Proceedings of the 38th Annual Conference on Computer Applications and Quantitative Methods in Archaeology, CAA2010
F. Contreras, M. Farjas and F.J. Melero (eds.)

Virtual 3D Reconstruction of the East Pediment of the Temple of Zeus at Olympia. A Mid-term Report

Patay-Horváth, A.
Institute for Ancient History, University Eötvös Loránd, Budapest, Hungary
pathorv@gmail.com

The arrangement of the five central figures of the east pediment of the temple of Zeus at Olympia has been the subject of scholarly debates since the discovery of the fragments more than a century ago. A recent project tries to approach this controversy in a new way, by producing a virtual 3D reconstruction of the group. Digital models of the statues are produced by scanning the original fragments and by reconstructing them virtually in order to test the technical feasibility and aesthetic effects of the different reconstructions. The present paper gives an overview of the work in progress.

Keywords: 3D scanning, classical sculpture, virtual modelling.

1. Introduction

1.1. The subject

The temple of Zeus at Olympia was built in the first half of the 5th century B.C. (ca. 475–455). Its sculptural decoration consists of two pediments and twelve metopes. Given the large size of the building itself, the sculptures were all well over lifesize and were made of white parian marble. A large number of fragments survive and are conserved in the Archaeological Museum of Olympia and in the Musée du Louvre at Paris. Most of them are quite well preserved and are depicted in practically every handbook on Greek art or on ancient art in general, because nowadays they are generally considered to be one of the most important and most magnificent works of ancient Greek art.

The sculptures of the temple in general and the fragments of the east pediment in particular have been thoroughly studied since their discovery in the 1880's, but they still pose some important questions, as indicated by the growing number of monographs and scholarly articles related to them (e.g., TREU, 1897; ASHMOLE-YALOURIS, 1967; SIMON, 1968; SÄFLUND, 1970; HERRMANN, 1987; KYRIELEIS, 1997; BARRINGER, 2005; WESTERVELT, 2009; REHAK–YOUNGER, 2009). The most recent debate has started with a series of publications by the author (PATAY, 2004; PATAY, 2005; PATAY, 2006; PATAY, 2008) and concerns the interpretation of the east pediment, which involves the problematic issue of the correct reconstruction of this group as well.

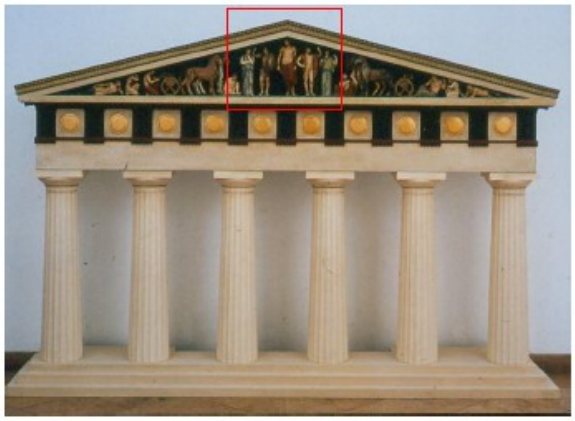

Figure 1: *Reconstructed model (approx. scale 1:10) of the east front of the temple of Zeus at Olympia. Staatliche Kunstsammlungen Dresden (Albertinum). Photo: author.*

1.2. The problem

The arrangement of the five central figures of the east pediment has been the subject of scholarly debates since the discovery of the fragments more than a century ago (HERRMANN, 1987; PATAY, 2008). The basic problem is that the fragments themselves can be arranged in four substantially different ways (Figure 1 and 2) and there are no obvious clues for choosing the most probable one. There is a fairly detailed description of the group by Pausanias, who saw it in the 2nd cent. AD, but his text (V 10, 6-7) is not conclusive regarding

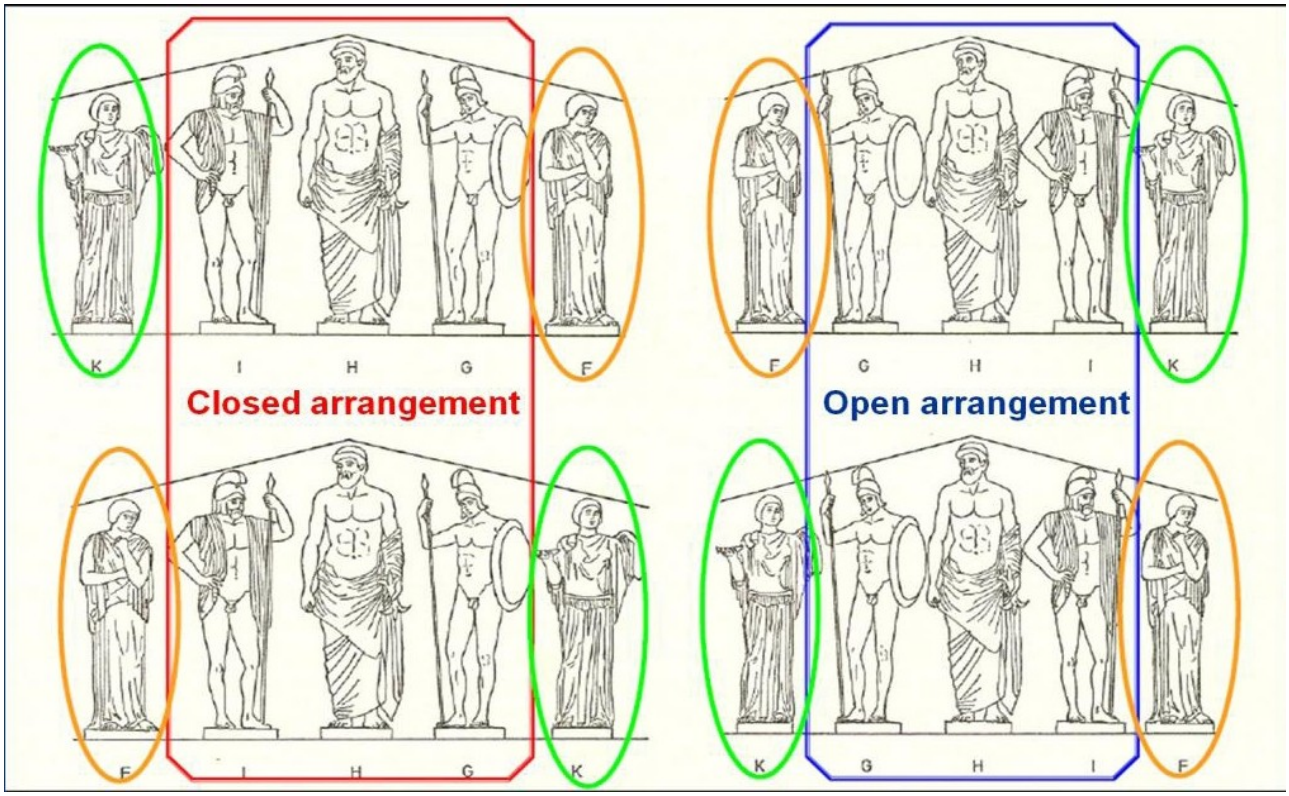

Figure 2: *The central part of the pediment (marked with red in Figure 1) enlarged. Schematic reconstruction drawings showing every conceivable arrangement of the five central figures (usually referred to as F, G, H, I and K). Different colours highlight the differences between the four variants. After Herrmann 1987.*

the precise arrangement of the figures (he does not specify how to understand his indications "to the left" and "to the right" of the central figure). The findplaces are not unequivocal either, since the pieces were scattered around the temple by an earthquake in the 6th cent. AD and the fragments were subsequently reused in medieval buildings. In sum, there are four substantially different arrangements, all of which have already been selected by certain scholars for various aesthetic, technical and other considerations. Most often the reconstructions were presented in simple drawings, ignoring the three-dimensional form of the statues and the results of the early experiments with life-size 3D plaster models are nowadays equally ignored.

The most important result of these experiments was, that they were able to exclude at least one of the four possibilities, purely because the lack of space. The renown German scholar, G. Treu stated explicitly (TREU, 1897; 120), that figures G and K can not be placed next to each other in the southern part of the pediment, because their arms would come into collision. Obviously enough, he was absolutely convinced, that this arrangement is physically impossible and invited everybody to verify this statement with life-size plaster models. This has been done by various scholars following him until 1939, and no one questioned this observation, even if some arrived at another arrangement, different from the one suggested by him. After the Second World War, the models were totally inaccessible and the results of the early experiments are nowadays totally ignored: in recent publications they are practically not mentioned any more, and no one has attempted to verify or to refute them. This is all the more astonishing, because it is precisely the arrangement, which has been condemned as impossible already in the 19th century (and afterwards generally accepted as such), which is considered today as the most probable one (Figure 3).

1.3. The project

Since experimentation with the precious and monumental original fragments is out of question and the plaster casts are similarly ill-suited for this purpose, it seemed to be reasonable to apply the latest 3D scanning technology to the problem. The aim of the project is to test the practical feasibility and aesthetic effects of the possible arrangements with 3D models of

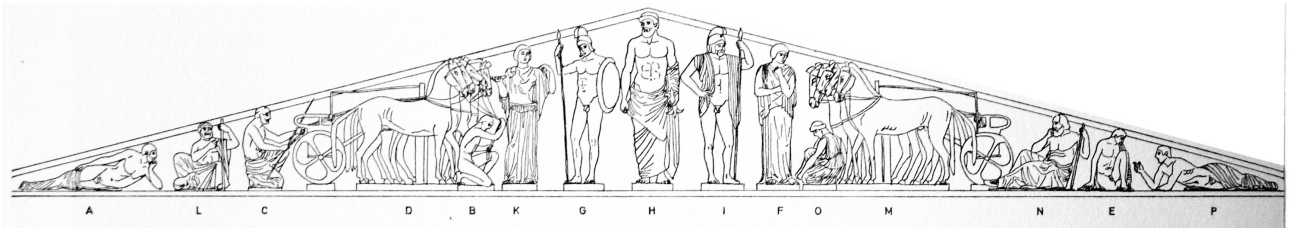

Figure 3: *The most commonly accepted reconstruction of the pediment (after HERRMANN 1987 fig. 95).*

the reconstructed statues. The digital models are produced by scanning the original fragments and by reconstructing them (i.e. completing their missing limbs and armour) virtually.

Scanning was done with Breuckmann smartSCAN Duo structured light scanner by Tondo Ltd., the reconstruction was attempted with different software products (e.g. Poser 8 by Smith Micro and Leonard3Do by 3DforAll). The scanning campaign was carried out with the permission of the 7th Ephorate of Prehistoric and Classical Antiquities in Greece and in close collaboration with the German Archaeological Institute at Athens (conducting the excavations on the site for more than 125 years). Financial support is provided by a research fund of the Norway Grants, the Hungarian National Research Fund (OTKA) and the János Bolyai scholarship offerred by the Hungarian Academy of Sciences.

2. Data capture

The difficult task of scanning the marble fragments was carried out in the Museum of Olympia from 23.08 to 03.09. 2009 by two experienced technicians of Tondo Ltd. (Budapest, Hungary) under the supervision of the project coordinator. The difficulties encountered during the data capture can be summarized as follows (for details see PATAY, 2010):

- monumental scale (1,5-2 times lifesize) of the fragments, upper parts are accessible only with a special equipment (Jimmy Jib; Figure 4)
- absolutely unmovable pieces: fastened to the wall with several massive iron bars, alignment close to the wall, rear sides difficult to reach with the scanner
- world-famous pieces, highlights of the museum: restricted working hours from 8–12 p.m.

Figure 4: *The scanner mounted on the Jimmy Jib in the Archaeological Museum of Olympia. Photo: author.*

The difficulties were overcome in most cases very successfully and all the figures of the pediment (13 human figures and two four-horse chariot teams) were scanned in two weeks. Some parts, however, proved to be entirely inaccessible for the scanner. As these parts were in most cases only roughly hewn from the block, their exact rendering is actually irrelevant for the reconstruction. Moreover, they are sufficiently documented in drawings and photographs, and can therefore be approximately completed during the processing of the scans. (Figure 5).

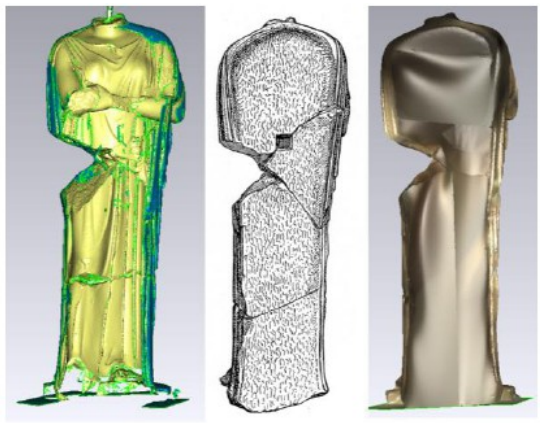

Figure 5: *The rear side of figure F. Data void on the scan (left), drawing of the original roughly modelled surface (middle) and completed 3D model (right).*

3. The reconstruction

3.1. Preparation of the models

Triangulation, meshing and smoothing of most scans is already completed. This process required more than 4 months of constant work by an assistant (Mr. D. Bajnok, cand. phil.) trained especially for this task. Data voids, which are sometimes of considerable size (due to the inaccessibility of the rear sides of the statues) are in most cases also filled in by using Geomagic. These artificially completed parts are clearly visible on the models (Figure 5). Currently every fragment of the five central figures is processed and the resulting 3D models are ready for the virtual reconstruction (Figure 6).

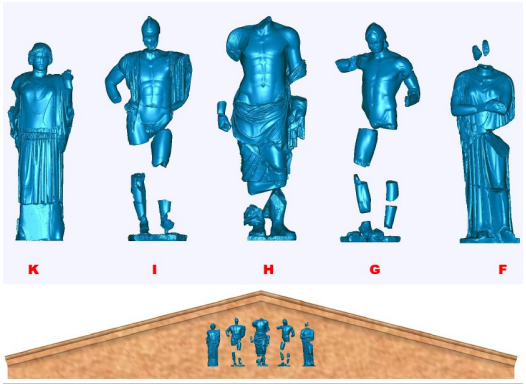

Figure 6: *The central group of the east pediment according to the opinion of the author. 3D models of the fragments (above) and set in their proper pedimental frame (below).*

3.2. Virtual modelling

Missing parts (limbs, heads, armour, etc.) are currently being completed. We try to make use of different software products since they are not equally suitable for the rendering of each kind of objects. The most problematic issue is the completion of the missing arms, because their exact position is far from being certain. Modelling each possible pose separately and testing them in connection with the other figures in every possible arrangement would be very time-consuming. Missing human limbs can be thus completed most conveniently by using Poser 8, because it enables easy experimentation with slightly different poses (Figure 7). For objects made up of simple geometric forms (shield, lance, staff) Bentley Microstation and Autodesk 3ds Max are completely sufficient, for the rendering of non-geometric objects (e.g. horses and garments) Leonar3Do (currently under development) is employed, because it enables a much faster modelling than the other tools.

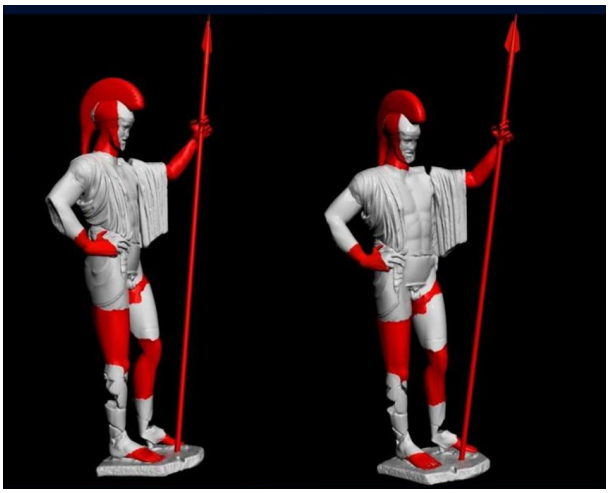

Figure 7: *Tentative reconstruction of figure I using Poser 8 (design by G. Z. Horváth).*

The virtual reconstruction of the pediment was done with ArchiCAD and takes account of the most recent architectural studies (GRUNAUER, 1981). It reproduces exactly the original context for the reconstructed models, which will be set into this frame in order to test the feasibility and the aesthetic effects of each reconstruction (Figure 6 and 8). Our aim is to achieve a complete virtual reconstruction of the east facade of the building and to present a full documentation similar to the CD-ROM of SIBA (Lecce) on the metopes of temple C at Selinunte (ISBN 8883050398; cf. BERALDIN *et al*., 2009).

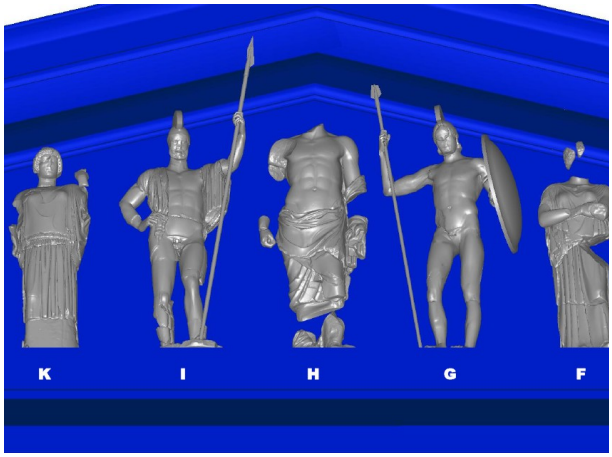

Figure 8: *Partial reconstruction of the central group according to the author's opinion.*

Conclusions

At this stage, the first experiments with the virtual 3D models seem to suggest, that the century-old observations made with the life-size plaster models are valid, indeed i.e. at least one of the possible reconstructions can be ruled out (Figure 9), but of course we still have to make many adjustments to the models, and can offer definitive results only after completing and placing all figures in the pediment. This requires still much time and experimentation.

For the final results see (PATAY, 2011). The documentary CD-ROM planned in 2010 has also been completed (ISBN 978-963-284-196-0) For further information see the forthcoming proceedings of the XXIIIrd CIPA Congress (http://cipa.icomos.org/PRAGUE.html).

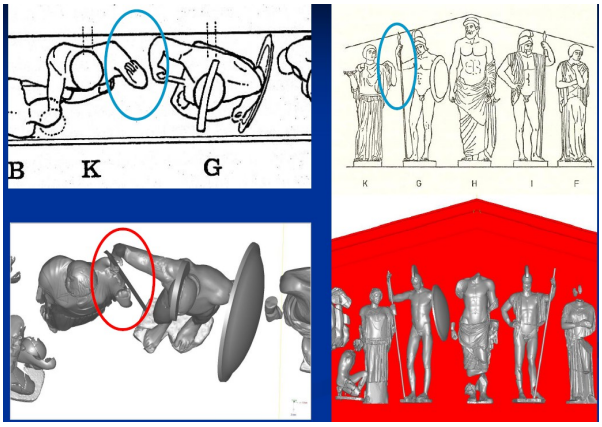

Figure 9: *Figures K and G in the southern part of the pediment. The collision of the arms can be avoided in drawings (above) but becomes apparent with 3D models (below).*

References

ASHMOLE, B., YALOURIS, N., 1967. *Olympia. The Sculptures of the Temple of Zeus*. London: Phaidon.

BARRINGER, J. M., 2005. The Temple of Zeus at Olympia, Heroes and Athletes, *Hesperia* 74, pp. 211-241.

BERALDIN, J.-A., VALZANO, V. AND BANDIERA A., 2009. The metopes of Selinunte: Presentation of the interactive CD-ROM", in: *XXI International CIPA Symposium*, 01-06 October 2007. Athens.

GRUNAUER, P., 1981. Zur Ostansicht des Zeustempels in: 10. *Bericht über die Ausgrabungen in Olympi*a. Frühjahr 1966 bis Dezember 1976. (Berlin 1981) 256-301.

HERRMANN, H.-V. (ed.), 1987. *Die OlympiaSkulpturen*. Darmstadt: Wissenschaftliche Buchgesellschaft.

KYRIELEIS, H., 1997. Zeus and Pelops in the East Pediment of the Temple of Zeus at Olympia, in: Buitron-Oliver, D. (ed.) *The Interpretation of Architectural Sculpture in Greece and Rome*. Washington: National Gallery of Art.

PATAY-HORVÁTH, A., 2004. Pausanias und der Ostgiebel des Zeustempels von Olympia, *Acta Antiqua* Acad. Hung. 44 pp. 21-33.

PATAY-HORVÁTH, A., 2005. Die Frisur der weiblichen Protagonisten im Ostgiebel des Zeustempels von Olympia, in: Ganschow, Th., Steinhart, M. (eds.) Otium. Festschrift für Volker Michael Strocka. Remshalden: Greiner, pp. 275-283.

PATAY-HORVÁTH, A., 2006. The armor of Pelops, in: Mattusch, C. C., Donohue, A. A. , Brauer, A- (eds.) Common Ground. Archaeology, Art, Science and Humanities. *Proceedings of the XVIth International Congress of Classical Archaeology Boston*. Oxford:Oxbow, pp. 424-427.

PATAY-HORVÁTH, A., 2008. Zur Rekonstruktion und Interpretation des Ostgiebels des Zeustempels von Olympia, *Mitteilungen des Deutschen Archäologischen Instituts*, Athenische Abteilung 122, pp. 161-206.

PATAY-HORVÁTH, A., 2010. Virtual 3D Reconstruction of the East Pediment of the Temple of Zeus at Olympia – A Preliminary Report, Archeometriai Műhely / *Archaeometry Workshop*, 2010 / 1, pp. 19-26.

PATAY-HORVÁTH, A., 2011. The complete Virtual 3D Reconstruction of the East Pediment of the Temple of Zeus at Olympia, in: Remondino, F., El-Hakim, S. (eds.) Proceedings of the 4th ISPRS International Workshop 3D-ARCH 2011, International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences http://www.isprs.org/proceedings/XXXVIII/5-W16/pdf/patay.pdf

REHAK, P. – J. G. YOUNGER, 2009. Technical observations on the sculptures from the temple of Zeus at Olympia, *Hesperia* 78, pp. 41-105.

SÄFLUND, M. L., 1970. *The East Pediment of the Temple of Zeus at Olympia. A Reconstruction and Interpretation of its Composition*. Göteborg.

SIMON, E., 1968. Zu den Giebeln des Zeustempels von Olympia Mitteilungen des Deutschen Archäologischen Instituts, *Athenische Abteilung* 83, pp. 147-167.

TREU, G., 1897. O*lympia III. Bildwerke aus Stein und Thon*. Berlin.

WESTERVELT, H., 2009. Herakles: The sculptural program of the temple of Zeus at Olympia in: Schultz P., von den Hoff, R. (ed.) *Structure, Image, Ornament: Architectural Sculpture in the Greek World*. Oxford: Oxbow, pp. 133-152.