of their originals. An artwork, or more extensively an object of the past, once in a museum, is detached from its original context and from its world (Heidegger 1950). The artwork stops being what was before and becomes an object in a new context: from that moment its *authentic reality* is conserved. Besides 'being a thing' (in the philosophical/ontological sense) there is its character of authenticity and the first is the *conditio sine qua non* for the second (Martino 2010).

Conclusions

Differently from Benjamin (Benjamin 2008), according to whom the technical reproduction annihilates the authenticity of the artwork, in our case the 3D replica makes possible a new cultural value, a new identity that enhances and spreads knowledge among the audience. Even if the identity and the aura of the artwork, determined by its unicity in a spatio-temporal interval (the *hinc et nunc* of the artwork), cannot be replaced, nevertheless another identity and another aura is created.[3] The aura of the new object acts as intermediate between its origin and the present, providing living information about its existence through time. As discussed above, great importance is given to the digital provenance and data transparency. Indeed, by preserving the integrity and the transparency of the chain of activities that lead to the creation of a 3D digital or physical reproduction, its authenticity can be ensured.

The use of digital technologies has raised various ethical issues and new challenges. Rights and intellectual properties, originality and reproducibility are just some of the possible consequences. According to Morgan & Morgan the advance of information technology created an expansion in innovation, communication, education, etc. Nevertheless, ethical issues increased exponentially: *'ethical implications associated with the topics of veracity, identity and ownership and the impact of these fundamental ethical issues on human behaviour in emerging digital technologies.'* (Morgan & Morgan 2008). Ethics in 3D digital reproduction can be connected with the concept of transparency and the other suggestions proposed to the scientific community by the London Charter less than 10 years ago. If the digital copy (or the 3D replica) provides information on its provenance, the transparency of all its production processes and, in the case of a 3D replica the specification of being a replica and not the original, the matter of ethics is not an issue anymore.

Quoting Perry, '*the more meaningful displays of ethically-loaded objects are those that are well-contextualised, that use both visuals and text to jar viewers out of simplistic interpretations of the subject matter, that weave displays together into a larger critical narrative; and that attempt to trace – or account for the lack of tracing of – consent*' (Perry 2011).

As in the words of Terdiman about online digital media, the '*3D printed object* [should] *be* clearly labeled *so all viewers or listeners understand the altered or artificial nature of the content. This labeling is the only way to maintain standards of truth, accuracy, and fairness.'* (Terdiman 2011). The 3D replica represents a tool for storytelling and might have ethical implications concerning its appropriate or inappropriate use (When is it appropriate to provide a 3D object? How can the legitimacy of a 3D copy be authenticated?).

The traditional boundaries of disseminating knowledge are somehow outdated and we have to find a new method of communication. This communicative approach's aim is not that of substituting the ancient object but presenting 'A' reproduction (nor 'THE' reproduction, nor an unoriginal copy) and the affordances that it brings with it.

Therefore, based on the results of the case study presented, we can assert that the replica recreated with 3D technologies brings along all the processes of creation, giving life to a new identity. Through the new identity of the object, a new biography is given: we might now introduce the concept of *augmented authenticity*. Similarly to augmented reality whereby the virtual environment is something more than the reality itself – because the virtual world can be enriched with data that in the real world does not exist – the physical replica represents an 'augmented' copy of the real object, on which new actions can be performed, that are otherwise not possible on the real object.

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Notes

1 Other software applications are available for photogrammetry today. At that moment it was decided to use ARC3D since it was developed by the University of Leuven within the 3DCOFORM project, which also made possible this research (http://www.3d-coform.eu/index.php/tools/arc-3d-webservice).
2 The software is developed by ISTI-CNR and it is freely available at http://meshlab.sourceforge.net/.
3 Similarly to what Hazan calls 'virtual aura' in regards to virtual exhibitions in museums (Hazan 2001).

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