

The virtual model in archaeology

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

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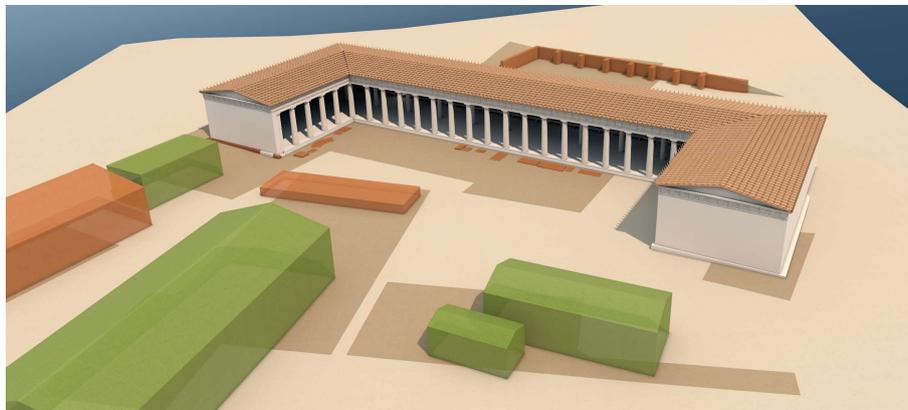
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Introduction

Whether it is 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 – The 3D medium sees its application within archaeology in many shapes and for various purposes.

Rather than just focusing on one aspect of these, the aim of this project around the virtual reconstruction of an ancient stoa in Amarnthos¹ was to pay attention to the complete pipeline, from the beginning till the publication. Looking at the use of the 3D medium at different parts of the process allowed to better understand, which needs and benefits the various forms of the medium bring. It is necessary to reflect, which information gets preserved, generated or constructed at the different stages, and how they can be transformed and used at the next stage. This is crucial to develop 3D workflows and finally to establish the medium within archaeology as a tool for documentation, research and communication.

This paper and especially the poster which it precedes offer an applied example to one such solution, and



contribute to the ongoing discussion on how the 3D medium can and should be used successfully throughout archaeology.

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.

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 of excavation get also irrevocably altered or lost during

¹ The paper is based on the master project of the author, which successfully graduated in summer 2020 at the Zurich University of the Arts. In collaboration with the Swiss School of Archaeology in Greece (ESAG) the virtual reconstruction model of a late classical / early hellenistic stoa was built. The project continues as a research project at the Zurich University of the Arts (ZHdK).

the 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.

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

It is important to note that, besides all the 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 directly at the original object, thus representing a first interpretation by differentiating between different structures, materialities etc.

Reconstruction modelling

One of the main benefits of 3D modelling for archaeological research is given through 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 also an ideal basis for the discussion between experts.

The way these reconstruction models get 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 as precise as possible. Based on the available finding, 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.

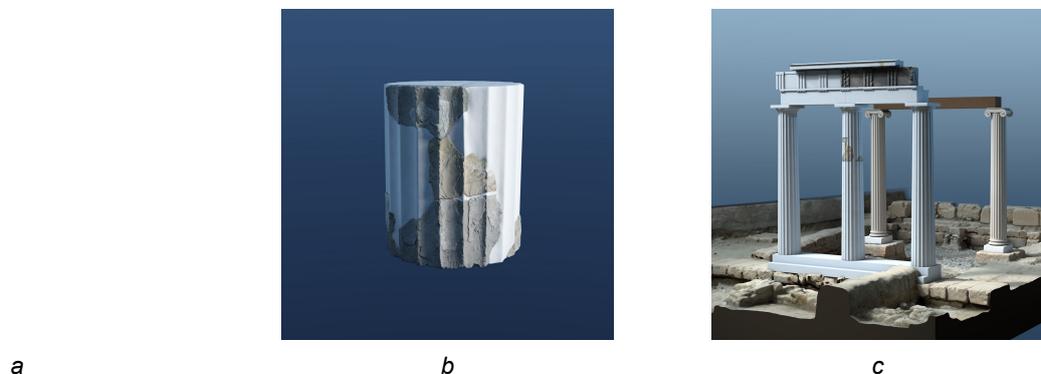


Fig. 2. Reconstruction of the doric column. a) Fragments found and recorded through SfM were 3D printed in scale 1:10 and thus could be assembled. b) That was repeated with the virtual SfM-Models in 3D space. The column drum could be reconstructed. c) With the aid of secondary sources the columns could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

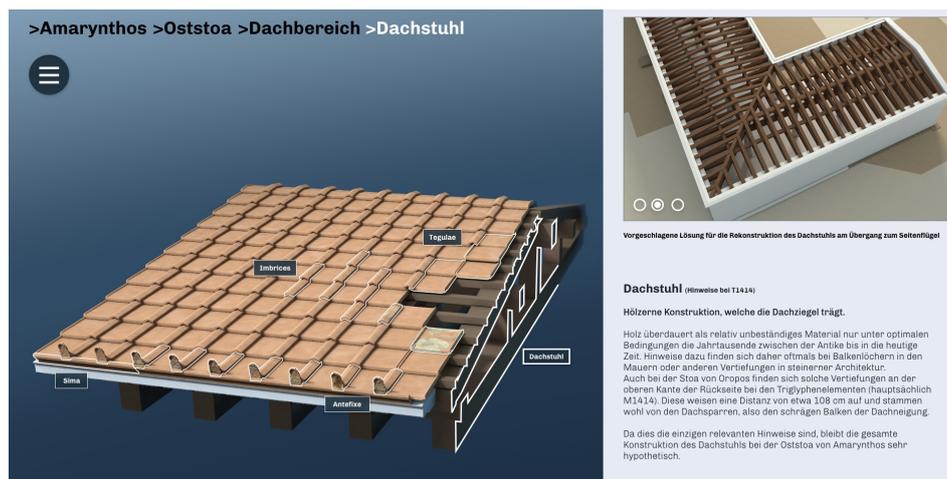
The first step for the reconstruction model was to define the elements in situ. To that end the modelling process started with the replication of the excavated features through cubes, based on a georeferenced SfM model of the excavated structures and on precise CAD drawings. Thus each building element 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 an important 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 another excavation team. 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 how crucial good documentation is also for other peoples work. Finally, there are always parts where one has only secondary sources that are rather hypothetical or that need some sort of „educated guesswork“ for the reconstruction. This last step to complete the reconstruction should be done very cautiously and influence the final model as little as possible.

For the whole reconstruction process, there were a few crucial points to be considered. First, the whole reconstruction process was documented in detail (through text and screenshotst). This allowed to be always aware of the available evidence, the conclusion 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.

Fig. 3. An interactive prototype allows the user to take the reconstruction model apart and compare it with the findings. Text and illustrations explain the decisions made during the modelling process in detail.

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 simulate an interactive publication based on the research model. The aim was to reflect the final model with the available sources and the conclusions made, similar to 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 informations involved. Much to the opposite of classical print publications, it offers not only a multilinear approach through

interactivity, 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.

References

- Wittur, J. (2012). *Computer-generated 3D-Visualisation in Archaeology: Between added Value and Deception*. Oxford: BAR Publishing.
- Grellert, M. and Pfarr-Harfst, M. (2019). `Die Rekonstruktion-Argument-Methode: Minimaler Dokumentationsstandard im Kontext digitaler Rekonstruktionen`, in Kuroczyński, P., Pfarr-Harfst, M. and Münster, S. (eds.) *Der Modelle Tugend 2.0*. Heidelberg: arthistoricum.net. doi: <https://doi.org/10.11588/arthistoricum.515>