The virtual model in archaeology

Continuity of the 3D medium in documentation, reconstruction, and publication.

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Introduction

The 3D medium sees its application within archaeology in many shapes and for various purposes. The documentation of findings with Structure from Motion (SfM), the virtual reconstruction of architecture through 3d modelling software or the communication of research to a broader public through VR are some examples for these. This project around the virtual reconstruction of an ancient stoa in Amarynthos1 paid attention to the complete visualisation process rather than just focusing on one single aspect. Observing the use of the 3D medium from the field documentation till the digital publication allowed to better understand the potential the various forms of the medium bring. It involves reflection on how information gets preserved, generated or constructed at the different stages, and how the 3D models can be transformed and used at the next stage. This finally helps to develop 3D workflows and thus to establish the medium within archaeology as a common tool for documentation, research and communication. This paper and especially the poster which it describes offer one such solution in an applied example and contribute to the ongoing discussion on how the 3D medium can and should be used successfully within archaeology.

Documentation

The objects of research in archaeology are usually bound to a specific location, even more so when it comes to the remains of architecture. Quite often the context gets also irrevocably altered or lost during the excavation process. The basis of any further research and communication is thus the documentation, with its form and quality being crucial for any work beyond the site. An important part of it is visual information, represented through drawings, photographs, 3D models, etc.

[1] The paper is based on the master studies diploma project of the author, which successfully graduated in summer 2020 at the Zurich University of the Arts. The project continued as a research project at the Zurich University of the Arts (ZHdK). The virtual reconstruction model of a late classical / early hellenistic stoa was elaborated together with the Swiss School of Archaeology in Greece (ESAG). The ESAG conducts excavations at the sanctuary of Artemis in Amarynthos, in collaboration with the Ephorate of Antiquities of Euboea. For further informations about the excavation project visit: www.esag.swiss/amarynthos/

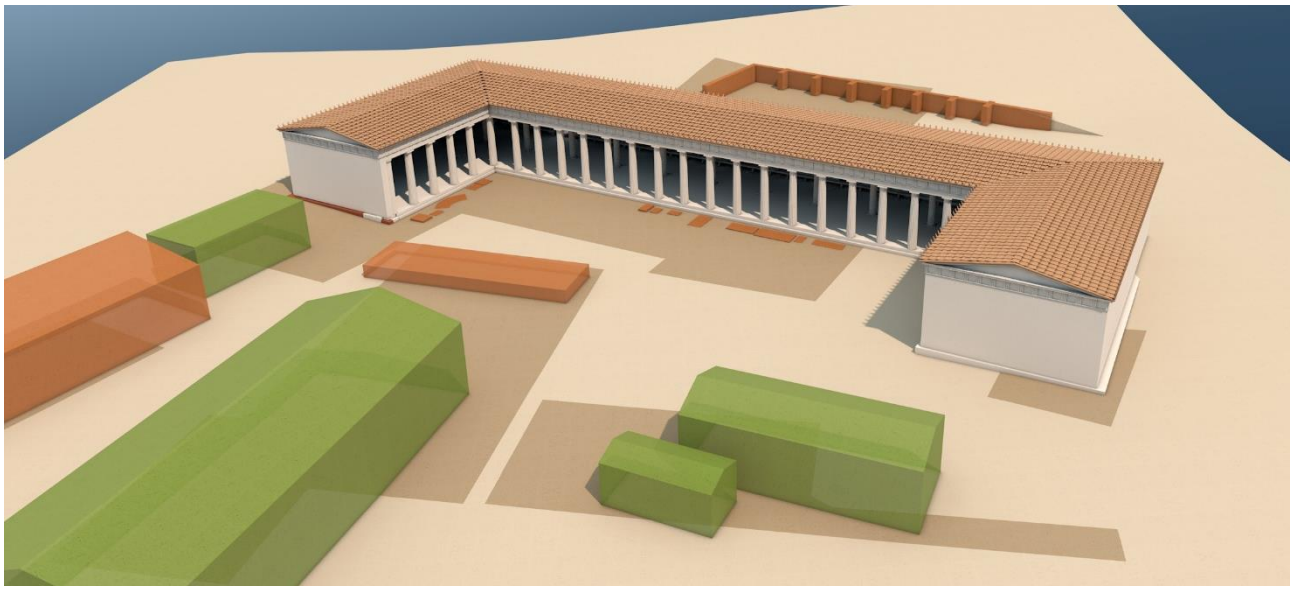

Fig. 1. Final reconstruction model of the stoa. The buildings around are still part of ongoing research and thus shown in an abstract shape. The colours represent the period of their construction: green – classical; orange – hellenistic. The darker fields on the ground represent the currently excavated areas. (© O. Bruderer, ZHdK / ESAG).

The reconstruction of the stoa of Amarynthos started with the documentation of the relevant findings, besides the fundaments still in situ these were mainly fragments of architectural elements. In addition to drawings, the objects and structures were documented with *Structure from Motion (SfM)*. That allowed to generate textured polygonal models of all findings, ready for use in virtual 3D space.

It is important to note that besides all the benefits of 3D technology, the drawings of these objects and structures remain an important part of the documentation. The automatically generated 3D data via *SfM* consist solely of surface data in the form of polygons and pixels (or points in the case of point clouds), and do not contain any archaeological interpretation. They are quite the opposite of field drawings or find illustrations produced by observation of the original object, thus representing a first interpretation by the drawing person.

Reconstruction modelling

One of the main benefits of 3D modelling for archaeological research is given by the possibilities to (re-)construct the appearance of architecture or artefacts. The modelling allows to evaluate the available evidence, develop hypothesis and construct multiple solutions where clear findings are lacking, offering a perceptival basis for the discussion between experts.

The way these reconstruction models are built depends largely on the available data as well as the project goals. A wide variety of project goals come into consideration for a virtual reconstruction, as discussed for example thoroughly in Wittur (2012). The goals of the reconstruction to the stoa of Amarynthos were to analyse the construction based on the available findings. The aim was to Figure out where the different elements were placed and how they connected together. That was also inevitable to confirm, whether an object actually belonged to the building or not.

a b c

Fig. 2. Reconstruction of the doric column. a) Fragments found and recorded through SfM were 3D printed in scale 1:10 and thus could be assembled. b) That was repeated with the virtual SfM-Models in 3D space. The column drum could be reconstructed. c) With the aid of secondary sources, the columns could be modelled and integrated to the doric order. (© O. Bruderer, ZHdK / ESAG).

The first step for the reconstruction model was to define the elements in situ. To that end the modelling process started with the replication of the excavated features through cubes, based on a georeferenced SfM models of the excavated structures and on precise CAD drawings. Thus, each building element was modelled with a separate volume and multiple elements combined into groups according to structure.

The second step was the completion of found elements not anymore in situ, often only fragmentary preserved. They were reconstructed and completed as necessary, either directly based on the SfM models or on reconstruction drawings or find illustrations – quite often a two-dimensional and orthographic drawings was a valuable assistance to 3D reconstruction. The reconstruction also helped to decide if an object had the right proportions and measurements to belong to the building.

The SfM models of the findings proved very helpful to assemble fragments, especially if that could not happen with the original findings (due to heavy weight, insufficient state of preservation or storage in different locations). Such was done with the fragments belonging to doric column drums (Fig. 2). Rather than assembling the virtual fragments virtually, it proved much more efficient to reproduce them via 3D printer and aligning the pieces physically. Some areas or elements of the building could not be completed solely by the findings of the excavation. Thus, comparable secondary sources from other excavations had to be consulted. These are commonly available as reports, articles etc. published by other excavation projects. The quality of these sources are accordingly substantial for the own reconstruction process. For the stoa of Amarynthos, the most relevant secondary source was the stoa in the sanctuary of Oropos, just across the South Euboean Gulf. Unfortunately, not all references were properly illustrated in the publication, making it necessary to rely on tourist photographs of the site. This example shows the importance of thorough documentation for any kind of further visualisation work.

To finally complete the reconstruction model, there are more often than not parts where one has only rather hypothetical secondary sources or that need some sort of „educated guesswork“. This last step to complete the reconstruction demands lots of caution and should influence the final model as little as possible.

For the whole reconstruction process, there were some crucial points considered. First, the whole reconstruction process was documented in detail (through text and screenshots). This allowed to be aware of the available evidence, the conclusion met whilst modelling and the knowledge gained. Second, every

conclusion made was discussed with the experts of the team, the archaeologist Tobias Krapf and the architect & researcher Alexandra Tanner. She was also responsible for final 2D CAD plans, that contributed a lot to the final model.

Communication & Publication

At the end of the modelling process remains the question of how to communicate it to fellow researchers or to a wider public. The reconstruction model made for research purposes offers great possibilities for both. The model itself needs some manipulation, not only to show the final conclusion but also to make the research process transparent. For the model of the stoa in Amarynthos an interactive prototype was created using Adobe XD, to present the research model as part of an interactive publication (Fig. 3). The aim was to show the final model in comparison to the available sources and the decisions made, based on the reconstruction-argumentation-method as proposed by Grellert / Pfarr-Harfst (2019).

The interactive prototype allows the user to analyse the 3D model itself and access all the information involved. Much to the opposite of classical print publications, it offers not only a multilinear approach through interactivity, but it is also the model itself that gives orientation to the users. Integrating the SfM models of the finding into the virtual model allows direct comparison between find objects and hypothetical reconstruction.

Fig. 3. An interactive prototype allows the user to compare the reconstruction model with the findings. Text and illustrations explain the decisions made during the modelling process in detail. (© O. Bruderer, ZHdK / ESAG).

References

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