RECONSTRUCTIONS OF THE EAST PEDIMENT OF THE TEMPLE OF ZEUS AT OLYMPIA (OTKA NNF 85614) – FINAL REPORT

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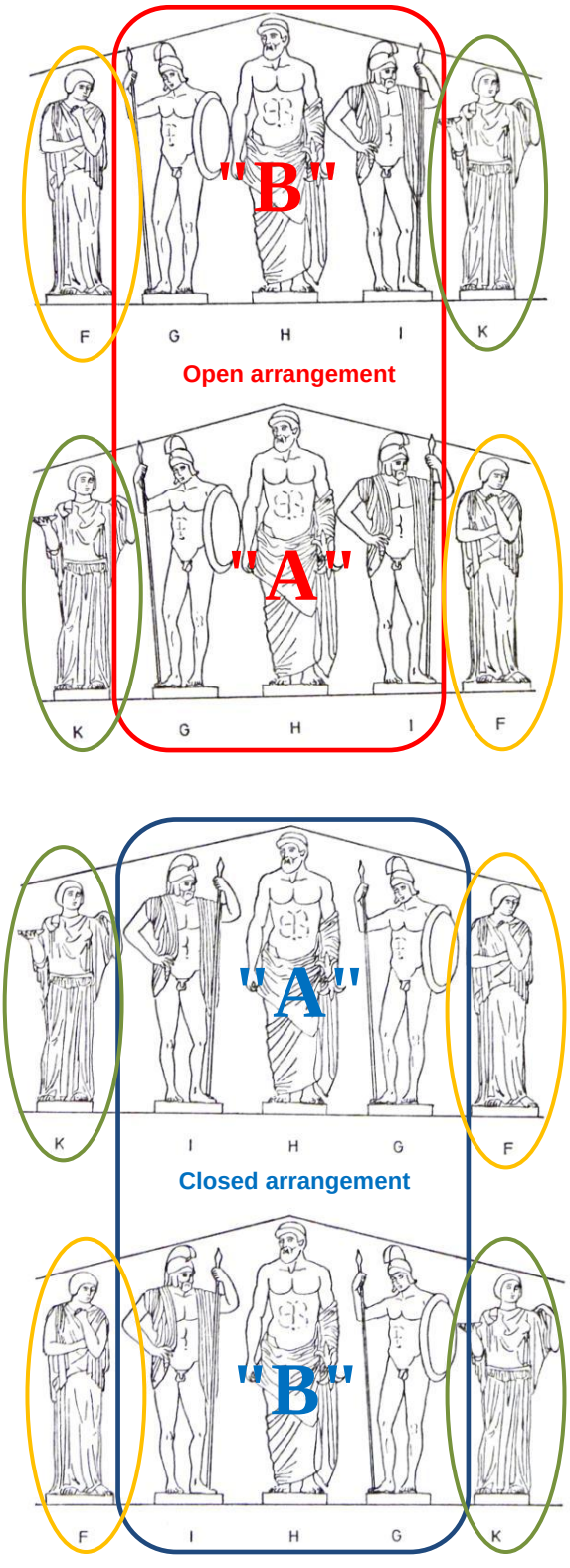

Fig. 1. Schematic reconstruction drawings showing every conceivable arrangement of the five central figures.

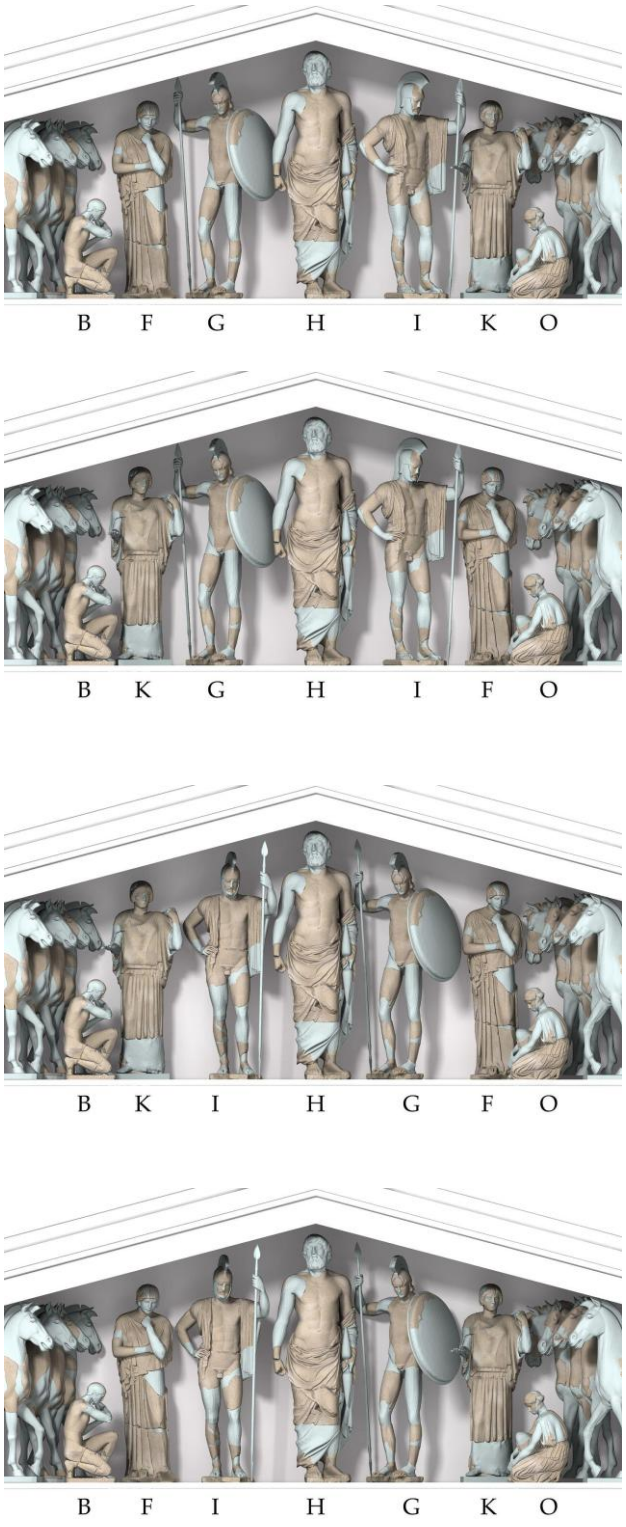

Fig. 2. Virtual 3D reconstructions of the central figures arranged as in Figure 1. Original fragments are displayed in grey, the reconstructed parts in pale blue

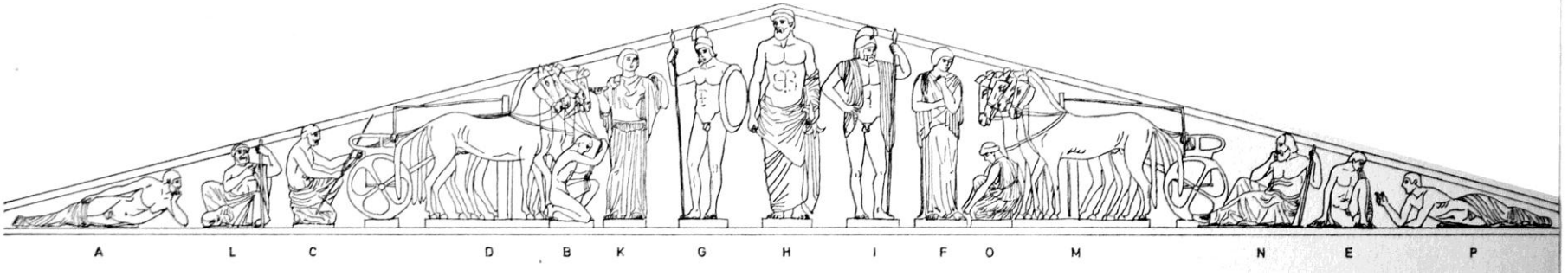

Fig.3. The most commonly accepted reconstruction (open arrangement Typee "A") of the pediment (after Herrmann 1972 fig. 95)

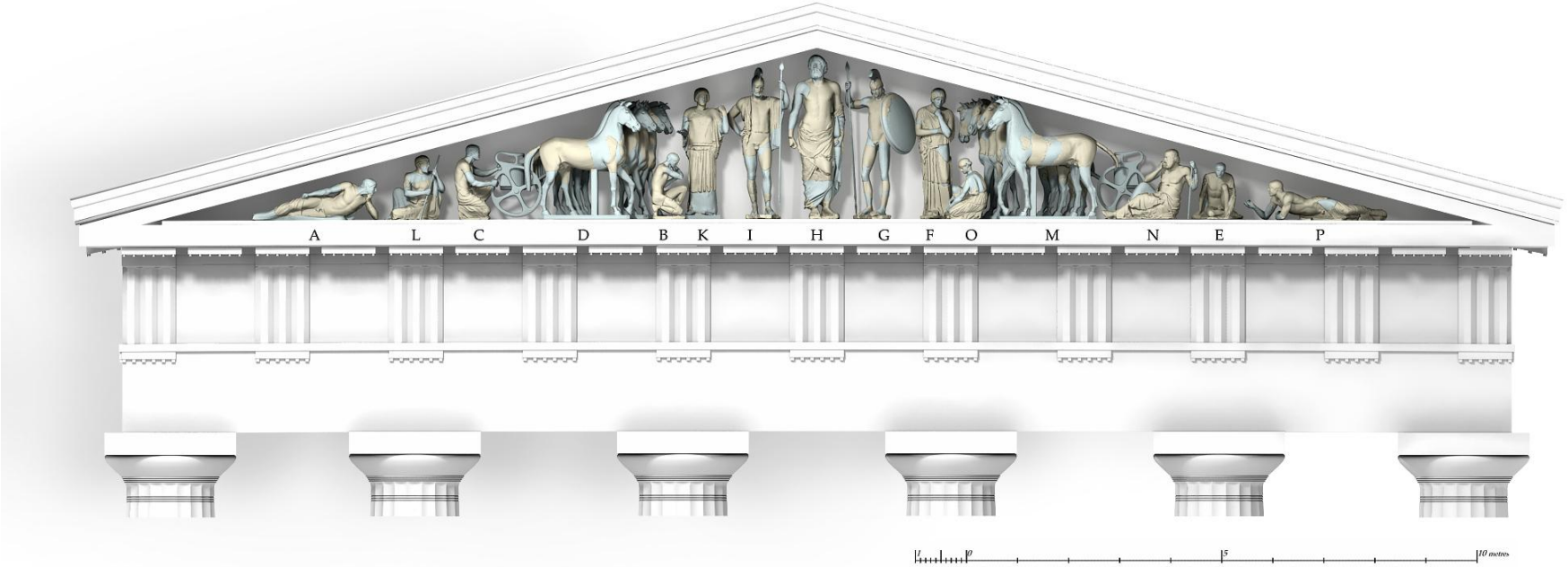

Fig. 4. The new virtual reconstruction (closed arrangement "A") of the complete pediment

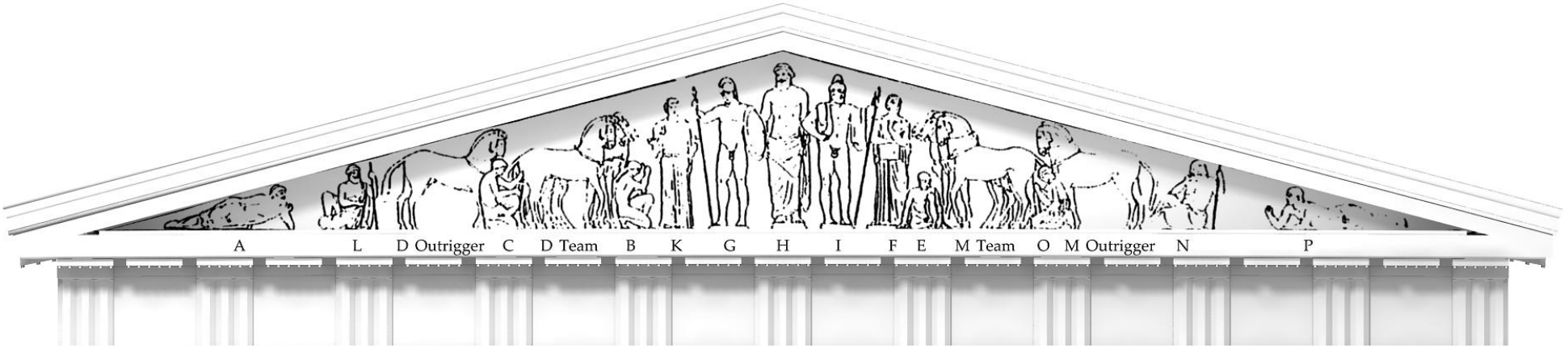

Fig. 5. Reconstruction drawing of Rehak and Younger inserted into the virtual reconstruction of the pediment

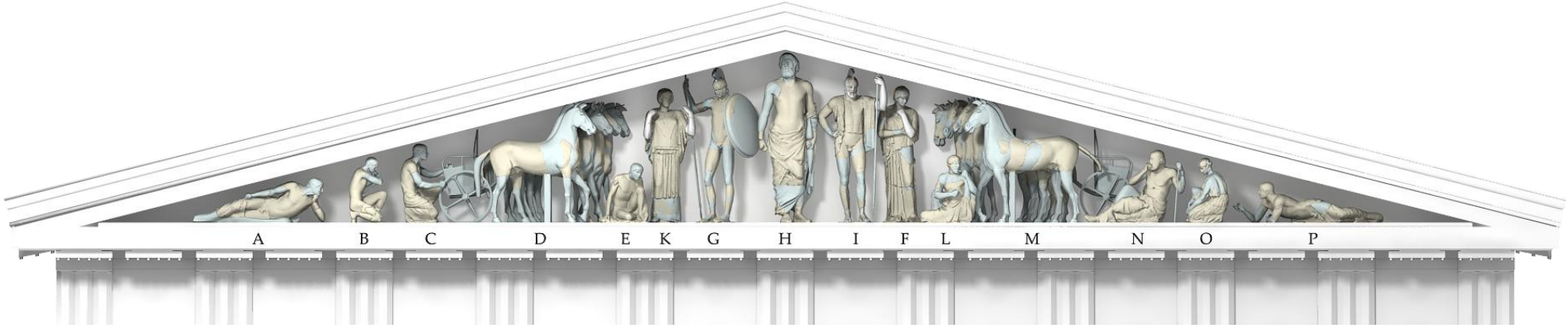

Fig. 6. Virtual 3D reconstruction of the arrangement excluded by Treu 1897.

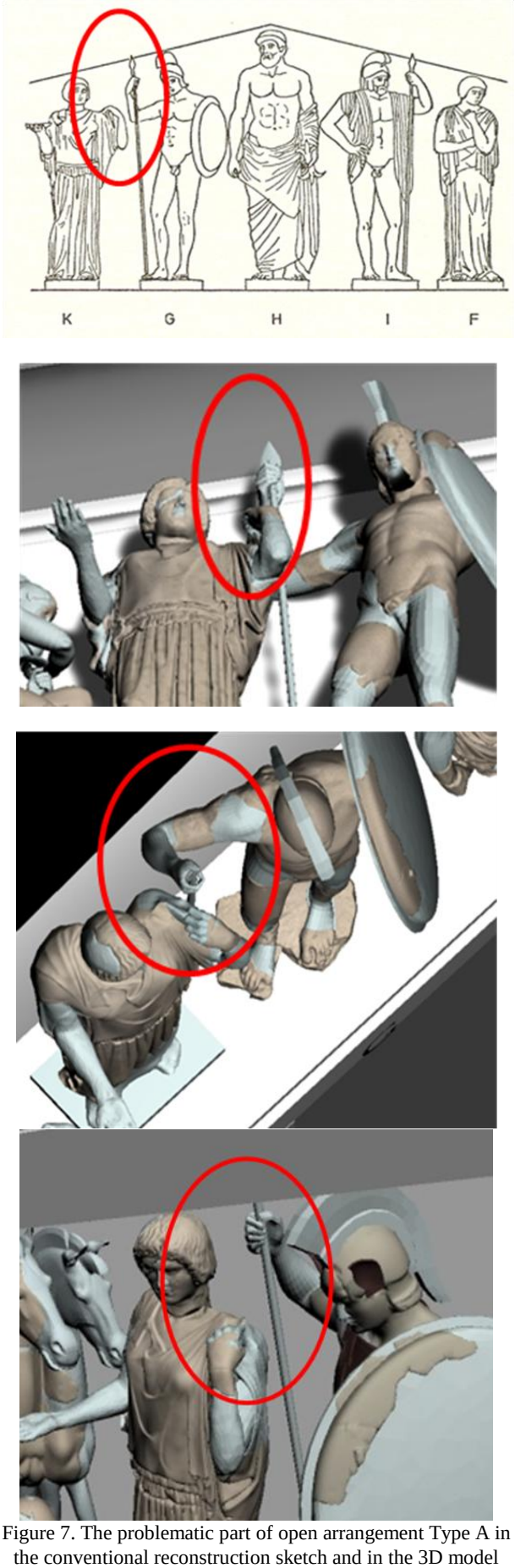

Figure 7. The problematic part of open arrangement Type A in the conventional reconstruction sketch and in the 3D model

1. COMPARATIVE EVALUATION OF THE DIFFERENT RECONSTRUCTIONS

1.1 Reconstruction drawings vs. 3D models

It is not surprizing that reconstruction drawings (Fig. 1) tended to show only one particular view of the group and an additional view was published only in an exceptional case (Grunauer 1981). 3D models, however, whether real plaster models (on a reduced scale or in the original size) or virtual ones, offer the possibility of looking at the statues (and especially at problematic parts) from any point of view and to produce many different renderings of the same arrangement. This difference is quite obvious, but should not be very significant, if both were equally accurate in rendering the preserved fragments. But precisely this is not the case, for hand drawings are bound to be inaccurate and are therefore not quite reliable, when studying smaller details, like in this particular case the realtive position and the poses of figures G and K. The slight differences can not be percieved by the naked human eye in each single case, but their effect becomes apparent, if compared with an accurate 3D model. (Figure 7) Although archaeologists used to rely heavily on these sketches reproduced in practically every relevant publication, their deficiencies should be particularly stressed: they show every single figure from one particular point of view, irrespective of its actual position in the composition, they do not differentiate between original and reconstructed parts and they are actually based not on the originals, but on a miniature plaster reconstruction made by the sculptor H. Grüttner at the end of the 1880ies.

It is all the more astonishing that a fundamentally new reconstruction of the entire pediment, which was not primarily concerned with the central group, but with the chariot horses (Figure 5) was put forward a few years ago only in a simple drawing (Rehak-Younger 2009) and no attempt was made at a more detailed or more accurate visualization. The published sketch was used by the present author to test this latest reconstruction by adapting the virtual 3D model to the proposed new arrangement. The rendering reproduced here (Figure 8) shows, I think, that although the proposed reconstruction is technically feasible, if we accept the basic idea of reducing the height of the horses (which is again possible, but not very likely), but results in a crowded and aesthetically unsatisfactory reconstruction in the central part, retaining moreover the open arrangement Type "A", which has been shown to be ill-founded on iconographical and technical grounds.

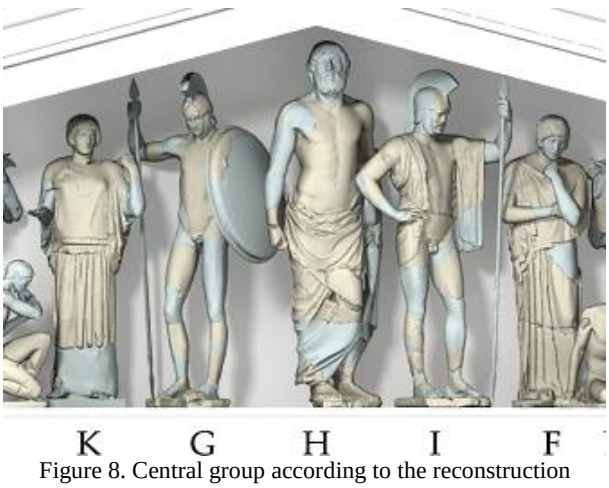

Figure 8. Central group according to the reconstruction proposed by P. Rehak and J. G. Younger in 2009

1.2 Plaster models vs. virtual 3D models

There were two different sets of plaster reconstructions. The earlier one on a reduced scale (1:10) was created by the sculptor H. Grüttner in the 1880ies for an exhibition in Berlin (Figure 12), and formed the basis for the most popular reconstruction drawings. But these miniature figures did not result from long studies or discussions, but represented only a first attempt for a general visualization of the composition.

These colored models were soon replaced by plaster models on the original, monumental size of the fragments, which were created by supplementing the plaster casts of the original fragments under the supervision of G. Treu in Dresden. (Figure 9, 10)

Figure 9. Original size plaster models of G. Treu arranged by himself (Dresden, 1897). From left to right: F, G, H, I, K.

Figure 10. The same models (subsequently altered by H. Bulle) in their actual state of preservation (Dresden, 2011).

Treu actually studied all the fragments from Olympia for more than a decade, experimented with the plaster casts and with the models, and published his results with a remarkable accuracy (Treu 1897). His observation regarding the inaccuracy and unreliability of the miniature plaster models should not be ignored. It is true, that Treu did not give his reasons for discrediting the miniature models, but he stated this very confidently and was not corrected in this respect by later generations of researchers, who took the trouble of using the large models. That others dismissed his results without any reasoning and without repeating his experiments is not a serious obstacle for believing him. The scanning of the miniature plaster models actually confirmed Treu's statement regarding their inaccuracy. If scaled to the original dimensions and compared with the digital models of the fragments, it is clearly visible, that the differences are sometimes quite remarkable, especially in the case of the male figures (Figure 11, 12)

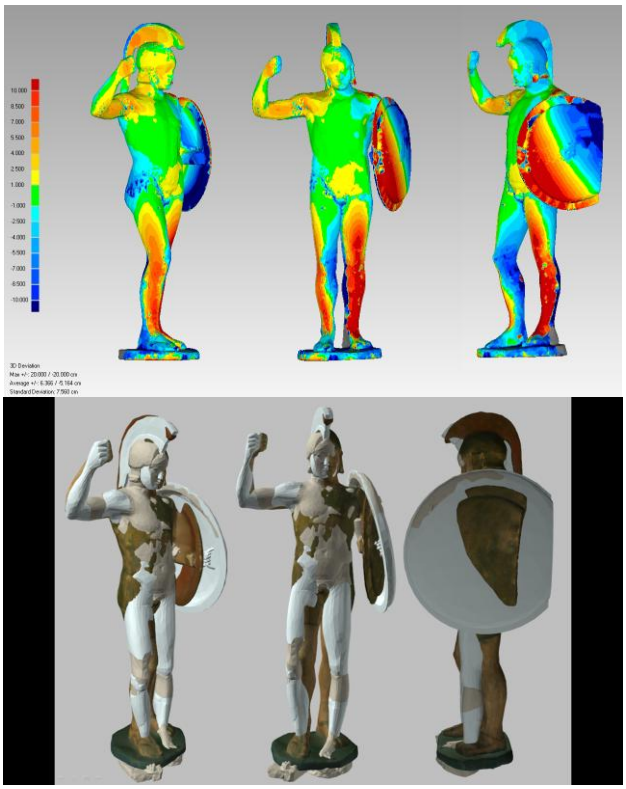

Figure 11. Figure G. Comparison of the miniature plaster models (in color) and the virtual 3D models (in grey).

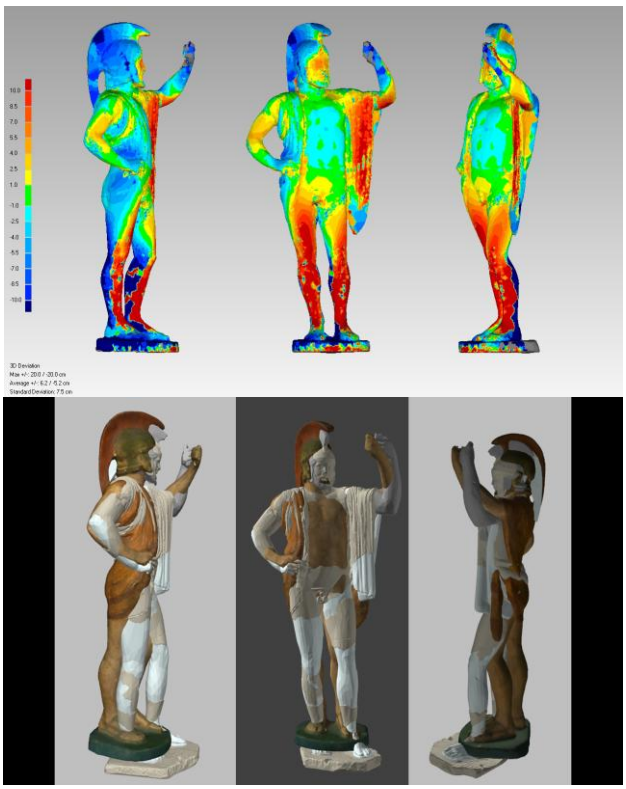

Figure 12. Figure I. Comparison of the miniature plaster models (in color) and the virtual 3D models (in grey).

Nevertheless, it was still puzzling, that Treu's conclusions based on the long experimentation carried out with the large plaster models were markedly different from the results achieved with the digital models. It could be easily demonstrated, that the difference was not due to the fact that the pediment was at the time of Treu reconstructed with slightly different (smaller) dimensions, because the same digital models placed in the virtual reconstruction of the pediment using the former, smaller dimensions yielded the same result as with the recent ones. The discrepancy was thought to be caused by the slightly different rendering of some reconstructed parts (or because of different poses adopted for some limbs) and to test this hypothesis, the preserved parts of these models were also scanned in Dresden. Although regrettably little is preserved of the models, and even the preserved parts were subsequently altered by later scholars using them (see e.g. the right lower arm of figure K), the digitization could clearly show, that the reconstructions realized in plaster on the original scale by Treu were not markedly different from those in the virtual reconstruction. (Figure 13)

Figure 13. Original size plaster models (light grey) and the virtual 3D models (dark grey) compared. From left to right: Figures K, F, I.

So the discrepancy between the results can not have been caused by the differences between the details of the reconstructions realized in plaster and in virtual reality. The alternative seemed to be to blame either Treu or myself of committing some serious error during the course of the reconstruction, e.g. with testing the different arrangements; but eventually the explanation turned out to be different and without discrediting either Treu's accuracy or my own. When looking at the figures flanking the central group, I realized, that the ones adopted for these positions by Treu were markedly different from those generally accepted today (which I naturally adopted in the digital recreation of the pediment) and affected the positions of the central figures by reducing the space available for them (Figure 14). Having realized this and adjusting the digital reconstruction in this respect to the one suggested by Treu, the same result emerged, as described by him: the collision of figures G and K became unaivoidable. (Figure 7, 15) Treu's statement was thus confirmed and explained without compromising either method or anyone of us. At the same time, the inaccuracy of the miniature models emerged again with a remarkable clarity: if arranged in the same way (Figure 15), they absolutely do not reveal the problem of the collision between figures K and G.

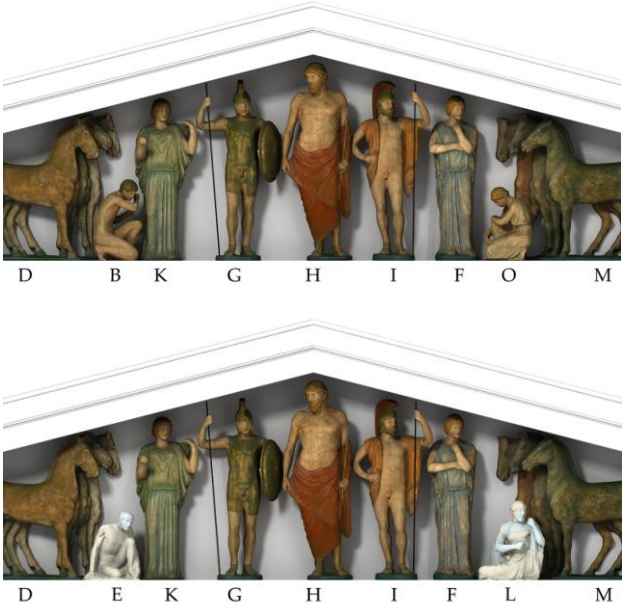

Figure 14. Miniature plaster models by Grüttner (open arrangement Type A). Figures in front of the horses according to the present consensus (above), and to Treu (below).

Figure 15. Virtual 3D models (open arrangement Type A) according to Treu. Problematic part enlarged below.

2. PRESENTATION OF THE INTERACTIVE CD-ROM CONTAINING THE VIRTUAL 3D RECONSTRUCTION

2.1 Objectives

During the course of the project reports were regularly presented on various meetings and international congresses and the results were published in due course, but all these publications (both digital and printed media) were restricted to 2D format and did not enable visualization in 3D. An appropriate documentation in the present case can, however, be conceived only in 3D and the most convenient solution seemed to be the publication of an interactive, multimedia CD-ROM.

Our goal was to present the 3D models in a fairly good resolution and in a way, which enables the user to manipulate (to rotate, to zoom, to move) them in a relatively easy and uncomplicated fashion, without the need to purchase costly software products (and to learn, how to use them). At the same time, to preserve intellectual property rights, we did not want to disclose the original 3D data captured or created during the project. (They can be obtained on request – mainly for scientific purposes with no commercial implications – from the author, if both the German Archaeological Institute and the Greek authorities agree.)

Since the project is a multidisciplinary one making use of the latest technological innovations and concentrating on a very specific and complex archaeological problem, it seemed to be reasonable to envisage a mixed audience consisting of both classical archaeologists / students of art history and computer scientists / experts in multimedia visualization. The inclusion of at least some pieces of basic information for both groups was deemed to be essential.

Because the monument investigated during the project, the temple of Zeus and its sculptures are very well-known and famous pieces of the European cultural heritage (the site itself belonging to the UNESCO World Heritage), it was intended to present the project and the models at different levels, not only for specialists, but also for the interested general public.

2.2 Structure and content

Our aim was to create a clear and logical structure enabling easy orientation and navigation for every interested party. We chose therefore a format, which combines the appearance of a traditional printed publication with the extended functions of a website. By inserting the CD-ROM into the computer (PC or Mac), the user is automatically confronted with a screen, which functions like an ordinary website with an animated flash intro and a dynamic, multi-level menu (Table of contents) on the left. The content itself is structured in fact like that of a book and the appearance resembles that of a printed book as well (all pages numbered consecutively and having clearly defined dimensions and a constant layout fitting the screen). The pages can not be scrolled down, but there are arrows on the left and on the right of each, to turn over to the following or to the previous one. In addition there is a navigation bar on top of each page, directly below the title. By clicking on this, a complete scrollable list of all pages (with their individual titles) appears on the screen and the user can easily move to any other page, he is interested in. (Figure 16)

The text contains links to attached documents of various kinds (e.g. publications in pdf, reports in mp3 and avi format) and to other pages of the book guiding or informing the user, like cross-references and footnotes of a traditional book. Images and 3D models displayed on the pages can be enlarged and viewed in a separate window by clicking on them. In order to ensure wide and easy usability, 3D models were included in 3D pdf format. This enables the user to observe the models from any point of view and to enlarge any part of them, but the original 3D data sets are not disclosed.

The fragments of each figure have been generally designated by alphabetic letters since their original publication (Treu 1897) and precisely because their arrangement in the pediment is disputed, they were arranged in alphabetical order, one figure per page. Navigation between them is facilitated for the non-specialists by a page showing miniature icons of the models and the commonly used designations of the figures, both functioning as a direct link to the page, where the models of that particular figure are displayed. On these pages, the model on the left shows the surface of the preserved torso as recorded by the 3D scanner, the one in the centre displays a closed digital model of the piece, whereas each one on the right presents the whole figure as completed during the project, the original parts displayed in grey, the completed ones in pale blue. (Figure 16) Textures taken from the present state of the fragments were not applied to the models, because they are irrelevant for the project and because they are generally misleading, since ancient marbles were originally colored in general, and in this case practically every trace of polychromy has completely disappeared.

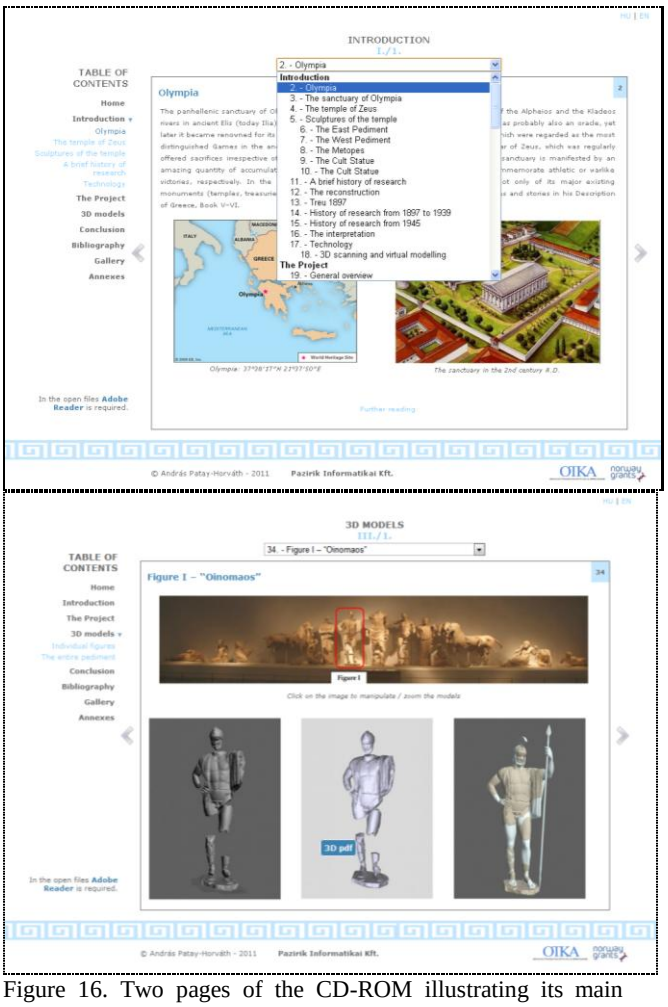

Figure 16. Two pages of the CD-ROM illustrating its main features (structure, navigation, 3D models of individual figures)

The four different virtual 3D reconstructions of the central part of the pediment are displayed in a similar way (the original and the completed parts differentiated by the same colors and with a navigation aid showing all variants side by side). Two pages are devoted to every single arrangement (Fig. 17) showing the model from three different but constant viewpoints (all of them on the main axis of the pediment): 1. "museum view" (viewer standing approximately on the same level as the statues); 2. "ancient view" (viewer standing approximately on the ancient ground level before the temple); 3. "aerial view" (from above, pedimental frame removed from above the statues). In addition, by clicking on the museum view, each possible arrangement of the central group can be viewed and manipulated in 3D pdf format. With the help of these models, everyone can decide which option seems most or least satisfying technically and aesthetically. The most probable reconstruction of the entire pediment (according to the author) is also included and can be studied in 3D pdf.

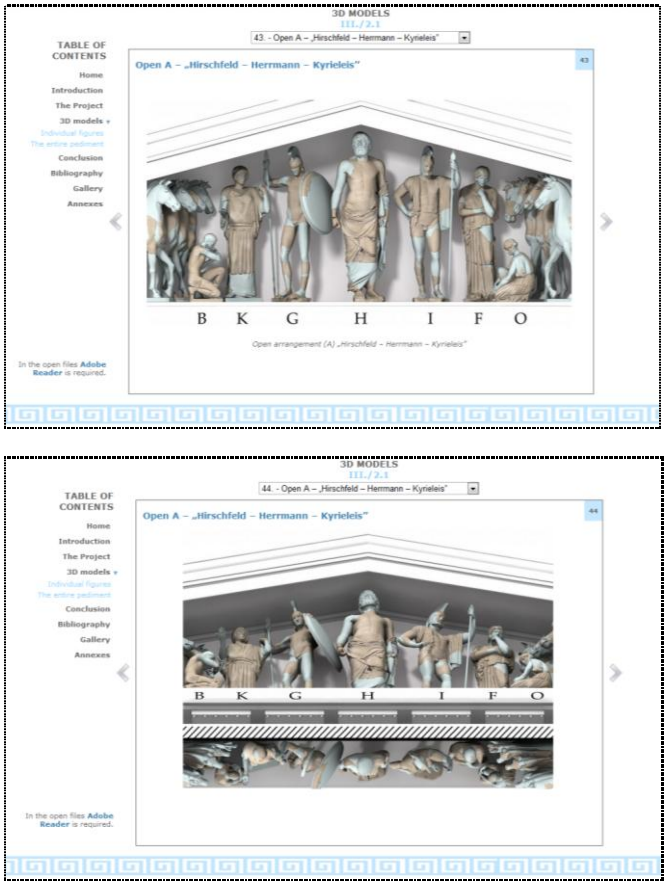

Figure 17. Two pages of the CD-ROM illustrating the presentation of the central group

Texts, presentations and audio-recordings of lectures, interviews of various genres are displayed in unaltered form (each one of them in the original language, i.e. English, German, Hungarian or French). The differences are due to the various types of audiences (specialists or general public) and reflect at the same time the progress of the research. Published and forthcoming manuscripts of the author are also included in the appropriate sections.

Numerous photographs of each figure are also added in the Gallery section and may thus be compared with the 3D models. The aesthetic value of these images cannot be denied, but at the same time, they clearly show the limitations of this kind of documentation.

2.3 Comparison with similar projects

There are two distinct groups of projects, which invite comparison with the present one. (1) During the last decade, several virtual 3D reconstructions of the sanctuary and of the temple of Zeus have been produced. These recreations (Powerhouse museum, Sydney 2000 and Foundation of the Hellenic World, Athens 2004) were in fact motivated by the growing interest in the olympic games and they were thus fundamentally different from the present project regarding their aims, methods and results as well. The attachments in the Annex section are intended to give a quick overview of them. (2) There were, on the other hand, a few notable projects involving 3D scanning and visualization of ancient sculpture, which can be more readily compared with the present one, although they were concerned with other monuments. These projects are mentioned and illustrated in the Introduction of the CD-ROM, because they had a decisive impact on the present project. The most recent one was the Trier Constantine project (ArcTron Ltd., 2007), which involved both 3D scanning and virtual 3D reconstruction and thus provided the basic idea for the author. The earlier one, ("Metopes of Selinunte" by SIBA, Lecce – NRC, Ottawa, 2004), which involved only the scanning and visualization of Greek sculpture (but actually of the sculptural decoration of a monumental Greek temple, like the one at Olympia), served as a model for the CD-ROM. Despite the similarities of all these projects, the CD/DVD presentations of them became very different in many respects. The Constantine project was advertized only on a DVD by a 12-minutes movie illustrating the workflow and containing some very impressive 3D renderings and animations. The production of such a documentation was beyond the means of the present project and would also have been insufficient to convey its results appropriately. The Selinunte CD used Macromedia Director and contains almost exclusively audiovisual material (whereas in our case the material was mainly presented in written form), but its basic structure could be adapted. Our renderings and animations are (mainly for financial reasons) clearly less elaborated and the design of the CD is much less sophisticated than the "Metopes of Selinunte", but perhaps the structure is clearer and the navigation easier. The main difference and the progress can be observed in the rendering of the 3D models, since the 3D pdf format enables a manipulation practically free of any constraints (as opposed to the Quick Time Viewer used on Selinunte CD). The other differences derive mainly from the different aims of the two projects: the Selinunte CD focuses on technology using the archaeological material as an example without discussing it in detail, whereas the CD presented here focuses on an archaeological problem using 3D scanning technology as a tool to solve it.

3. CONCLUSIONS

The complete virtual 3D reconstruction of the composition leads to the conclusion that the reconstruction, which is most widely accepted today (Open "A"), is technically the most difficult to realize and that both open arrangements would be feasible only if we ignored a general pictorial convention of ancient Greek art. Still, it is important to emphasize that the virtual reconstruction does not enable us to establish the right arrangement, i.e. the one actually realized in antiquity, but only to exclude (with a high degree of probability) two of the four options. However, considering the uncertainties experienced so far, this result can be regarded as a great progress. 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 point to type "A", which can be considered therefore as the most probable reconstruction.

The project reached therefore its major goal and contributed significantly to a debate, which engaged archaeological research for more than a century. It demonstrated at the same time, that 3D scanning can be used not merely for documentation (as it is most frequently employed), but for effective research purposes as well.

The project also clarified the history of research. More than a century ago, the reconstruction of this monumental sculptural group could only be attempted by miniature or life-size plaster casts. Both ways were tested and it was correctly realized, that the miniature models made by a contemporary artist, were not accurate enough to make decisions on minor details. They could be just used for a general visualization. At that time, there was no objective proof available to detect where the differences exactly were, but the differences between the two sets of plaster models were clearly visible, as they become apparent for anyone comparing Figure 14 and 15 or the drawing and the digital model in Figure 7. It is only to be expected, that the same differences exist between the drawings and the digital models on the one hand and between the miniature and the large plaster models on the other hand, because the drawings are actually based on the miniature models and reproduce them fairly correctly just as the original size plaster casts and the digital 3D models both reproduce the original fragments mechanically and therefore with quite a great degree of accuracy. Both are equally reliable, the advantage of the digital replicas and reconstructions lies merely in their easier and faster manipulation. This is, after all not to be neglected, since the complicated handling may have contributed to the fact, that Treu, who otherwise tried to test every possibility, did not venture to carry on his experiments on all the figures, but restricted himself to the central group.

One can therefore conclude, that the virtual 3D models enable highly accurate reconstructions and easy and very instructive experimentation, which would be otherwise impossible with the originals and with simple drawings or very expensive and not very effective with real-size plaster models.

The complete virtual model can effectively be used to various scholarly and educational purposes, i.e. to study and to compare the aesthetic effects of the different reconstructions or to visualize the monumental fragments from any point of view all over the world. One can e.g. easily adopt the viewpoint of a visitor standing in front of the temple and have a look at the model from below or to rotate and zoom to any part, which is otherwise hidden in the museum or in the published photographs. (e.g. Figure 7)

The 3D models of the individual fragments can be used for further research and for visualization, as well. One can e.g. proceed to build a complete virtual reconstruction of the temple or to analyze the individual characteristics of the sculptors and thus identify the origin of the craftsmen producing these exceptional works of art.

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