Virtual 3D State Models of the West Pediment of the Temple of Zeus at Olympia

Deploying Cultural Heritage Online

Zackary HEGARTY, Indiana University, Bloomington, U.S.A.
András PATAY-HORVÁTH, Eötvös Loránd University / ELKH Institute of Archaeology, Budapest, Hungary

Objectives

This study has created state models of the original sculptures from the west pediment of the Temple of Zeus at Olympia as displayed in the Archaeological Museum of Olympia. It also seeks to provide the first 3D, digital models of these sculptures publicly available for research. This work was completed using photogrammetric methods and readied for presentation online at The Digital Sculpture Project published by Virtual World Heritage Laboratory (Frischer et al., 2013).

The Temple of Zeus and its West Pediment

At the time of its construction (ca. 475-455 BCE), the temple of Zeus at Olympia was the largest temple in mainland Greece, and it has remained the largest ancient temple on the Peloponnese.

The extant sculptural decoration of the temple consists of two pediments (east and west) and twelve metopes, all depicting mythological scenes. The west side was the rear side of the building and the pedimental group depicts a version of the Centauromachy myth in dramatic fashion (Ashmole and Yalouris, 1967, pp. 171–2, 180–1). Mortal men, including the hero Theseus, attending the marriage of Peirithoos and Deidameia struggle against a drunken band of centaurs who are attempting to kidnap the Lapith women; meanwhile, Apollo stands centrally over the fight casting his arm out to one side, possibly signalling the centaurs' defeat and acting as a stabilizing presence to this otherwise tumultuous scene (Ashmole and Yalouris, 1967, pp. 17–22). This over life-size group is sculpted from Parian marble, with the exception of figures "A," "B," "U," and the right arm of "V" which are sculpted from Pentelic marble and betray their likely addition to the group in later centuries (Ashmole and Yalouris, 1967, pp. 7, 179). There were also some attachments (weapons, locks of hair) made in some kind of metal (bronze or led) which are now lost, except for the holes which were drilled into the marble to fix them. Their date cannot be determined with absolute precision but they were most

probably contemporary with the original pieces, which are left in some cases, quite strangely, in an unfinished state (Rehak, 1998; Patay-Horváth, 2008).

Previous Digitization Campaigns at the Site

The exact arrangement of the figures in the east pediment of the temple is a long-debated controversial issue and has prompted digitization already in 2009. The difficult task of scanning the large marble fragments was carried out with a Breuckmann smartSCAN Duo structured light scanner and the resulting models were reconstructed and published on CD-ROM in 3D pdf. Some of the metopes (especially the well-preserved parts) have also been digitized in 2015 with an Artec Eva scanner. The architectural remains of the temple were not recorded but a 3D model of the temple was created according to the most recent reconstruction. The famous gold and ivory statue of Zeus, one of the seven wonders of the Ancient World is entirely lost but its measurements are known and a tentative reconstruction was produced and was inserted into the model of the temple (Patay-Horváth, 2014). Thus it was only the Centauromachy of the West pediment, which was missing to complete the virtual 3D documentation of the monument.

Digitization Campaign of the West Pediment Sculpture Group

The digital models of the west pediment sculpture group were made photogrammetrically on the basis of their presentation at the Archaeological Museum of Olympia in 2014. At the time of the photographic campaign, 3,722 digital photos were taken of the 21-figure group with a Nikon D600 camera. This campaign was conducted by Bernard Frischer in 2014. The process for modelling these sculptures was conducted based on methods developed by the Virtual World Heritage Laboratory at Indiana University and was performed by Zackary Hegarty in 2021.

To create the state models of this sculpture group the resulting photos from the 2014 photographic campaign were imported to Adobe Lightroom and color corrected. This photo set was subsequently imported into Agisoft Metashape (Metashape). However, due to the large size of the photo set, the creation of the 3D model of the pediment sculptures was divided into sub-groups according to their usual arrangement (Ashmole and Yalouris, 1967, pp. 178–81). As such, each sub-group was modelled in the following manner.

The photos for a given sub-group were imported into Metashape and a sparse point cloud was generated. At this point the gradual selection tool was used to remove all points with a reconstruction uncertainty greater than 25.0 and a reprojection error greater than 0.3. The optimize photos tool was run against the remaining points and the sparse point cloud was subsequently processed using depth maps to create a 3D mesh. This mesh was then imported into Pixologic ZBrush (ZBrush) as an OBJ file with the purpose of making the mesh web-ready. This was done in number of steps. First, the polygons of the mesh were transformed into quadrangles. This step not only makes the mesh's topology more regular but also reduces the overall polygon count of the mesh. The mesh was then subdivided, a logical UV map was created, and finally the original details of the Metashape mesh were projected onto the now restructured ZBrush mesh. These steps were done to ensure that a computationally light version of the mesh would be available for upload online without sacrificing accuracy (Fig. 1). A subdivided mesh with around 1 million polygons was chosen for use online and was exported as an OBJ file. The final step was to create a normal map texture with the software,

xNormal. Once the above processes were complete, each model was imported into Sketchfab (Fig. 2). Meta- and paradata were then associated with each model and they were labelled as per the reconstruction illustrated by Ashmole and Yalouris (Asmole and Yalouris, 1967, fig. 17). The Sketchfab models were then able to be embedded into The Digital Sculpture Project website.

a

b

"Fig. 1. Before and after making the model of the west pediment sculptures "P" and "Q," as labelled by Ashmole and Yalouris (1967, fig. 17), web-ready. a) the model immediately before export from Metashape, 17,974,405 "faces"; b) the web-ready model immediately before export from ZBrush, 795,276 "polys." (Copyright © 2021, The Trustees of Indiana University)."
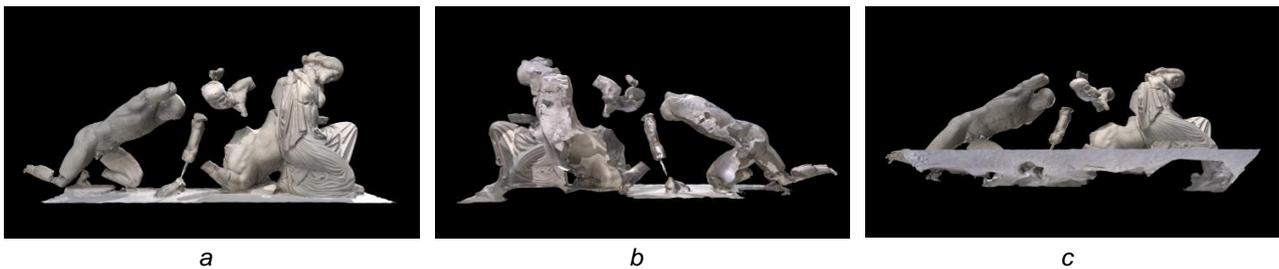

a

b

c

Fig. 2. Views sourced from Sketchfab of the digitization of the west pediment sculptures "C," "D," and "E" as labelled by Ashmole and Yalouris (1967, fig. 17). a) front view; b) back view, showing missing data; c) low view (Copyright © 2021, The Trustees of Indiana University).

Implications for Use Online and Conclusion

By leveraging the power of photogrammetry, this study was able to efficiently produce state models of the west pediment sculpture group and utilize digital tools to create web accessible models for public consumption, especially for the research community. This is particularly important for those concerned with reconstructing the temple complex at Olympia, examining the art historical implications of the sculptures both within their local context and also their regional context, among others. Leveraging photogrammetric methods to create high fidelity state models and then using an online deployment pipeline as laid out above provides the best of both worlds; it provides both accurate and also accessible models of these unique artefacts of cultural heritage.

Funding

Conflict of Interests Disclosure

There are no potential conflicts of interest to disclose.

Author Contributions

Software: Adobe Lightroom, Agisoft Metashape, Pixologic ZBrush, xNormal, Sketchfab
Writing – original draft: Z. Hegarty, A. Patay-Horváth
Writing – review & editing: Z. Hegarty, A. Patay-Horváth

References

Ashmole, B. and Yalouris, N. (1967). *Olympia: The Sculptures of the Temple of Zeus.* London: Phaidon.

Frischer, B., et al. (2013). *The Digital Sculpture Project.* Available at: http://www.digitalsculptur e.org/ (Accessed: August 31, 2021).

Patay-Horváth, A. (2008). *Metallanstückungen in der archaischen und klassischen griechischen Skulptur*. Rahden/Westf: Marie Leidorf.

Patay-Horváth, A. (2014). 'Visualizing the History and Analyzing the Sculptural Decoration of the Temple of Zeus at Olympia in Virtual Reality', *Mediterranean Archaeology & Archaeometry (Rhodes)*, 14(4), pp. 45–54.

Rehak, P. (1998). 'Unfinished hair and the installation of the pedimental sculptures of the temple of Zeus at Olympia', in Hartswick, K.J. and Sturgeon, M.C. (eds.) *Στεφανος. Studies in honor of Brunilde Sismondo Ridgway*. Philadelphia: University of Pennsylvania Museum of Archaeology and Anthropology.

Younger, J. and Rehak, P. (2009). 'Technical Observations on the Sculptures from the Temple of Zeus at Olympia', *Hesperia: The Journal of the American School of Classical Studies at Athens*, 78(1), pp. 41–105.