From the fragment to the big picture

Virtual reconstruction of a fragmented terracotta sculpture[1]

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The project's background

The excavations by the German Archaeological Institute's Athens Department in the Greek village Kalapodi began in 1974. Since 2014 they continue under supervision of the head of department Prof. Dr. Katja Sporn. The research focuses on a sanctuary that shows continuous use from the Mycenaean to the Roman period and is generally associated with the Apollon sanctuary of Abai. The topic of this paper is the virtual reconstruction of a large terracotta horse acroterion, which was found in the context of the southern temple dating to the archaic period. (For the find see W.-D. Niemeier, [2009, p. 108]. The terracotta acroteria and figurines are being studied by Katja Sporn. For the latest excavations in Kalapodi [see Sporn et al., 2017]).

Digital Reconstruction

Although the various fragments were excavated already years ago, previous reconstruction attempts stayed incomplete due to large areas missing. Virtual 3D reconstruction proved to be an easy and valuable approach to fit the diverse fragments together and give a suggestion about the sculpture's original appearance. Because the reconstruction process itself was in some aspect also an evaluation of the find, it was important for the final visualisations to show not only the relation between original find and reconstruction (interpretation), but also how each single fragment matters to the complete statue.

Digitisation of the sculpture's fragments with SfM

The starting point consisted of 18 fragments that could clearly be identified as being part of the horse acroterion and were large enough to be relevant for the reconstruction. To restore the sculpture virtually, digitising the fragments was the first step. A fast and easy method to accomplish such was

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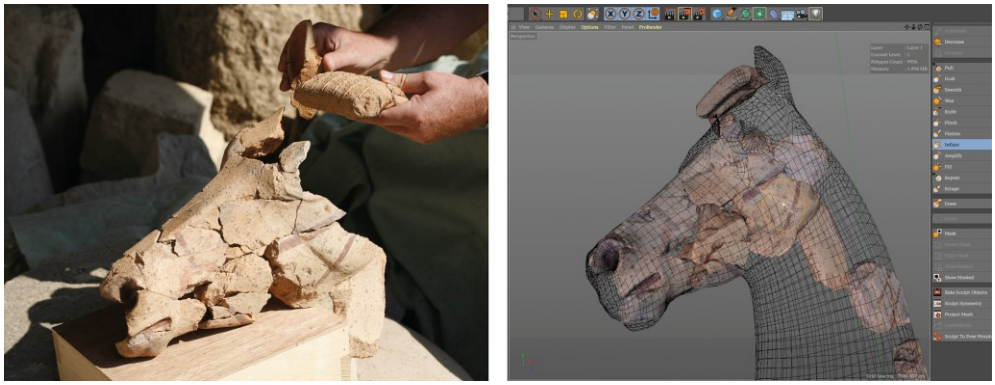
"Structure from Motion" (SfM), a method to easily generate detailed and textured 3D models to an object out of multiple photographs. The 3D models of the fragments were then directly imported to Maxon's Cinema 4D Studio, where all the rest of the work was done.

Assembling the fragments

To align all fragments one to another, it made sense to start with the best preserved parts, belonging to the area of the head. The lower parts were oriented separately and eventually combined with the fragment assembly of the head. As a third step, all the fragments in between and without any direct matching were positioned as best as possible.

Although the alignment of the various fragments was performed digitally, it was crucial to have the find objects available nearby and to double check every single connection or assumption made. Through that, even tiny traces of paint could be discovered by eye that eventually played an important role to the orientation of some fragments.



a *b*

Fig. 1. a) First reconstruction attempts by hand proved to be rather difficult due to large areas missing. (Photo from 2011 © Deutsches Archäologisches Institut, Abteilung Athen) b) Digital modelling directly on top of the placed SfM models. (© DAI Athen / Oliver Bruderer)

After the alignment of the fragments, the missing parts were complemented and a 3D reconstruction was made directly on the SfM 3D models and with the help of 3D sculpting tools. At last the texture was applied and the painted areas replicated, according to the preserved traces on the fragments (see Fig. 2b).

Comparison with contemporary artistic depictions (vase paintings and sculptures) of horses helped to get an idea of possible stylistic appearance. The whole process was accompanied by the expertise of Prof. Dr. Katja Sporn and the conservator Angelos Sotiropoulos. A meticulous documentation accompanied the whole reconstruction process and makes it possible to understand the decisions made even in retrospective.

But the understanding of the process should not be limited only to text, instead it should get represented in the visualisation itself.

The final design

The aim of the visualisations as the end product of the whole reconstruction process was not primarily to show a restitution of the sculpture in its original state. Since the reconstruction process itself contributes to the understanding of the archaeological finds (Adkinson and Adkinson, 1989, p. 131),

it was evident enough that the path from the fragments as archaeological find (Fig. 2a) to the restitution as a product of archaeological interpretation (Fig. 2b) needed to be visualised somehow. That was achieved through an easy solution by showing both the find material and the reconstruction together (Fig. 2c). This allows seeing and comparing them together, whilst they visually melt in enough to get the impression of the complete object.

a b c d

Fig. 2. different renderings show different aspects: a) the placed SfM fragments b) the complete reconstruction of shape and surface colour c) the fragments and the reconstruction combined d) colours from red to yellow indicate the certainty for the position of each fragment (© Deutsches Archäologisches Institut, Abteilung Athen / Oliver Bruderer)

Still, when we consider the aspect that a reconstruction is the result of logical reflection and argumentation rather than that of free artistic creation (Golvin, J.-C., 2012, p. 80), we are left with the problem that some fragments could not be aligned as certainly as others, which is not evident from simply showing find and reconstruction in comparison. To visualise the rather abstract concept of uncertainties accurately, different colours were used to show different previously defined levels of certainty as follows: Parts with direct connection to other parts were assigned a yellowish hue. Fragments that did not have a direct match but could be determined in orientation and location fairly precise through traces of colour, surface treatment or structure of the clay, received an orange colour as indication. The last category of only roughly assignable fragments was marked red. The choice of colour was mainly an artistic one, but going from colder to warmer hues to mark the more critical alignments makes sense as well.

The strategy to use colour code to show “archaeological evidence” gets already recommended in detail by other practitioners (Resco P. A. & Figueiredo C. published a concept they call “Scale depicting historical / archaeological evidence” basing on an idea of the project “Byzantium 1200”). The quoted example focuses rather on the type of source (e.g. preserved structures, pictorial depictions, written sources etc.) rather than on fragments in comparison.

Final thoughts

This case study hopefully makes evident that a reconstruction visualisation does not necessarily end with the picture of a perfectly restored object or structure, but has also the potential to bring up visual argumentation for an archaeologists interpretation. As in the previously discussed example, that could be achieved by including the find objects directly in the reconstruction, or by colour coding important aspects. The various visualisations produced in this project were all rendered out with the same camera angle, with the idea to enable using them in an interactive environment. Switching

between the different representations would allow the observer additional insights by personal comparison. This could be pushed even further to an interactive 3D environment or virtual reality.

But however far we bring this on a technical level, the additional value is given through the insights that we allow to the observer, to see not only the end product but the path of interpretation itself.

References

Adkinson, L. and Adkinson, R. A. (1989). Archaeological illustration, New York: Cambridge University Press

Byzantium 1200 (NA) Portus Theodosiacus and colour coded level of knowledge. Available at: http://www.byzantium1200.com/port_t.html (Accessed: 21.06.2019).

Golvin, J. C. (2012). 'Drawing reconstruction images of ancient sites', in: Green J. et al. (eds.) Picturing the Past. Chicago: The Oriental Institute of the University of Chicago, pp. 77–82.

Niemeier, W.-D. (2009). 'Abteilung Athen: Ausgrabungen und Forschungen' in *Deutsches Archäologisches Institut, Jahresbericht 2008.* Archäologischer Anzeiger 2009/1 Beiheft, München: Hirmer Verlag, pp. 105–122.

Resco, P. A. and Figueiredo, C. (2014). Escala de Evidencia Histórica / Scale of historical evidence. Available at: https://parpatrimonioytecnologia.wordpress.com/2014/07/21/escala-de-evidencia-historica-scale-of-historical-evidence/ (Accessed: 21.06.2019).

Sporn, K. et al. (2017). Forschungen zur Anlage, Ausdehnung und Infrastruktur des Heiligtums von Kalapodi: Die Kampagnen 2014–2016, in Sporn, K. & Senff, R. (eds.) *Mitteilungen des Deutschen Archäologischen Instituts Athenische Abteilung*, Band 131/132, 2016/2017. Berlin: Gebr. Mann Verlag, pp. 193–278.