



VISUALIZING THE HISTORY AND ANALYZING THE SCULPTURAL DECORATION OF THE TEMPLE OF ZEUS AT OLYMPIA IN VIRTUAL REALITY

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Received: 27/01/2014

Accepted: 26/06/2014

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ABSTRACT

The project presented here started approximately four years ago and concerns the main temple of Olympia, a UNESCO world heritage site, which is visited by thousands of tourists nearly every day. Although Olympia is familiar to everybody and its monuments have been well-researched for more than a century, there are still many puzzles related to its history and remains. A new interpretation of the east pediment of the temple and the ensuing debate caused the reopening of the issue of the reconstruction. The historical setting of the temple-building was also reconsidered and led to a detailed study and reconstruction of the architecture as well. All these investigations made extensive use of digital technologies and are presented here as a case study for applying virtual reality to old problems of classical archaeology.

The digitization of the extant fragments and a three-year project enabled the production of a virtual 3D reconstruction of the east pediment of the classical temple of Zeus. In addition, the Doric temple itself as well as the famous cult statue made by Pheidias were also reconstructed virtually, making thus the visualization of the long and complicated history of the entire monument possible.

The model is highly flexible and can thus be adapted to illustrate and to test different scholarly hypotheses concerning some details, e.g. the arrangement of the central group of the east pediment or the effects of different lighting conditions. It also allows the non-specialist user to manipulate the individual pieces of sculpture, to familiarize him- or herself with their original appearance and position on the building and finally to observe minor details and to learn more about the problems involved in reconstructing ancient works of art.

A short video-summary and a CD ROM have been published, both of which can be used for different purposes and audiences.

KEYWORDS: 3D modelling, virtual reconstruction, 5th century BC, Greece, architecture, pedimental sculpture, Pheidias.

1. INTRODUCTION

The project presented here started approximately four years ago and concerns the main temple of Olympia. Although Olympia is familiar to everybody and its monuments have been well-researched for more than a century, there are still many puzzles related to its history and remains. The present project started from a recent controversy surrounding the interpretation of the east pediment.¹

2. HISTORICAL BACKGROUND

The temple (Figure 1) was built in the early classical period, ca. 475-455 BC.² At the time of its construction, it was the largest temple in mainland Greece, and it has remained the largest ancient temple on the Peloponnese. Given the large size of the building itself, the sculptural decoration was well over lifesize and was made of white marble. A large number of fragments survive in a fairly good condition. They are depicted in practically every handbook on Greek art, because nowadays they are considered to be one of the most important and most magnificent works of ancient Greek art. They are contemporary with the building itself. For ten to fifteen years after the completion of the building and its outside decoration, the temple seems to have been empty, i.e. without any cult statue. The famous gold-ivory statue of the seated Zeus by Phidias, one of the seven wonders of the ancient world, was only erected in a second building phase ca. 440-430 BC.³ Afterwards, there was a tremendous earthquake in 373BC which caused considerable damage and several subsequent rebuilding and restoration episodes and also later additions, like the

¹ Patay-Horváth 2008. For earlier reports see Patay-Horváth 2011a; 2011b; 2011c; 2012; 2013a.

² For the temple in general and for the date see e.g. Dinsmoor 1950, 151-153; Mallwitz 1972, 211-234; Lawrence 1983, 184-185; Gruben 2001, 56-62; Hellmann 2002, 124; Lippolis et al. 2007, 385-389, 655-657. For the historical circumstances Patay-Horváth 2013b.

³ Schiering 1991; Strocka 2004, 228.

21 golden shields hung up after 146BC on the cornice.⁴



Figure 1 Reconstruction of the temple as it was seen by visitors in 2nd century AD.

3. THE RECONSTRUCTION OF THE TEMPLE IN VIRTUAL REALITY

The long and complicated story of the building can only be narrated or visualized with a series of reconstruction drawings. A flexible digital model, like the one produced during our project (Figure 2), is much more suitable for this purpose and offers additional features, which would be hardly feasible with any traditional model.



Figure 2 Uncolored virtual 3D reconstruction of the temple as completed around 450 BC.

The best illustration of the possibilities is the simulation of the lighting conditions in the interior of the temple. A recent attempt without the help of a digital model envisaged two possibilities: sunlight comes either only through the door (Figure 3), or through a hole in the roof (Figure 4).⁵

⁴ For the 4th century BC see esp. Grunauer 1981. For all the renovations Hennemeyer 2010. For the shields dedicated by Mummius Paus. 5, 10,5.

⁵ Hennemeyer 2011, 101-104.

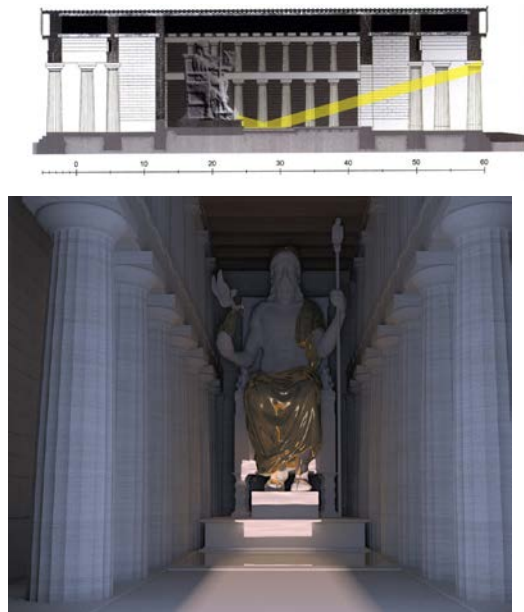


Figure 3 The cult statue in its architectural setting (above: cross section of the temple after Hennemeyer 2011 fig. 1; below: virtual 3D reconstruction).
Illumination through the doors.



Figure 4 The cult statue in its architectural setting (above: cross section of the temple after Hennemeyer 2011 fig. 2; below: virtual 3D reconstruction).
Illumination assuming a hole in the roof.

In either case, the light would fall on a shallow pool filled with olive oil in front of the statue and could illuminate just the footstool or the lower part of the statue. Both arrangements would not be particularly satisfactory, because the upper part and especially the head of the seated

god would remain dark. The second possibility would be better than the first, but the actual remains of the temple do not support this idea (there is nothing to suggest a hole in the roof). The placement and the measurements of the pool in front of the statue are absolutely certain but as the digital model clearly shows, it can not effectively be used to illuminate the head of the statue.

The best illumination would be by direct light from above, and this possibility is perfectly feasible, if we suppose an open ceiling, instead of a hole in the roof. Rooftiles are made of white marble and are therefore translucent and most probably they were employed exactly in order to achieve this lighting effect.⁶ (Figure 5)



Figure 5 Illumination of the cult statue through translucent marble tiles and an open ceiling.

Curiously enough, this possibility was not considered earlier, and in any case it was impossible to test it without a digital model, but is actually favoured even by Hennemeyer, who opted for the hole in the roof a few years ago.⁷

The virtual 3D model can thus be used not just for visualizing earlier research results and to test earlier hypothesis, but also to improve our understanding of the monument. This is actually even more appropriate in the case of the pedimental sculptures.

⁶ Ohnesorg 1993, 118–119 with Plin. NatHist 36,46.

⁷ Hennemeyer 2012, 123.

4. THE RECONSTRUCTION OF THE EAST PEDIMENT

4.1 *The problem of the central group*

The surviving fragments are substantial and numerous enough to enable a fairly reliable reconstruction. This was done at the end of the 19th century and has duly received general acceptance till today.⁸ The only detail which is still controversial is seemingly a minor one, but is actually crucially important for the interpretation and concerns the arrangement of the five central figures of the east pediment; it has been continuously debated among archaeologists and art historians since the discovery of the fragments more than a century ago.⁹

The basic problem is that the fragments themselves (Figure 6) can be arranged in four substantially different ways (Figure 7) 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 (*Description of Greece*, book V, ch. 10, 6-7) is not conclusive regarding the precise arrangement of the figures. The locations of the finds 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.



Figure 6 Fragments of the central group of the east pediment, as displayed in the Archaeological Museum of Olympia today.

⁸ Treu 1897; most recently: Heilmeyer et al. 2012.

⁹ For an overview of the debate cf. Herrmann 1987 and Patay-Horváth 2008.

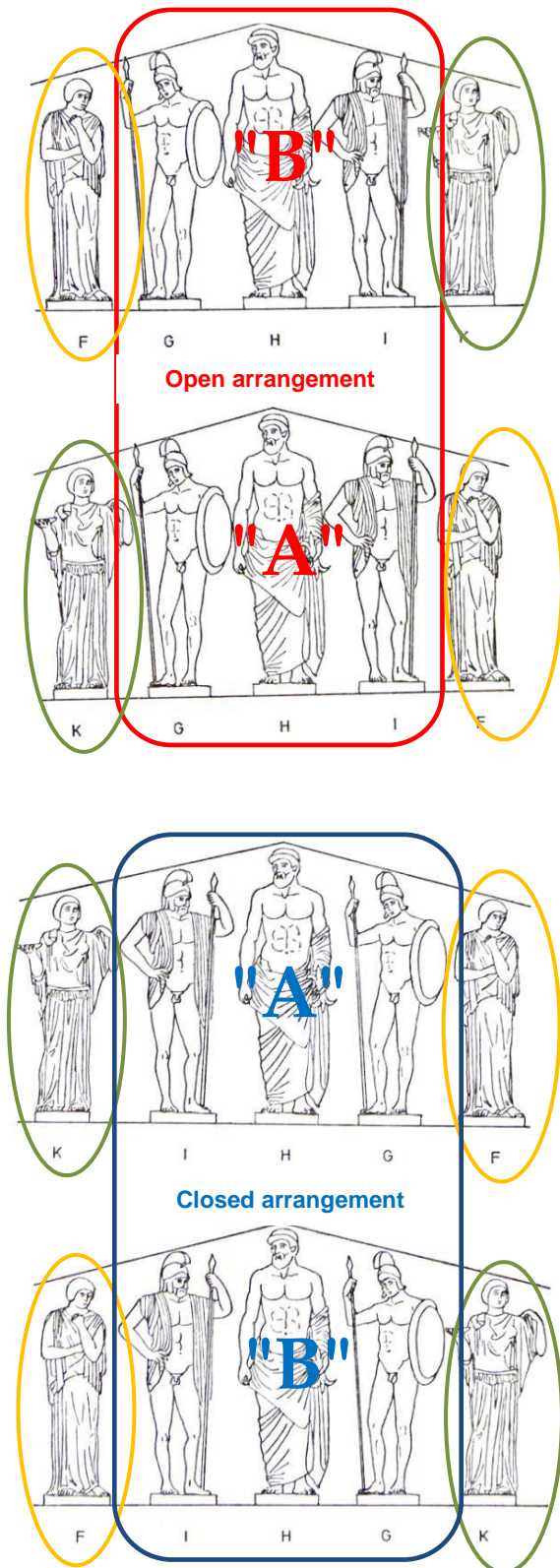


Figure 7 Schematic reconstruction drawings showing every conceivable arrangement of the five central figures. Different colours highlight the differences of the four versions.

4.2 Earlier reconstructions

Most often the reconstructions were presented in simple drawings, ignoring the three-dimensional form of the statues or in miniature plaster models. These miniature models are beautifully coloured, but they are actually not quite accurate. Produced immediately after the discovery of the fragments, they represent only the first attempt and not a final, elaborate version of the reconstruction.¹⁰ Actually, they had been replaced already by the end of the 19th century, with life-size models, which were made by using the plaster casts of the fragments and by restoring the missing parts in plaster as well. The most important result, based on long experimentation with them was summarized by G. Treu as follows:

„Sodann ergeben sich bei einer Aufstellung von K* neben Pelops unüberwindliche räumliche Schwierigkeiten. Es wird, wenn man Pelops die richtige, durch die Rückendübel angezeigte Dreiviertelsdrehung zur Ecke hin giebt, unmöglich, seinen Speer an dem schleierfassenden linken Arm von K* vorbei zu bringen. Davon überzeugt ein Versuch mit den Abgüssen in dem richtig gebauten Rahmen ohne weiteres.“¹¹

Treu stated thus explicitly, that figures G and K can not be placed next to each other, because their arms would come into contact. Obviously, he was absolutely convinced, that this arrangement (Open Type „A“) is physically impossible and invited everybody to verify this statement with the life-size plaster models. This has been done by various scholars following him, and no one questioned this observation.¹² But afterwards, the results of the early experiments were totally ignored: the models were not used for experimentation after World War II and they are no longer mentioned in recent publications, and no one has attempted to verify or to refute this

result.¹³ Instead, a great number of studies, and two complete monographs were published on the east pediment, but no-one was able to present a fully satisfactory reconstruction.¹⁴ It is symptomatic that a pair of renowned Greek-English authors presented two completely different reconstructions side by side in the same volume.¹⁵

After a while it seemed that all conceivable arguments had been formulated and no approach proved to be entirely convincing; thus archaeologists grew tired of a seemingly unproductive debate and they gradually agreed on a reconstruction, which was proposed by a few famous scholars.¹⁶ But in this way, an absurd situation emerged: nowadays, the most widely accepted reconstruction is precisely the one (Open Type „A“), which was declared to be technically impossible by Treu. Obviously, this would not present a problem, if his results had been thoroughly tested and clearly refuted, i.e. if anyone had shown that Treu had experimented with poorly-restored models or had come to incorrect conclusions for some other reason. Instead, everyone has ignored his arguments and his results without any discussion. Apparently nobody realized that the best evidence for the benefit of experimenting with life-size models is provided by Treu himself, who had advocated the arrangement widely accepted today, while he only had the miniature models at his disposal, but later his experiences with the life-size models made him change his mind.

In spite of the widespread acceptance of this particular arrangement several scholars expressed their doubts and reservations and proposed either other solutions or emphasized that the problem is still open to

¹⁰ Patay-Horváth 2012.

¹¹ Treu 1897, 120.

¹² Studniczka 1923, Bulle 1939.

¹³ As far as I know, the models and the results achieved by experimenting with them is mentioned only by Grunauer 1981, 287-288.

¹⁴ Säflund 1970, Paterake 2005, Becatti 1971.

¹⁵ Ashmole – Yalouris 1967.

¹⁶ Simon 1968, Stewart 1983, Herrmann 1987, Kyrieleis 1997, 2011.

debate.¹⁷ It should be noted, that during the rearrangement of the fragments in the new archaeological museum of Olympia, the Greek specialists opted for another arrangement (Closed type “B”) and this solution was also advocated by the first detailed monograph dedicated to the reconstruction and interpretation of the east pediment.¹⁸ The most recent volume on the other hand voted for Closed type “A”.¹⁹ This one was suggested earlier by F. Studniczka, another archaeologist who used the life-sized plaster models at Dresden, and it was also advocated by P. Grunauer, an architect who has studied the temple for several decades and corrected the measurements (albeit by a few centimeters only) given by Treu for the dimensions of the pediment.²⁰ By doing this, he laid the foundation for every future reconstruction of the composition. In addition, a few years later, he made another important contribution to the reconstruction and following a detailed analysis, based exclusively on objective, measurable criteria, he concluded that from the four possibilities the reconstruction type “Closed A” is the least problematic.²¹

4.3 The virtual 3D reconstruction

Since experimentation with the precious and monumental original fragments is out of question for practical reasons and plaster casts and models are expensive to produce and not easy to handle, it seemed to be reasonable to apply the latest 3D scanning technology to the problem. The aim of the project was to test the practical feasibility issues raised by the early experiments and to assess the aesthetic effects of the possible arrangements with 3D models of the recon-

structed statues. The digital models were produced by scanning the original fragments and by reconstructing them (i.e. completing their missing limbs and armour) virtually.²²

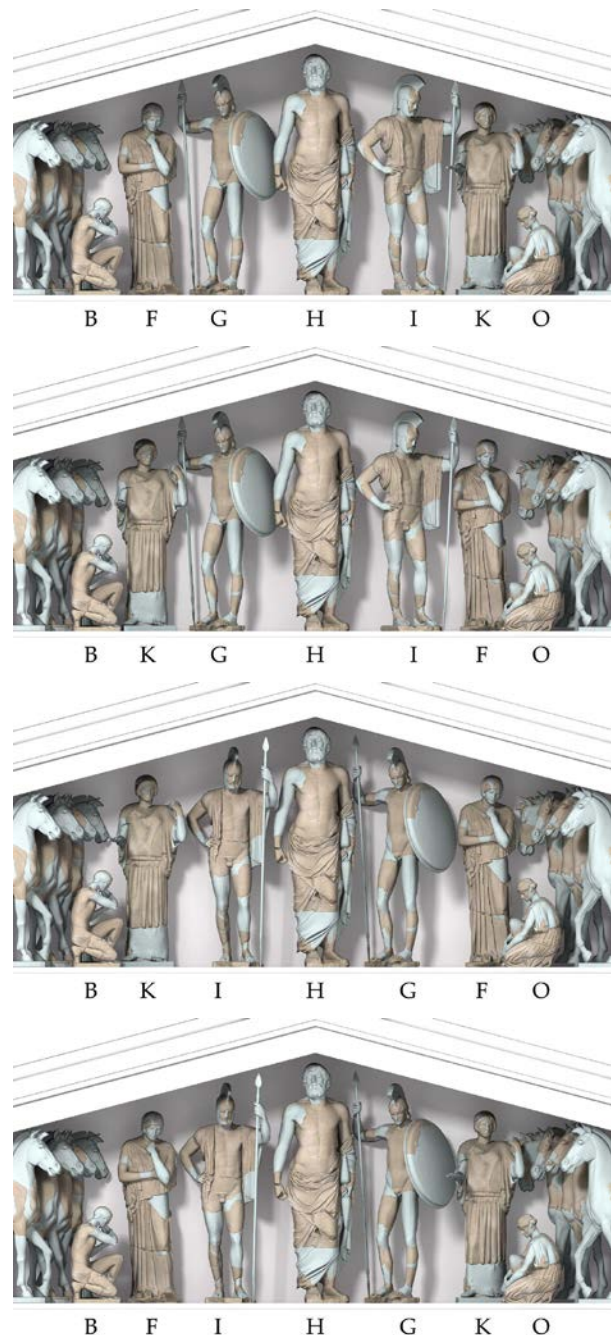


Figure 8 Virtual 3D reconstructions of the central figures arranged as in Figure 7. The fragments are displayed in grey, the reconstructed parts in pale blue

¹⁷ Both N. Yalouris (Ashmole-Yalouris 1967) and G. Becatti (Becatti 1970) have opted for the closed arrangement type A. Hurwit 1987: 6 note 2, Steuben 1990: 383, Knoll 1994: 80 just emphasize that the question is open to debate.

¹⁸ Säflund 1970, 81-96 with Fig. 56.

¹⁹ Paterake 2005, 171-174.

²⁰ Grunauer 1971.

²¹ Grunauer 1981, 281-301, esp. 288.

²² For technical details see e.g. Patay-Horváth 2011a,b; 2012; 2013a.

4.4 Results

Studying and testing the different reconstructions with 3D models revealed that contrary to the expectations based on the results of the early experiments with plaster casts, every arrangement could be realized. (Figure 8)

The virtual models show, however, that the arrangement, which was considered to be physically impossible in the 19th century (open "A") and which is most commonly accepted today, is indeed the most difficult to realize (Figure 9): the limbs of figure K and G do not necessarily run across each other, but the distance between them is so small (max. 10 cm) that we can hardly believe that this arrangement could follow the original intentions of the designers or the sculptors.

Furthermore, the model clearly shows that in the case of both open arrangements, another problem arises: the spears in the hands of the male figures fit the available space only if both of them grip the shaft directly under the spear-head (Figure 10) which is otherwise not attested in Greek art.

In the case of closed arrangements (Figure 11), we have no such problem with the spears; these arrangements can therefore be regarded more probable than the open ones. Though the remaining two closed arrangements are possible both technically and iconographically, one can observe, that every piece of evidence, which is independent from the interpretation actually points to type "A", which can be considered therefore as the most probable reconstruction.²³ (Figure 12)

5. CONCLUSION

The accurate virtual 3D reconstruction of the temple, including its east pediment and its cult statue as shown in Figure 13, has clearly demonstrated the possibilities and advantages of virtual archaeology. The digital models can be employed for differ-

ent scholarly and educational purposes and it would be highly desirable to complete the digitization and virtual reconstruction of the temple's architectural decoration (i.e. the west pediment and the 12 metopes depicting the labours of Heracles).

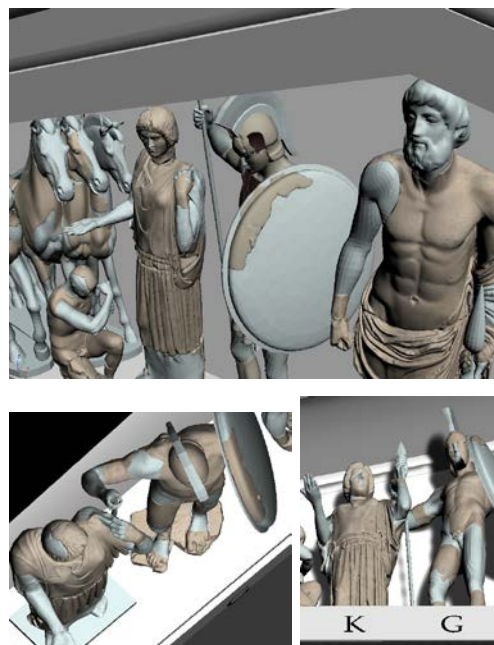


Figure 9 Figures K and G according to the open arrangement Type "A"

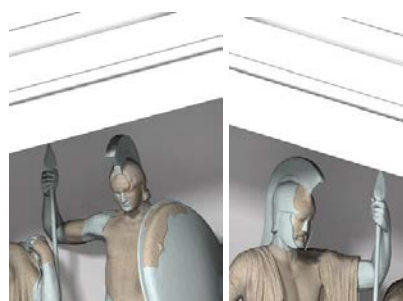


Figure 10 The spear-heads of the male figures in the open arrangements.



Figure 11 The spear-heads of the male figures in the closed arrangement

²³ For a detailed discussion see Patay-Horváth 2008.

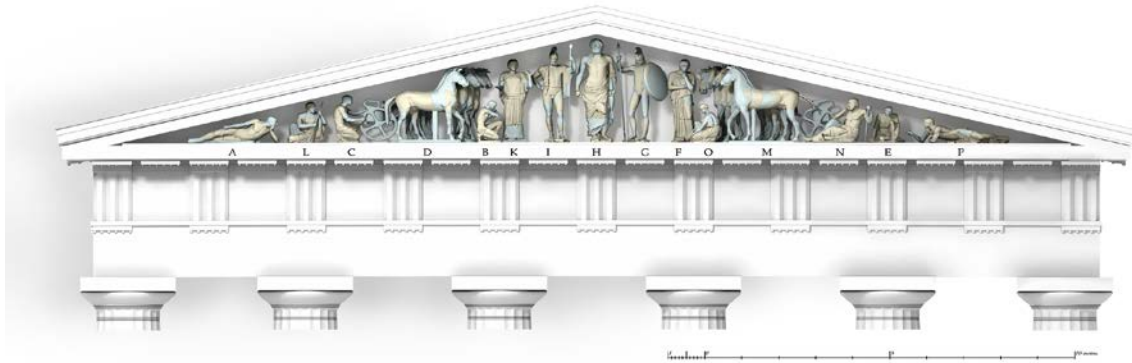


Figure 12 The virtual 3D reconstruction of the entire east pediment according to closed arrangement Type "A"



Figure 13 The virtual 3D reconstruction of the entire east pediment according to closed arrangement Type "A"

ACKNOWLEDGEMENTS

The project was carried out with the financial support provided by the Norway Grants and the Hungarian National Research Fund (OTKA ref. no. NNF 85614) as well as the János Bolyai scholarship offered by the Hungarian Academy of Sciences. Special thanks are due to G. Hatzi (head of the Ephorate at Olympia) and R. Senff (German Archaeological Institute at Athens, supervisor of the Olympia excavations). I am indebted to Prof. B. Frischer (Univ. of Virginia) for his constant help and encouragement.

Scanning of the original fragments of the east pediment was carried out by Tondo SP1 Ltd. (Budapest), the virtual reconstruction and the illustrations were produced by G. Gedei (occasionally assisted by D. Bajnok and M. Hitter).

REFERENCES

- Ashmole, B. – Yalouris, N. (1967) *Olympia. The Sculptures of the Temple of Zeus*. London: Phaidon.
- Becatti, G. (1971) Controversie olimpiche. *Studi miscellanei* Vol. 18, 65-84.
- Bulle, H. (1939) Der Ostgiebel des Zeustempels zu Olympia, *Jahrbuch des Deutschen Archäologischen Instituts* Vol. 54, 137-218.
- Dinsmoor, W. B. (1950) *The Architecture of Ancient Greece: an Account of its Historic Development*. 3rd ed. New York: Batsford.
- Gruben, G. (2001) *Griechische Tempel und Heiligtümer*, München: Hirmer.
- Grunauer, P. (1971) Der Zeustempel in Olympia – Neue Aspekte. *Bonner Jahrbücher* Vol. 171, 114-131.
- Grunauer P. (1981) Zur Ostansicht des Zeustempels. A. Mallwitz (ed.), *X. Bericht über die Ausgrabungen in Olympia. Frühjahr 1966 bis Dezember 1976*, Berlin: De Gruyter, 256-301.
- Heilmeyer, W.-D. et al. eds. (2012) *Mythos Olympia. Kult und Spiele*. Berlin: Martin-Gropius-Bau.
- Hellmann, M. C. (2002) *L'architecture Grecque I*. Paris: Picard.
- Hennemeyer, A. (2010) Der Zeustempel von Olympia, Griechenland. *Geschichte der Rekonstruktion, Konstruktion der Geschichte*, ed. by W. Nerdinger, München: Prestel, 218-219.
- Hennemeyer, A. (2011) Zur Lichtwirkung am Zeustempel von Olympia. P. I. Schneider, U. Wulf-Rheidt (eds.), *Licht. Konzepte in der vormodernen Architektur* (Diskussionen zur archäologischen Bauforschung 10), Regensburg: Schnell, 101-110.
- Hennemeyer, A. (2012) Der Zeus-tempel, *Mythos Olympia. Kult und Spiele*. ed. by W.-D. Heilmeyer et al., Berlin: Martin-Gropius-Bau, 121-125.
- Herrmann, H. V. (1987) *Die Olympia-Skulpturen*. Darmstadt: Wissenschaftliche Buchgesellschaft.
- Hurwit, J. M. (1987) Narrative Resonance in the East Pediment of the Temple of Zeus at Olympia, *The Art Bulletin* Vol. 69, 6-15.
- Kyrieleis, H. (1997) Zeus and Pelops in the East Pediment of the Temple of Zeus at Olympia. D. Buitron-Oliver (ed.), *The Interpretation of Architectural Sculpture in Greece and Rome*, Washington: National Gallery of Art, 12-27.
- Kyrieleis, H. (2011) *Olympia. Archäologie eines Heiligtums*. Mainz: Philipp von Zabern.
- Knoll, K. ed. (1994) *Das Albertinum vor 100 Jahren - Die Skulpturensammlung Georg Treus*. Dresden: Staatliche Kunstsammlungen.
- Lawrence, A. W. with revisions by R. A. Tomlinson (1983) *Greek Architecture*, New Haven: Yale Univ. Press.
- Lippolis, E. et al (2007) *Architettura greca: storia e monumenti del mondo della polis dalle origini al V secolo*, Milano: Mondadori.
- Mallwitz, A. (1972) *Olympia und seine Bauten*, Darmstadt: Wissenschaftliche Buchgesellschaft.
- Ohnesorg, A. (1993) *Inselionische Marmordächer*, Berlin: De Gruyter.
- Patay-Horváth, A. (2008) Zur Rekonstruktion und Interpretation des Ostgiebels des Zeustempels von Olympia. *Mitteilungen des Deutschen Archäologischen Instituts, Athenische Abteilung* Vol. 122, 161-206.
- Patay-Horváth, A. (2011a) Virtual 3D Reconstruction of the East Pediment of the Temple of Zeus at Olympia – A Preliminary Report". *Proceedings of the 14th International Congress "Cultural Heritage and New Technologies" 2009*, edited by K. F. Ausserer, W. Börner, S. Uhlirz, Wien: Museen der Stadt Wien – Stadtarchäologie, 653-658.

- Patay-Horváth, A. (2011b) The complete Virtual 3D Reconstruction of the East Pediment of the Temple of Zeus at Olympia“ Paper presented at 4th ARC 3D conference, Trento, Italy, 3-5 March 2011. Accessed 30th May 2012. <http://www.isprs.org/proceedings/XXXVIII/5-W16/pdf/patay.pdf>.
- Patay-Horváth, A. (2011c) The Virtual 3D Reconstruction of the East Pediment of the Temple of Zeus at Olympia (CD ROM), Budapest. ISBN 978-963-284-196-0
- Patay-Horváth, A. (2012) Reconstructions of the East Pediment of the Temple of Zeus at Olympia – A comparison of drawings, plaster casts and digital models. *International Journal of Heritage in the Digital Era*, Vol. 1 No. 3, 331-349.
- Patay-Horváth, A. (2013a) Virtual 3D Reconstruction of the East Pediment of the Temple of Zeus at Olympia - An old puzzle of classical archaeology illuminated by recent technologies, *Digital Applications in Archaeology and Cultural Heritage*, <http://dx.doi.org/10.1016/j.daach.2013.06.001>.
- Patay-Horváth, A. (2013b) Die Perserbeute von Plataia, die Anfänge der elischen Münzprägung und die finanziellen Grundlagen der „Grossbaustelle Olympia“. *Klio*, Vol. 95, 61-83.
- Paterake, K. (2005) *To anatoliko enaetio tou naou tou Dia sten Olympia*. Rethymno: Panepistimo Kretes.
- Säflund, M. L. (1970) *The East Pediment of the Temple of Zeus at Olympia. A Reconstruction and Interpretation of its Composition*. Göteborg: P. Åström
- Schiering, W. (1991) *Die Werkstatt des Pheidias in Olympia II, Werkstattfunde*. Berlin: De Gruyter
- Simon, E. (1968) Zu den Giebeln des Zeustempels von Olympia. *Mitteilungen des Deutschen Archäologischen Instituts, Athenische Abteilung* Vol. 83, 147-167.
- Steuben, H.von (1990) Sterope und Hippodameia, *Études et Travaux* Vol. 15, 379-384.
- Stewart, A. F. (1983) Pindaric Diké and the Temple of Zeus at Olympia. *Classical Antiquity* Vol. 2, 133–144.
- Strocka V. M. (2004) Phidias, *Künstlerlexikon der Antike*, ed. by R. Vollkommer, München/Leipzig: Saur, Vol. II, 210-236.
- Studniczka, F. (1923) Die Ostgiebelgruppe vom Zeustempel in Olympia, *Abhandlungen der Sächsischen Akademie der Wissenschaft, Phil.-Hist. Klasse* Vol. 37, 3-36.
- Treu, G. (1897) *Olympia III. Bildwerke aus Stein und Thon*. Berlin: A. Asher.