

Palette of possibilities:

developing digital tools for displaying the
uncertainty in the virtual archaeological
“reconstruction” of the house V 1,7 (Casa
del Torello di Bronzo) in Pompeii

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ABSTRACT

This thesis has two major purposes: (1) to create a 3D virtual “reconstructive” model of the peristyle with the *nymphaeum* wall (room **b**) of the house V 1,7 (House of the Bronze Bull) in Pompeii, and (2) to prepare a probability map based on this model that will show the reliability level for each individual part. The author underlines the importance of recording paradata of the entire workflow. The aim of this study is to highlight the problems concerned with 3D virtual archaeological reconstructions – in particular, the lack of proper referencing tools and lack of reflexivity when presenting those models to the public.

The basic data for this study were scans obtained in a framework of the Swedish Pompeii Project. One set of scans was imported into 3DStudio Max and the reconstruction was modelled with reference to it. After this stage, a probability map was created in order to present the plausibility of every element in the form of a color scale (green being most plausible, red being least plausible). Furthermore, the probability map was geo-referenced and visualized within ArcGIS. Once this task was realized, a database was created and linked in order to connect the different parts of the probability map with the sources used to perform the reconstruction.

The project proved that 3D virtual models are useful tools in examining the spatial relations of the objects and the visual representation of the scene. The results obtained show the necessity of documenting the entire scientific process thoroughly. Furthermore, it was concluded that this subject needs to be more discussed by archaeologists, and that the scientific vocabulary concerning these implementations should be standardized.

Key words: reconstruction, 3D modelling, computer vision, digital archaeology, Geographic Information System, model, paradata, Pompeii, probability map, public archaeology, transparency, virtual heritage, Virtual Reality, visualization

TABLE OF CONTENTS

ABSTRACT	2
TABLE OF CONTENTS.....	3
CHAPTER 1. INTRODUCTION	5
RESEARCH QUESTIONS	7
AIMS	7
DEFINITIONS	8
"RECONSTRUCTION"	8
VIRTUAL REALITY	8
GEOGRAPHIC INFORMATION SYSTEM	9
STATE OF THE ART	9
MODERN HISTORY OF THE HOUSE	9
HISTORY OF RELIABILITY REPRESENTATIONS IN VIRTUAL ARCHAEOLOGY	11
DATA	11
METHODS.....	12
CHAPTER 2. THEORETICAL PERSPECTIVE	13
PROBABILITY MAP	13
APPLICATIONS OF THE PROBABILITY MAP	16
SHARING UNCERTAINTY WITH THE PUBLIC	18
3D GIS AND PROBABILITY MAP.....	18
SUMMARY	19
CHAPTER 3. MODEL	20
DATA PREPARATION	20
SOURCES.....	22
VIEW AXES	23
NYMphaeum WALL	24
DESCRIPTION OF THE MODELLED PARTS	25

ARCHITECTURAL ELEMENTS.....	26
FINISHING COMPONENTS.....	28
DECORATIONS.....	30
MOSAICS.....	36
ROOF.....	40
WATER.....	41
GARDEN.....	45
PROBABILITY MAP	46
SUMMARY	49
<u>CHAPTER 4. PROBABILITY MAP IN GIS</u>	<u>49</u>
DATA PREPARATION	50
DESCRIPTION OF THE LAYERS.....	51
DESCRIPTION OF THE DATABASE	51
ATTRIBUTE TABLE WITH THE REASONING REFERENCES.....	52
ATTRIBUTE TABLE WITH THE BIBLIOGRAPHY	53
<u>CHAPTER 5. RESULTS.....</u>	<u>54</u>
RESULTS OF THE VIRTUAL SIMULATION	54
RESULTS OF THE PROBABILITY MAP	55
<u>CHAPTER 6. DISCUSSION</u>	<u>56</u>
<u>CHAPTER 7. CONCLUSION</u>	<u>59</u>
ACKNOWLEDGEMENTS.....	60
<u>BIBLIOGRAPHY</u>	<u>60</u>
<u>LIST OF FIGURES</u>	<u>65</u>

CHAPTER 1. INTRODUCTION

Pompeii is a deeply rooted symbol in our culture. Romantic vision of the “lost city” or “city frozen in time” has been an inspiration for countless histories and books throughout centuries. However, this myth, still cultivated by movies and literature, is falling, taken down by the very same people who brought it to life – archaeologists. We now know that it was not the ferocious lava flows that buried the innocent citizens but the pumice and ash; we know that they had a plenty of time to escape – yes, but still how little we know about this town! People tend to think that classical archaeologists have an easy job, that everything is known (as opposed to ever-discovering prehistory researchers). The truth is that we see bare ruins, and there are still many open questions concerning the life in the ancient city. In the jungle of everlasting excavations which begun already in the 18th century, the matters of what is the original composition of the walls, original placement of the artifacts, and even original position of the frescoes are blurred and irretrievable, given that there are no solid reports about most of the actions undertaken at the site in the first decades of excavations.

Considering the above, any “reconstruction”¹ planned in those conditions would rather resemble the construct known in literature as the “story within the story” – a big box, and a smaller one inside, and a smaller one inside this one, and the next one... The first story is about the amendments and corrections which were undertaken in the recent history, the second (within the first) is about the anastylosis with the additions, performed soon after the discovery. The third is a story about how the house looked like when volcano has spoken, the fourth is about the changes that the owner decided to make before the final days, etc. ..., up to the story about the stone that constitutes the freshly new building raised in Regio V more than two thousand years ago.

The story I want to present here goes back to those final days and finishes with the modern remains. Even by saying “modern remains”, I encapsulate a few stories, take for example the recent event (collapsed wall) that changed the structure of one of the houses.² Deterioration is irreversible – however, archaeologists were able to scan this house with high-resolution laser scanners few years before that event, providing a virtual model, which – in some way – prevented a new story to begin. A virtual model opens entire new possibilities for the story to follow.

¹ For the explanation of the use of brackets, see **Definitions** section below.

² Prisco 2013.

In this thesis, I would like to focus on the house V 1,7 from Pompeii (fig. 01), in particular on the peristyle with the astonishing *nymphaeum* wall (room **b** on the plan below) and a very complex water system that provided water for the more than 20 fountain nozzles located in the room.

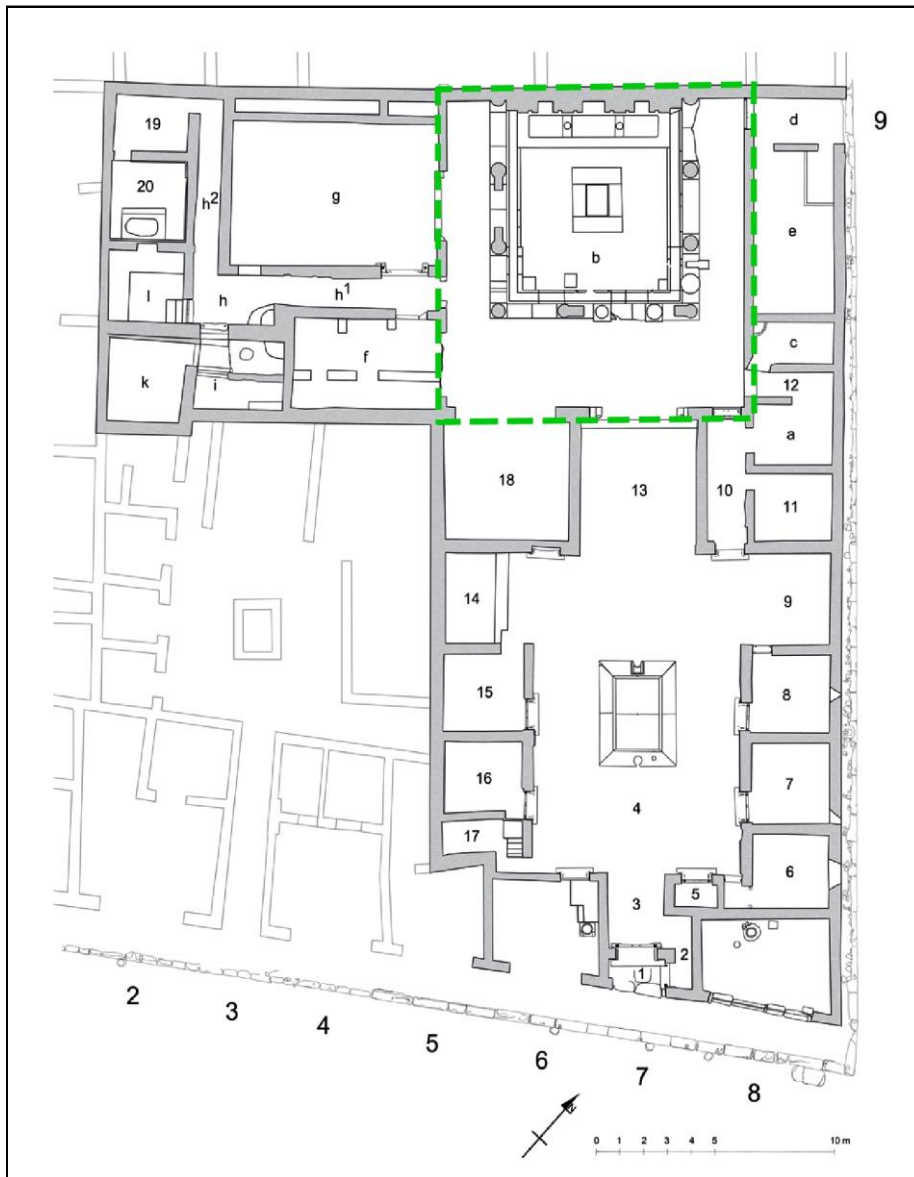


Fig. 01. Plan of the house V 1,7 in Pompeii, with the peristyle area marked in green (plan: H. Boman, editing: M. Perlińska).

Insula V 1 is being investigated by the Swedish Pompeii Project³ since 2000. The aims of the project are mainly to provide a complete documentation and an analysis of the structures in the insula. In the scope of the investigation, the entire insula had been scanned.

³ <http://pompeijiprojektet.se/project.php> (accessed: 10.06.2014).

I want to use the data which was collected by the project to create a model that shows one possible way of how the peristyle of the house V.1.7 might have looked like. I am well aware that it will not be exactly the same as an ancient archetype, since many parts will be based solely on comparisons and not original data. That is why I decided to transform my doubts into a plausibility map, a virtual visualization instrument designed to show the reasoning and scientific justification for each element. It is my intention to attach a database to the plausibility map, in order to provide a tool for a further discussion about the model. In my opinion, it is important to share this uncertainty with others – both scholars and public – because to expose our hesitation and to search for a satisfactory answer for it is what constitutes archaeology as an academic discipline.

Research questions

The aim of this thesis is to answer the question of how the peristyle might have looked like and this will be accomplished in the form of a 3D model. I will try to describe what kind of obstacles I encountered during the process, and how – if possible – those can be overcome. In addition, I will reflect upon what making “reconstruction” models in general gives the community, both the scientists and a wider public. This is an important issue, and if the outcome of this research will further reinforce its significance, we should consider introducing a uniform set of principles to form a theoretical base for further models. I would also like to focus on the potential that lies in the use of virtual tools (Virtual Reality, Geographic Information System) to analyze archaeological data and visualize digital interpretations. Furthermore, I want to focus on the issue whether a 3D model of an archaeological “reconstruction” can display all the steps that lead archaeologists to define the final interpretation.

Aims

My primary aim is to develop a digital “reconstruction” of a part of the house. I want to realize that by using the 3D information collected by the Swedish Pompeii Project with the laser scanner technology. After importing it into 3D GIS software, I would like to develop a probability⁴ map to show the level of certitude concerning each part of the virtual reconstruction. Using a GIS platform, I will be able to link the 3D information with a database. Furthermore, this database will enable the connection of every individual part of the model with the sources used during

⁴ *Plausibility* is more suitable word for this application. However, for the reasons explained broader in chapter 2, I will use the word *probability* instead.

the modelling process. This could form a base for a wider discussion about how these types of models could be ultimately handled in the future.

Definitions

“Reconstruction”

There has been many articles written concerned with the issue of the adequacy of the word “reconstruction” in archaeology. I will use the words *model* or *virtual simulation* instead, as proposed by Jeffrey Clark.⁵ “Reconstruction”, as pointed out by many authors⁶, assumes that we know precisely how the things were in the past and that we are reproducing an exact image of the past. It is hard to uproot this concept, as there has not been any convincing replacements proposed. *Model* and *virtual simulation* might still be too ambiguous, but it is not in the scope of this thesis to define a new technical terminology. In this work, *model* or *virtual simulation* will be used alternatively to denominate a 3D virtual construct done on the basis of the remains of the ancient Pompeian house V 1,7. In some instances, where those words can cause the confusion or may seem unclear, I will continue to use the word “*reconstruction*”.

Virtual Reality

Virtual Reality (in short VR) can be defined as a cyber space environment (sometimes called a computer simulation⁷), resembling the real world or not, that can be explored by people, and, in some cases, interacted with.⁸ It should give the viewer a sense of telepresence, which is a feeling of being physically present in this environment through a medium (like 3D glasses).⁹ For each visitor, the sensual perception (sometimes also other senses than vision are stimulated) will be slightly different, depending on each individuals physical and mental condition.

The VR environment enables its users (depending on the level of accessibility) to perceive the model and to freely move around in it, but also to interact with it in a variety of ways. This creates interesting possibilities for archaeological research which have not been completely explored yet and – looking at the intense pace at which technology develops today – might never be fully researched.

⁵ Clark 2010: 69.

⁶ One of the earliest criticism was posed by Taylor 1948: 35, who noticed that “[this term] implies a re-building to exact former specifications which (...) are not verifiable and, hence, not knowable.”

⁷ Conolly and Lake 2006: 300.

⁸ Conolly and Lake 2006: 300.

⁹ Steuer 1992: 76.

Geographic Information System

Geographic Information System (in short GIS) is a tool that archaeologists have been familiar with for a long time. It denotes all software that deal with the data acquisition and management, database management, visualization and analysis using a variety of spatial tools. It allows data sets to be displayed in layers that can be manipulated in order to obtain new information about the spatial relationships between the different elements.¹⁰

Its suitability for archaeological purposes was established already in the 1990s.¹¹ GIS is valued for its ability to handle and organize huge amounts of spatial data – a tool much used by archaeologists, who often produce much of this data. Moreover, it can also analyze information in almost any way desired for, from broad landscape analyses to small-scale visibility studies. One of the most important features is the ability to add metadata for all the objects (that informs about the spatial location and important attributes)¹² – much like a paperclip, that keeps all the documentation about a certain artifact together with the object itself – and query this database in an easy and quick way.

State of the art

Modern history of the house

My work will be focused on the Pompeian house, which according to the modern “address” system has code V 1,7 (Regio V, Insula 1, entrance 7). Due to the long history of the excavations, the house has many different names. Another frequently used appellation is House of P. Pontius Successus, who was perhaps its owner, given the small seal stamp found at the entrance¹³ and an inscription in the *atrium*¹⁴ with the same name. Moreover, the house is often called House of the Young Bull¹⁵ (or Bronze Bull), after the bronze statuette of a bull found by the *impluvium*.¹⁶

The problems related to the often very poor documentation, especially of the earlier excavations in Pompeii, that are a frequent source of irritability for all those who work there, did not omit this house. The documentation is very scarce, and is often blurred by the lack of consistency in the naming of the houses excavated simultaneously at the time. Very thorough

¹⁰ For a more detailed definition, see Conolly and Lake 2006: 11-15.

¹¹ See, almost a classical now, work of Gaffney and Stančić 1991.

¹² Conolly and Lake 2006: 291.

¹³ Fiorelli 1862: 329.

¹⁴ CIL X, 8058/69.

¹⁵ Jashemski 1993: 107. This name is also frequently used in its Italian form: Casa del Torello di Bronzo.

¹⁶ Fiorelli 1862: 337.

investigation of the history of excavations is presented by Thomas Staub.¹⁷ I would like to briefly present some important stages of the excavations here.

The front part of the house was excavated in 1836-1838.¹⁸ Since most work was focused more on removing the soil from the streets, the houses were given less attention. The excavators probably did not reach the peristyle. In this period the seal stamp mentioned above and the eponymous bronze bull statue were found.¹⁹

The rear part of the house with the peristyle was excavated later, in 1875.²⁰ Such a long period of inactivity in the house might have been caused by a small number and “poor” quality of the finds, contradictory to the contemporary approach, focused mainly on valuable “treasures”.²¹ Unfortunately, no documentation exists for these works. There is a short description by August Mau, but it hardly gives any details concerning the decorations or the impressive water installations present in this area.²²

Many traces of modern repairs can be seen in the house. Their number is so high that it would be pointless to list them all here. Such a list of all of the identifiable repairs was compiled by Thomas Staub.²³ Some interventions can be dated to Bourbon times, based on the technology used.²⁴ But many others show exquisite skills of the “all’ antichità” school of restoration²⁵, making the distinction between them and original parts extremely difficult and, in many cases, simply impossible.

Since 2000, the entire insula, along with the house V 1,7, is being studied by the Swedish Pompeii Project. It was initiated by the Swedish Institute in Rome²⁶ and from the beginning was directed by prof. Anne-Marie Leander Touati from Lund University²⁷ with collaborators from other research centers, mainly Stockholm University²⁸ and ISTI (Istituto di Scienza e Tecnologie dell’Informazione „A. Faedo”).²⁹ The aim of the project is mainly to thoroughly document the entire insula in order to fill in the voids in the existing documentation. In the scope

¹⁷ Staub 2013: 14-18.

¹⁸ Staub 2013: 14.

¹⁹ Fiorelli 1862: 329, 337.

²⁰ Staub 2013: 14.

²¹ Staub 2013: 14.

²² Mau 1876: 146, 148.

²³ Staub 2013: 199-201.

²⁴ Staub 2013: 18.

²⁵ Staub 2013: 18.

²⁶ <http://www.isvroma.it> (accessed 10.06.2014).

²⁷ <http://www.ark.lu.se/projekt/417> (accessed 10.06.2014). Lund University also hosts the Humanities Lab, which was taking part in the scanning of the insula during 2011-2012 field campaigns. Humanities Lab website: <http://www.humlab.lu.se> (accessed 10.06.2014).

²⁸ <http://www.archaeology.su.se> (accessed 10.06.2014).

²⁹ <http://www.isti.cnr.it> (accessed 10.06.2014). ISTI is a part of an Institute of the National Research Council of Italy. It also hosts the Visual Computing Lab, which was taking part in the scanning of the insula during 2011-2012 field campaigns. Visual Computing Lab website: <http://vcg.isti.cnr.it/index.php> (accessed 10.04.2014).

of the project, stratigraphic excavations were made in some parts of the insula, and the entire perimeter was cleaned and scanned.

History of reliability representations in virtual archaeology

The potential of VR technologies for archaeology was noticed a long time ago. Its first applications in the discipline were for virtual “reconstructions”, done mainly by computer graphic artists.³⁰ Nowadays, VR models are numerous. However, most of them are mainly focused on showing the complete interpretation of the site, without any additional information, e.g. the reliability of its different components. Several projects have already tried to solve this problem, and different solutions have been proposed and discussed in literature.³¹ The main issue was focused on ways of sharing the lack of knowledge with the scholars and a public. But the subject is fairly new, and there are new solutions appearing every year.

An interesting solution proposed by Kensek, Dodd and Cipolla concerns adding this information as a new layer using a color scheme (e.g. red-green scale), mixed opacity, a combination of both those indicators, or using different rendering types such as wireframe and texture.³² Other possibilities are to darken or lighten certain features³³ or to use variations in the thickness of the lines³⁴ in order to mark the variations in reliability. All these methods and attempts served to express the plausibility of different parts of the model. However, all of these examples share similar obstacles. The most severe of them is the impossibility to show both real-color textures and probability at the same time, but also a lack of a database with references used in the modelling process.

Data

Data can be divided into two sections: digital and traditional. The main source of data which the model was based on were the point clouds from scanning campaign made in 2011-2012 by the Swedish Pompeii Project.³⁵ The scans were created with phase shift laser scanners – Faro focus 3D for more delicate parts closer to ground, and Faro PHOTON 120 for the higher

³⁰ Frischer et al. 2002: 10-11.

³¹ E.g. Strothotte, Masuch, and Isenberg 1999, Kensek, Dodd, and Cipolla 2004, Pollini, Dodd, and Kensek 2006.

³² Kensek, Dodd, and Cipolla 2004: 178-179.

³³ Zuk, Carpendale, and Glanzman 2005.

³⁴ Strothotte, Masuch, and Isenberg 1999.

³⁵ Dell'Unto et al. 2013: 622.

parts.³⁶ Next, all the scans were aligned and joined in three bigger clusters using MeshLab. Then, point clouds were used to make a dense mesh.

Laser scanners provide very high-resolution point clouds, but they are not free of flaws. Being a tripod-based equipment, lasers are unable to scan features located directly beneath them. There are also rooms and corners which are too narrow for a laser scanner to be able to cover all areas. This is usually overcome by taking laser measurements from different positions, so that both scans are overlapping enough to cover the gaps. This sometimes requires many additional scans. Another problematic issue affects the data management. Since scans are done in such a high resolution, it is often difficult to handle the mesh, especially with older or less powerful computers. I decided to reduce the mesh resolution in order to save more computer memory for the modelling of the features. With today's technology, it seems more advisable to pursue a method which combines laser scanning with more flexible techniques, such as image-based modelling. Laser scanners are able to cover bigger areas in high resolution, whereas image-based modelling can be used to take series of pictures of features and details which are difficult to cover with the laser scanner.

I also used other, traditional sources such as books and articles. The greatest help for the modelling was surely the work of Thomas Staub³⁷, who has conducted a very thorough investigation of the house, and also provides many references. Also, consulting photos and engravings, both modern and old, proved to be fruitful. The problem is, that these pictures often are of a low quality, so that it is almost impossible to determine smaller features or details.

Methods

As I mentioned above, I built the virtual simulation of part of the house using the laser scanner acquisition realized in the frame of the Swedish Pompeii Project. My first step was to use MeshLab to prepare the model. Then I used Autodesk 3DStudio Max to model the missing parts and texturize them. Simultaneously with the modelling, I was consulting the book of Thomas Staub³⁸ and references mentioned there, as well as the author himself, who provided some solutions to certain problems concerning Roman architecture and decorations. In some cases I also used other sources, such as comparisons between certain features in this house with similar ones in other houses.

³⁶ Dell'Unto et al. 2013: 622.

³⁷ Staub 2013.

³⁸ Staub 2013.

After the modelling, I exported the model into ArcGIS, where I georeferenced it. Furthermore, in ArcGIS, I used editing tool to create a new Shapefile layer with the database containing the references related to the features in the model.

CHAPTER 2. THEORETICAL PERSPECTIVE

Within this thesis, I would like to focus on the theoretical issues concerning the virtual “reconstructions”. Some of the remarks can also be applied to any archaeological “reconstructions”, but virtual solutions are – in my opinion – more flexible and worth developing. In this work, I will use the solutions already developed – a probability map with the green-red color scale describing the certitude about each part, but also I would like to introduce a new quality to it – the possibility to import the model into 3D GIS, and adding a database which will show the reasoning for the modelling of each part.

Probability map

As Kensek et al. points out, there are three main types of restoration.³⁹ The first is filling the gaps so that they are indistinguishable from the original. The other is the so-called 10-in rule: the restoration is done in such a way, that it gives the sense of the whole when the viewer is at some distance, but the additions are visible when approaching. The last solution is to fill the losses with unicolor pieces. But these are applicable for the material culture, not virtual. In VR, we have the possibility to tear down and build again as many times as we desire – without any deterioration of virtual ruins. Because of that, we can say that the types presented above are in fact three *steps* of 3D modelling⁴⁰: firstly, we build the missing geometry in a uniform color. Then, we add a realistic texture where possible. Depending on the aim, we can fill the gaps with a realistic texture or its more distinguishable alternative.⁴¹ No physical material can present the certitude that lies behind the restored parts without a ridiculous motley look. Virtual reality can do that, through the probability map.

³⁹ Kensek, Dodd, and Cipolla 2004: 177.

⁴⁰ Cf. fig. 02.

⁴¹ E.g. Frischer and Stinson 2007.

There is no clear definition of what a probability map is, although there are many works that apply this solution to their models. The reason for that is, in my opinion, that it is a fairly new subject, and it is still more of a show than a science. A laconic notice that a probability map is “nothing more than the mathematical representation of a hypothesis”⁴² does not exhaust the topic. The London Charter notices, that

(...) the outcomes of research that include computer-based visualization should accurately convey to users the status of the knowledge that they represent, such as distinctions between evidence and hypothesis, and *between different levels of probability*.⁴³

This is a clear reference to the probability map – however, it is not discussed broader, most likely because a probability map is a very unclear term. Still, it is a very important notice. To begin with, I should say, very vaguely, that the probability used in archaeology is not a probability at all. The classical definition of a probability, as stated by Pierre-Simone Laplace, is as follows:

The probability of an event is the ratio of the number of cases favorable to it, to the number of all cases possible when nothing leads us to expect that any one of these cases should occur more than any other, which renders them, for us, equally possible.⁴⁴

The definition of probability assumes that the number of all possible cases is known. Unfortunately, we cannot hope for that in our discipline. Thus, *probability* is not a word we should use. In some cases, words such as *uncertainty*⁴⁵ and *confidence*⁴⁶ were used instead. Uncertainty is a misleading word: an uncertainty map shows the level of our certitude, or incertitude. This is very confusing, whereas confidence, in my opinion, is too close to actually believe and have faith in something (probably in the archaeological knowledge of the archaeologist).

The most suitable word could be *plausibility*. It is a more “humanistic” equivalent of the word *probability*. It states the possibility of an event to occur, but the chance for it is not calculated by any mathematical formula. I think that in future implementation *plausibility map* should be forced as a standard nomenclature. However, as I stated before⁴⁷, the introduction of a new terminology is not within the scope of this thesis. Under those circumstances, I would like to use this unfortunate *probability map*, but to do so, the term requires proper definition. Thus, a probability map should be understood as additional information to the virtual visualization, one that indicates the level of the researchers certitude in his knowledge about how each of the

⁴² Barceló and Pallares 1998: 67.

⁴³ London Charter: Preamble. My emphasis.

⁴⁴ Jaynes and Bretthorst 2003: 43.

⁴⁵ Strothotte, Masuch, and Isenberg 1999, Zuk, Carpendale, and Glanzman 2005.

⁴⁶ Kensek, Dodd, and Cipolla 2004.

⁴⁷ See **Definitions** section in chapter 1.

individual features looked like. It has not much to do with the “objective” past Roman world, but rather with our ideal imaginations that we have about it. The goal is not only to provide a “pretty picture” (this is something that everybody seeks, regardless of what they claim), but also to collect information about all the features and visualize it in as high a quality as technology allows us to.⁴⁸ Obviously, not being sure about details most often results in producing many versions of the same feature. In that case, the main structure of the building usually does not change substantially, but the decorative details will.⁴⁹ Sometimes, uncertainty can also be presented as a multi-choice interactive platform, where a user is allowed to make adjustments. Similarly, these changes do not alternate the main body of a building, but the finished elements, such as shape of columns etc.⁵⁰ Whatever version we choose, it is only a single and truncated simulation of the possible past, when exact antiquity is unreachable.⁵¹

The main problem of all those applications, regardless of the form, remains the same: we might be very sure, but still completely wrong.⁵² Some of the researches at this point are turning back to the processual methods, like using mathematical formulas to calculate the probability.⁵³ But this falls again under the critique common for all the mathematical applications in archaeology – to calculate anything, you need to have high quality data and – in best case – the finite total number. Both are impossible to achieve in our discipline.

Nevertheless, these inquiries are necessary. The “reconstructions” which are produced in such abundance nowadays, mostly lack any reflexivity and their sole purpose is to produce the photorealistic renderings of the “past places”. For 3D archaeological models to be presented in such a form, the information they are based on must be real, and by real I mean that each element should have a reliable equivalent in reality. If, in the model, the roof is presented as equally “real” as the floor, that means that the researcher had similarly solid data for both. Thus, in order to have a full model (an entire room, for example), we should have a full set of data. And that is impossible, given that what we unearth is only small percent of the past civilization. The illusion of a “lost world”, ready to be properly dug up, documented and restored, is long gone. If we are going to support the idea that there is no objectivity in archaeology, our models should not pretend to be so. The model, if it was standing in the museum without any other information, would definitely be a glaring example of hypocrisy. It would mean that archaeologist

⁴⁸ Pletinckx 2012: 203.

⁴⁹ E.g. Pollini, Dodd, and Kensek 2006.

⁵⁰ E.g. Kensek, Dodd, and Cipolla 2004.

⁵¹ Kensek, Dodd, and Cipolla 2004: 176.

⁵² Clark 2010: 70.

⁵³ E.g. Sifniotis 2012.

had proof for each and every element in this puzzle, and every feature s/he have built is exactly as it was, as if there was no bias in the very person of the archaeologist.

I would like to further develop the probability map which I defined above by adding metadata in 3D GIS. This will list all the references to each of the features, thus having a kind of bibliography for all the elements. I hope that a model in this form will create a space for unrestricted discussion about the quality of data used, and substantive issues – both within the theoretical and historical frames.

The next chapter will present the paradata of the model, which is a very important issue to take into consideration. The London Charter states that paradata is

Information about human processes of understanding and interpretation of data objects. Examples of paradata include descriptions stored within a structured dataset of how evidence was used to interpret an artefact, or a comment on methodological premises within a research publication. It is closely related, but somewhat different in emphasis, to “contextual metadata”, which tend to communicate interpretations of an artefact or collection, rather than the process through which one or more artefacts were processed or interpreted.⁵⁴

This is crucial for any model that claims to be scientific. It is also difficult to discuss the results if the reader does not know how the data was used.⁵⁵ In each experiment, what happens between an input and output is equally important as the end result. That is why the London Charter put such a heavy emphasis on that.

Applications of the probability map

Since almost each of the applications in this field is different from the other, I took the liberty of presenting the history of the research problematically, and not chronologically. As I mentioned before, most of the virtual “reconstructions” are just that – they are presenting how an ancient feature looked like. In this case, the most important aspect is how realistic the model is. In some cases, they also provide paradata.

Almost from the beginning of virtual reality its importance for archaeology was noticed. Already in 1997 a book was issued, a sort of catalogue of archaeological models.⁵⁶ Sadly, there was no information about the plausibility of their parts. These early applications were more of a playfield for computer graphists, not always consulting archaeologists.

⁵⁴ London Charter: Definitions.

⁵⁵ Bentkowska-Kafel and Denard 2012: 1-2.

⁵⁶ Forte and Siliotti 1997.

One of the applications of uncertainty is to make multiple models of the same object. Usually, it is used for making comparisons between theories.⁵⁷ It is a good application, because sometimes it is difficult to discuss the details without properly assessing them within a broader context. However, it is very time consuming since it requires to model new features from the beginning.

The necessity of creating new models can be omitted by using a multi-choice solution. As in case with Mausoleum of Augustus⁵⁸ or Sanctuary of the Great Aten Temple at Amarna⁵⁹, the Virtual Reconstruction Console⁶⁰ was created. VRC is based on a simple interface that allows the user to choose different versions of elements, e.g. top figure on the monument, or different capitals of the column. Each element is accompanied with the archaeological documentation, and software calculates the overall possibility for the features. It is a very good solution – however, there are only few limited versions of the model available, which I consider to be a major flaw.

With the applications that use probability map in a sense mentioned above⁶¹, these are the three main applications of the probability in archaeological “reconstructions”. There are also many others, such as the model of the Casa di Caecilius Iucundus (V.1.26)⁶², which is noticeable due to the applied methodology. The process of modelling lost features was broken up into several sections such as comparisons, deduction, testimony, etc. I would like to return to this in the latter part of my work concerning the probability map I prepared for Casa del Torello di Bronzo.

The methodological and theoretical fields of a virtual modelling (not only the simulations, but also documentation of excavations) are developing very rapidly, and it is not easy to keep track of them. It is not in the scope of this work to discuss them all, but perhaps someone should attempt to compile a good, systematic review of the works done so far, similar to what has been done for the aspects of paradata in the volume edited by Bentkowska-Kafel, Denard and Baker.⁶³ This thesis can be one of them, since it shows in a clear way the entire research process, which can be reproduced and applied in other case studies.

⁵⁷ Cargill 2009.

⁵⁸ Pollini, Dodd, and Kensek 2006.

⁵⁹ Kensek, Dodd, and Cipolla 2004.

⁶⁰ In short: VRC.

⁶¹ E. g. Pletinckx 2012, Sterckx 2007.

⁶² Dell'Unto et al. 2013.

⁶³ Bentkowska-Kafel, Denard, and Baker 2012.

Sharing uncertainty with the public

There is an ethical issue to the virtual simulations – how they should be presented to the public. Is the public even interested to know that? Maybe the information we want to share is not the information they want to know – after all, archaeology is not a mass product that can be adjusted to the market. We have an obligation to present the results of our investigations to the public, and from this point it is no longer up to us if people accept the form of presenting the results or not.

Nowadays the humanities sector is facing a strong crisis⁶⁴, and what people want are easy answers - just wrapped in a new technology. With the technology being so advanced, museums still do not want to change their policy about the data presented, and very often the only uncertainty highlighted in the museums are question marks close by the name or date on the description plate. If the archaeologists want to stay honest with the public, this attitude should change. I would also advocate for a closer collaboration between the archaeologists that provide the material and knowledge for the museums, and the museum staff. This bond had been broken when archaeology understood as “collecting antiquities” ended, and should be reestablished in order for the museums to gain a deeper understanding of the material given to them.

3D GIS and probability map

Archaeologists in their reports very often use the words like “probably”, “possibly”, “highly possible” in a faint attempt to ease their conscience, since it is impossible to know everything about the site. Nowadays, visualization instruments such as GIS allow for a strong control over the data, increasing the chances of the archaeologists to achieve a broader view of the site, and not exclusively from the “map perspective”.

3D GIS has turned out to be revolutionary for the archaeological methodology and theory. Still in 2006, Conolly and Lake were claiming that the “truly analytical three-dimensional GIS remains an elusive target”.⁶⁵ The limitations of a two-dimensionality had caused the research to focus either on the mapping and processual analyses, such as predictive modelling⁶⁶, or on more individual-oriented implementations, like visibility analysis.⁶⁷ With the introduction of a fully operative 3D GIS, the simple division of GIS applications described by Lock became too

⁶⁴ *The New York Times*.

⁶⁵ Conolly and Lake 2006: 38.

⁶⁶ See e.g. Verhagen 2007.

⁶⁷ Smith and Cochrane 2011.

simplistic⁶⁸ - the borders between PaleoGIS with its objective measurements, and GIS₂ oriented on the individual's experience, have become blurred. In my opinion, the implementations of 3D GIS in archaeology are beyond this processual and post-processual dichotomy and beyond the theoretical perspective of the two-dimensional GIS.

Differently from VR, a GIS allows the connection and visualization of different nature in the same space. In this thesis, I would like to combine this capability of the GIS to link the information with an archaeological process of interpretation. Through the use of 3D GIS I would like to link a specific part of my model with a textual information reporting an explanation of why the specific parts have been modelled in such way. This has not been done before, and I want to prove that this implementation can be useful and replicable in future studies.

It is possible to perform a variety of other analyses in GIS as well, which non-GIS software cannot manage – for example, examining the angles of the walls through the slope analysis. These functions have not been fully explored yet, but certainly extend beyond the methodology and theory developed for the two-dimensional GIS so far and, as such, require more study. Each new implementation should be properly discussed though, in order to avoid the dichotomy between the archaeological theory and practice, which was a big concern in the two-dimensional GIS⁶⁹, where the initial excitement about the new technology has clouded the reflexivity of the researchers.

Summary

As I presented in this chapter, there are many questions that need to be addressed properly by scholars. The probability map is a solution only to one of many issues in the wider problem of communicating the archaeological knowledge, especially nowadays when the technological media play more important role than traditional ones. The use of 3D modelling and 3D GIS is a step ahead towards the next generations. We already know how to use it now, but they will learn more. It is important to show them these new ways, because that will stimulate them to take it further than we dared. In the next chapter, I will describe in details the modelling process in 3DStudio Max, and the creation of probability map, so that the workflow can be followed and applied in other projects.

⁶⁸ Lock 2001.

⁶⁹ Lock 2001: 160-161.

CHAPTER 3. MODEL

The construction of the model has been a very long process. During the development of the 3D model, I tried to keep some of its elements⁷⁰ “as culturally neutral as possible”. I am aware that this is a pure oxymoron, since no scholar can escape from the culture s/he is anchored to. By using that phrase, however, I wanted to indicate that I did not give those elements any details characteristic for any specific period – rather, I wanted to give a general recognizable idea of an element. For example, with the creation of the water tap, modelling all the details of an original one in three dimensions would be very time consuming and beyond the scope of this work. I decided instead to adopt a modelling style capable to provide a general recognizable idea of the single elements, but not any details that would shift the viewer’s focus away from the other, more important, features within the room.

Once realized, the model has been rendered using V-Ray Plug-in for 3DStudio Max. V-Ray is a powerful rendering engine that uses advanced techniques to compute images characterized by photorealistic lighting effects. The use of this technique has been necessary for the full understanding of the visual functions of the peristyle and the garden. Photorealism allowed perceiving details such as for example shiny objects (like glass and water), which create the interplay of light with all the other elements. 3D models are very similar to the real models usually employed in the experimental archaeology museums – if there is a weak spot, like a poor quality painting (or sneakers on prehistoric hunter’s feet), it will draw the focus of an audience. Consequently, finding soft spots will be turning the attention away from the important elements. That is also the reason why I expanded the model from the originally targeted garden area to the entire room.

Data preparation

The starting data for the virtual “reconstruction” was the 3D model of the house V 1,7. The point cloud was obtained during the 3D acquisition campaign in 2011 performed by the members of Swedish Pompeii Project in collaboration with Visual Computing Lab⁷¹ and Humanities Lab⁷², within the sub-project called Pompeii Revived. Each of the rooms was scanned with either Faro Focus 3D (for more complex areas) or Faro PHOTON 120 (for other areas) laser scanners.⁷³ After their acquisition, all scans were cleaned and aligned using MeshLab⁷⁴,

⁷⁰ Because of the stylistic reasons, I use the words *elements* and *features* interchangeably.

⁷¹ Visual Computer Lab is a part of the National Research Council of Italy. For the website link, see footnote 29.

⁷² Humanities Lab is part of the Lund University. For the website link, see footnote 27.

⁷³ Dell'Unto et al. 2013: 622.

in order to obtain a full model of the house. For the purpose of this study and the fluency in the work of the software, I lowered the level of detail of the original model generated by the use of the laser scanner. I focused only on the peristyle area, in order to be able to further develop it in 3DStudio Max.⁷⁵ Using this software, I generated the interpretation model, employing simple geometry and modifiers to create new polygons.

In order to define the color information (textures) to apply on the model, I used the digital documentation available on the Swedish Pompeii Project website, as well as photos provided by Dr Staub, together with old documentation (engravings, photos, texts and such). The colors were reconstructed using Adobe Photoshop CS4.⁷⁶ In some instances, I used textures from the CG Textures website.⁷⁷ Once completed, the textures were imported into 3DStudio Max. There, they were transformed into materials, and then assigned to the corresponding polygons. The entire process is presented in fig. 02.



Fig. 02. Workflow of the modelling: mesh realized after the acquisition campaign (left), modelled geometry (middle) and geometry complete with the textures (right) (M. Perlińska).

⁷⁴ <http://meshlab.sourceforge.net> (accessed 10.06.2014).

⁷⁵ <http://www.autodesk.com/products/autodesk-3ds-max/overview> (accessed 10.06.2014).

⁷⁶ <http://www.adobe.com/products/photoshop.html> (accessed 10.06.2014).

⁷⁷ <http://www.cgtextures.com> (accessed 10.06.2014).

Once the model was completed, I assigned different levels of reliability to the polygons (see below) in order to create a map in 3DStudio Max that could display the level of reliability of my simulation. At the beginning, I was planning to perform this operation using ArcGIS. However, I came to the conclusion that it is an unnecessary and time-consuming enterprise, as it is far more difficult to draw complex 3D features in ArcGIS than in 3DStudio Max. Therefore, I decided to prepare the probability map in 3DStudio Max, and then export both models (i.e. one model with the textures and the other with the probability map) into ArcGIS as separate layers and, finally, link a database to these 3D information.

In the frame of this work I defined four levels of confidence, which are similar to the ones adopted for the creation of the model of the southern house of Caecilius Iucundus (V 1,26).⁷⁸ They are organized in a sequence, i.e. from the most reliable one, towards less reliable. When possible, I tried to apply them in that order – I used the remains where I could, and where it was not possible, I used the old documentation, etc. These different levels finally helped me to create a probability map. For this thesis, the levels have been defined as follow:

- 1) remains that were preserved at the time of the scanning, along with the documentation compiled by the Swedish Pompeii Project;
- 2) features that were still seen and are mentioned in earlier sources, such as old engravings, photos, descriptions and so on;
- 3) features which are lost, but whose existence can be assumed by the logic of space and some remains such as columns, doors, etc., which can be modelled by comparisons with similar features still existing in this house or in other houses;
- 4) features which existence is undeniable, but whose exact appearance is lost and which can hardly be compared to features in other houses, such as the glass shreds used in the mosaics, water outlets, etc.; in those cases I tried to follow the suggestions of Dr Staub.

Sources

I used quite an array of different sources, but there are four that I would specifically like to mention here, either because of the important part they have played in the modelling, or because of the limitations of their usability. The source that I used most frequently was the PhD dissertation of Thomas Staub.⁷⁹ It is, by far, the most detailed documentation of the entire house V 1,7, with many references to further literature on the subject. It also contains a Gazetteer with

⁷⁸ Dell'Unto et al. 2013: 624-625.

⁷⁹ Staub 2013.

measurements of every detail of the peristyle, which proved to be helpful in many occasions. The dissertation can be considered as a source for reliability on levels 1, 2 and 3, since it contains photographs of the present day state of the ruins, but also references to older documentation and some indications related to the logic of space mentioned above.

The next frequently used source is an article written by Espen Andersson.⁸⁰ The article is focused on the fountains in the house V 1,7. The author also argues for the use of the peristyle area as a summer *triclinium* and provides a “reconstructive” drawing reflecting this proposition.⁸¹ This idea has been criticized, mostly because of the small dimensions of the garden. If there had been wooden benches, as Andersson suggests, there would not have been any space left for the plants, thus the area would have been unpleasant to the eyes of visitors and residents alike.⁸² I assigned the “reconstruction” drawing as the lowest probability level, but nevertheless, I used some of the features presented there for the modelling. The entire article is over twenty years old, so I ranged it as a part of the older documentation, therefore all features modelled on the basis of this article (mainly on the drawing) were given the probability level 2.

A source which I could not use often, but still is worth mentioning, are the old photographs from the first half of the 20th century. They are in surprisingly good quality, made by the Fratelli Alinari which is one of the oldest companies that deal with photography.⁸³ Unfortunately, only one picture shows the peristyle area. I used the photo to model the gutter corners, and as a part of an old documentation I gave it the probability level 2.

Another source I would have liked to use for the architecture is the famous cork model of the unearthed city, commissioned by Giuseppe Fiorelli in the later 19th century. It was – and still is – an astonishing documentation of the architectures and decorations. Unfortunately, the cork model of the house V 1,7 has numerous mistakes that undermines its credibility. The most striking one is the lack of the marble fountain basin framed by tufa blocks. Also, the *tablinum* fountain walls are facing in the wrong direction. Those observations alone are sufficient not to consider the cork model as a reliable source of data.

View axes

The peristyle area also served as an eye catcher for visitors. There are two view axes leading towards and through the room. The first one is a long view axis, very common in Roman houses: from the entrance, through several rooms in a row (that the owner could either open or close)

⁸⁰ Andersson 1990.

⁸¹ Andersson 1990: 227.

⁸² Cf. Staub 2013: 37.

⁸³ <http://www.alinariarchives.it> (accessed 10.06.2014).

towards the rear parts of the residence. In the house V 1,7, this axis ran from room 3 (*fauces*, see plan in fig. 01), through the atrium (room 4), then *tablinum* (room 13) and between the *tablinum* fountains⁸⁴ into the peristyle. In this axis, the viewer saw a part of the *nymphaeum* wall as a kind of a picture, framed by the *tablinum* fountains.

The other view axis was much shorter, but provided an equally important background for the meeting, held in room g. People gathered in this large dining and reception room would have a look on the garden through the *cenatio* fountain, which – as in the view axis presented above – were framing this view.⁸⁵ The viewing axes are shown below in figs. 16-17.

Nymphaeum wall

The most important part of the model, that draws attention and constitutes an essential part of the room, is the *nymphaeum* wall (fig. 03).



Fig. 03. *Nymphaeum* wall before and after the modelling (M. Perlińska).

Its main features are three niches crowned with tympanum and – in one case – an arch. Each niche contained a water nozzle. The two lateral niches show stairs and small mosaics, the central one contains a plastered rectangular feature. The *nymphaeum* wall is on both sides framed by the pillars. Each pillar has a stuccoed capital and paintings depicting bunches of palm leaves

⁸⁴ For the fountains' names, see below the section **Description of the modelled parts**.

⁸⁵ Whether an eye catching painting was situated at the rear wall of this axis cannot be determined anymore.

with a *tondo* in the uppermost part. On the two central pillars, separating the middle niche from the lateral ones, the paintings showed statues of nymphs, holding a bowl of water – also with *tondi* above. Complicated mosaic panels are placed under each niche, separating these from the rim of the basin. Because of the importance that the mosaics have in the overall aesthetic reception of the room, I will discuss them separately in the following section.

Description of the modelled parts

I have decided to divide this part into several sections – architectural elements (based on the remains), finishing components (which were not preserved on the scan), decoration (paintings and the floor), mosaics (a separate section because of its complicated modelling), roof, water and garden. With so many fountains, it is laborious to describe them every time I mention them. That is why I have named them, hoping that this terminology – as happened so many times in archaeology – will not confuse the reader:

- *tablinum fountain* – two tall additions to the *intercolumnium* in front of the *tablinum* **13**, with small niches in the middle of their two facing sides; from those niches nozzles were spreading water into two cylinder-shaped vessels (sometimes incorrectly identified as *puteoli*⁸⁶); the water spilled over the rims and fell into the gutter;
- *cenatio fountain* – two small additions to the *intercolumnium* in front of room **g**, both equipped with water jets facing each other, that spread the water onto the floor, from where it fell into the gutter;
- *marble fountain* – the fountain situated in the middle of the peristyle, spreading water from the outlet in the center of the marble basin, surrounded by large tufa blocks; probably, the bright whiteness of the polished marble enhanced by the water must have contrasted nicely with the roughness of the dark tufa blocks⁸⁷;
- *mosaic fountains* – three water jets, situated in the niches of the *nymphaeum*; the lateral ones had small stairs along which the water ran down before spilling into the big basin in front of the *nymphaeum* wall; the middle one had a jet from a plastered rectangular feature, with no stairs;
- *rim fountains* – the row of water jets, constituting an astonishing row of at least 14 water spouts inserted into the rim of the basin, were sprouting water into the *nymphaeum* basin;

⁸⁶ Pernice 1932, in: Andersson 1990: 218.

⁸⁷ Thomas Staub, personal communication.

- *domestic water tap* – a small water tap installed on the column in the SE part of the room; it was probably used as a water supply for the domestic appliances, as shown in Andersson.⁸⁸

Most of the geometry was constructed on the base of scanned data – in those cases, new polygons were created on top of it to simplify the mesh from the scanning. In that case, I indicate in the text that no changes were made.

Architectural elements

Most of the basic geometry is preserved on the scans. Even if parts of it are modern repairs, these are integrated into the model. Since none of these modern repairs seem to stand in bright contrast with the overall aesthetics of the room (except for the shelter built over the *nymphaeum* wall), I assumed that they can be reliable as a geometry source.

The walls are preserved at least up to the upper part of the doors in all cases. Since in some instances the height of the door opening cannot be determined, two different door heights were used. All the wide openings were given the one height (ca. 3.2m⁸⁹) and all the smaller openings were given the same height as the opening in the middle of the west wall, leading to the corridor **h1** (2.2m⁹⁰).

Concerning the columns, the remaining parts enable a restoration of the entire shafts, as well as the capital, made in a simple Tuscan style.⁹¹ Although some of the columns show traces of canelure⁹², they were all covered with a white painted plaster during the last building phase.

The *tablinum* and the *cenatio* fountains are based on the remains. Almost no elements had to be added to the *tablinum* fountain, whereas the northern part of the *cenatio* fountain had to be copied from its southern equivalent, because of its bad state of preservation. The *tablinum* fountain vessels and stone plates were in a good overall condition. The eastern vessel was moved to the center of the plate – perhaps it had fallen over at the time of the excavations, and someone put it back in the wrong position. The cistern mouth in the eastern portico was not changed.

The gutter was in quite good shape, its strictly utilitarian purpose makes it easy to recognize its layout. The southern corners of the gutter, which are wider (for the water that was coming from the roof corners and was more likely to damage the garden if not secured in

⁸⁸ Andersson 1990: 218.

⁸⁹ Staub 2013: 161.

⁹⁰ Staub 2013: 163.

⁹¹ Cf. Curl 2006.

⁹² Staub 2013: 164.

that way), were based mostly on the photo made by Alinari⁹³, since Anderson gives the corner a bit different shape than it can be seen on the photograph. The search for the water distribution pipes caused much distortion of the ground of the garden area. I leveled everything to a uniform height.

The *nymphaeum* basin was in a very good shape, but the two cylindrical shafts placed inside were poorly preserved. Although the diameter of these can be determined, the exact height is unknown. I decided to give them the same height as the rim of the basin – in this way, anything that could have been placed on top of it, would not obscure the paintings depicting nymphs on the *nymphaeum* pillars, but still remained visible over the rim.

The *nymphaeum* wall was partially repaired in modern times. The overall shape of the niches and tympanons can still be determined. The western tympanon is a modern restoration, and it evidently lacks the subtle details of *cyma reversa* that the eastern one shows. I decided to take the western one as a reference and copied it over above the eastern niche. The middle niche was crowned by an arch, but it is so badly preserved that only bricks remained, showing its shape. Even they were covered by restoration plaster in 1920s-1930s, as visible on the Alinari photograph.⁹⁴ I used *bevel profile* modifier to assign the same cross-section as the tympanons have on the entire outline of the arch.

The steps inside the lateral niches are based on the remains⁹⁵ and the “reconstructive” drawing.⁹⁶ The middle niche preserves remains of a marble plate that once might have been the base for a statue. Since we have no knowledge about what that hypothetical statue might have represented, I made no attempt to model it. Because it is an essential part and the main point of the view axes, and any statue that I placed there would significantly change the perception of the *nymphaeum*, I decided to leave it blank. The plastered rectangular feature behind it, which was based on the same sources as the steps, could have had a double function: as an outlet for the fountain jet (or, perhaps, the statue itself could have served as such), and as a background for this statue.

A fairly well preserved stucco capital adorns one of the niches. It shows a lotus flower framed by two leaves, a fairly popular motive. The opposite side of the niche was probably embellished by an equivalent capital. Their existence can also be assumed for the other niches, probably adorning both the insides and the front side. In this way it forms an ensemble – a pillar, which is recognizable both from the front and from the sides, as a kind of illusion effect. An illusion was highly appreciated in Roman world – often seen, as in this case, with painted

⁹³ Alinari Archives.

⁹⁴ Alinari Archives.

⁹⁵ Staub 2013: 168-169.

⁹⁶ Andersson 1990: 227.

marble imitations, painted fake architecture, and vivid garden paintings, all designed to delude and/or impress the spectator.

The marble basin and its tufa border are unchanged – its state of preservation was very good.

Finishing components

I added some features that were not preserved. In most of the cases there was some kind of evidence that would indicate the existence of those elements, even if those features might have looked slightly different than they do in my model.

Traces of iron were preserved on some of the columns. These traces were either situated in the lower part of the column (on slightly differing heights, approx. 0.6m) or in the upper parts (on differing heights, approx. 2m).⁹⁷ Based on comparison material from other Pompeian houses, the lower nails were probably serving as a support for some kind of feature that separated the garden area inside the peristyle from the rest of the room. It might have been a wooden fence – an element frequently displayed on wall paintings.⁹⁸ I used a fence with a similar design as that from the fresco on the wall of the *nymphaeum* basin. In this way, it creates a 3D continuation of the motive presented on the fresco.

The iron traces on the upper part of the columns are more difficult to identify. But once again, when comparing with very popular motifs from wall paintings⁹⁹, these traces could be interpreted as remains of nails on which garlands could be attached. To model them, I used PArray geometry: I created an area that is filled with a constant number of leaves, which are assigned with a random direction (fig. 04).

⁹⁷ Staub 2013: 163-166.

⁹⁸ E.g. paintings from VI 17,42 (House of the Wedding of Alexander), VII 16,22 (House of Fabius Rufus).

⁹⁹ E.g. paintings from I 9,5 (House of the Fruit Orchard), VI 14,20 (House of Orpheus).

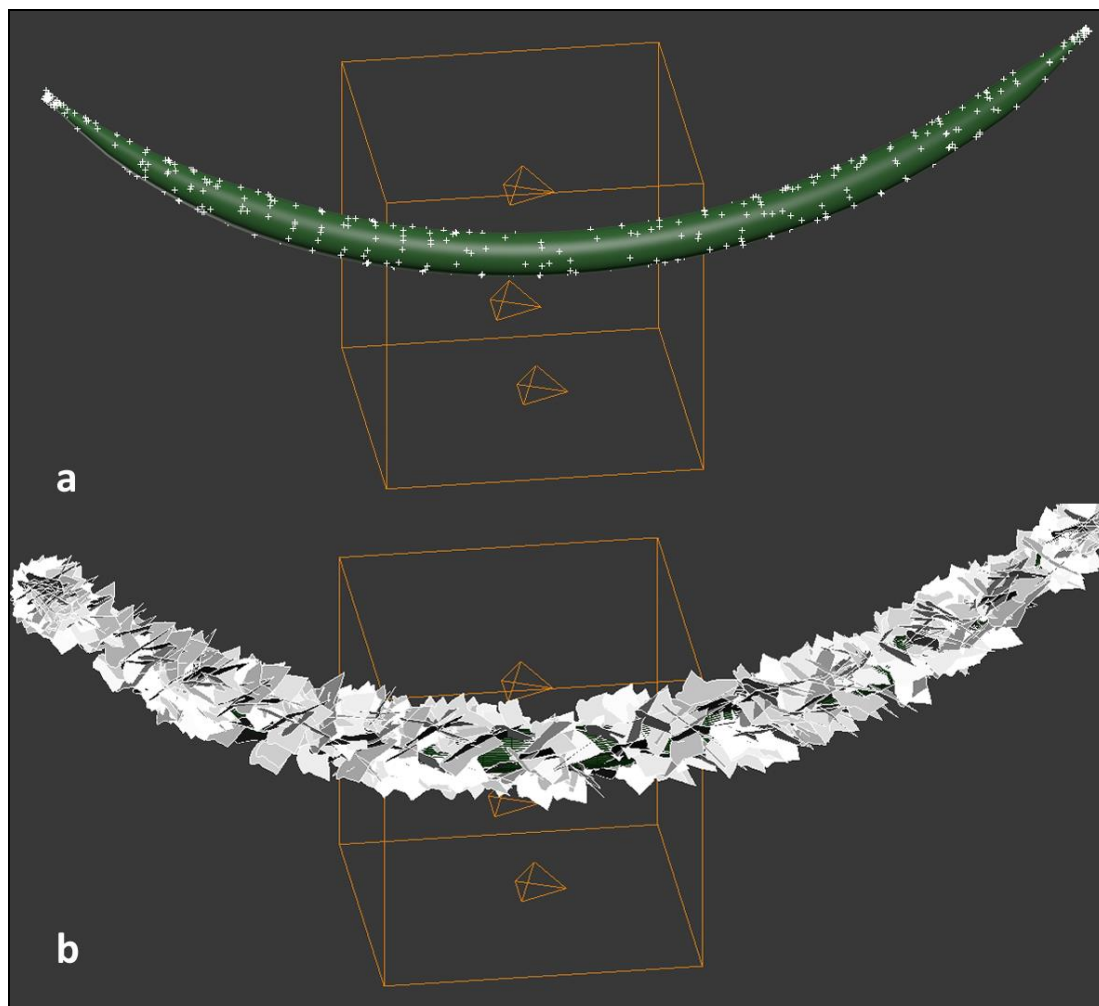


Fig. 04. Garland modelled in 3DStudio Max as particles (a) and as a mesh (b) (M. Perlińska).

I used ivy leaves texture for the garlands, since it is neutral and fits together with the wall paintings. I also created *pelta*-formed *oscilla*, which are marble (or sometimes metal) pendants in the shape of a crescent moon, which were hanging between the garlands; a motive that occurs often in Pompeian houses, especially on wall paintings.¹⁰⁰ Two of the *oscilla*, which hang in the *intercolumnia* probably lacking garlands, are bigger and round – a feature also present in the Roman houses.¹⁰¹

I modelled the water tap for the outlet serving utilitarian means. There is a wide variety of shapes of those devices, and I tried to keep it as culturally neutral as possible. It is very probable that the water tap had an entirely different shape.

Concerning the remains in the basin in front of the *nymphaeum* wall, there were probably two statues adorning the two cylindrical pedestals. We cannot say what they were depicting, so Staub suggested to create bronze pine cones, which are slightly more neutral than human

¹⁰⁰ E.g. paintings from VI 14,20 (House of Orpheus), VI 17,42 (House of the Wedding of Alexander).

¹⁰¹ E.g. “reconstructed” garden from VI 16,7 (House of the Golden Cupids).

figures, in a sense that they do not have a “front” part, and are very symmetrical. Also, they are not drawing such attention as figurative statues would.

There are many openings in the room **b**, which led to the other parts of the house. Some of them have marble thresholds. Probably some openings had curtains and some doors. For the sake of visualization, I decided to close all those openings with doors. In this way, there are neither black holes that draw attention, nor white bare scans of further rooms visible, thus the viewer will be able to focus solely on the peristyle.

There are two openings in the ground: one giving access to the water distribution box near the atrium fountain, and the other to the entrance to the small cellar located in the NW corner of the room. Since both must have had closing facilities for security reason, I covered them with the simple wooden lids. Again, as with many other features, I tried not to give them a too distinctive design that would draw the attention of the viewer – they are made of simple planks with a small bronze ring (serving as a handle) at the top.

Decorations

Once more I start this part with a description of the elements with higher plausibility, and then proceed with the more uncertain ones. The most obvious decorations, of which remains can be seen today, are the frescoes on the *nymphaeum* wall – mainly, the ones on the rim of the basin, as well as the faint traces of paintings on the pillars and some painted marble imitations. I tried to use the remains as much as possible, but in some cases it was easier and clearer to just use new elements.

The most problematic decoration, and probably one of the most problematic elements of the entire model, was the fresco of birds and plants enclosed by fences that adorns the rim of the basin. The remains are so faded, that it was not possible to determine the plant and bird species. What can be seen today, is shown in fig. 05.



Fig. 05. Remains of the fresco on the rim of the nymphaeum basin; scale: height ca. 50cm (editing: M. Perlińska, original photos: T. Staub).

With this level of deterioration, it was only possible to retrieve the general shape of the fence and some parts with plants and birds. I decided to use preserved parts of frescoes from other paintings where I could, and fill the rest with photo editor brush. The final result is shown in fig. 06. I deliberately did not use the guidelines proposed by Frischer and Stinson¹⁰², who stated that the fillings in frescoes used in VR modelling should be made in a manner that is distinguishable from the original parts. In this case, including existing deteriorated fragments would only make the scene unrecognizable, especially when taking into consideration the size of the fresco.



Fig. 06. Texture showing the basin fresco, used in the VR model; same scale as in fig. 05 (M. Perlińska).

This texture is not astonishing, and it was not meant to be. The fresco is very small in the model and it is not easily accessed, so the level of details did not have to be high (and it would have been impossible to make them so). It is useful, and it is used in the model in the same manner as the mosaics – some details are lacking, but it is situated where it is supposed to be (based on the available evidence), and it gives the impression about how it could have affected the viewer in antiquity. This fresco is very important for the proper reception of the garden. It is small, yet crucial – it creates a barrier of the garden because of its painted fence, but at the same time it creates the extension of the green area, by luring the spectator with painted flowers and worlds “beyond” the fence.

The inner side of the basin was – surprisingly – painted red (I was expecting it to be painted blue, as it is the case with other basins in the vicinity). The inside walls were protected by a very light reddish hydraulic mortar which was not painted over with any color. It was preventing the water from penetrating into the walls of the basin and destroying frescoes.

The next elements presented here are the paintings depicting two nymph statues on pedestals, holding water bowls and placed symmetrically on the two middle pillars of the *nymphaeum* wall. It is a fairly common motive in Pompeian wall painting.¹⁰³ Unfortunately, today it is almost impossible to detect any traces of these paintings, and the only documentation we have comes from the early 20th century watercolor made by Luigi Bazzani.¹⁰⁴ The painting is quite precise, but it falsifies the original colors of the fresco. In this situation, I decided to use

¹⁰² Frischer and Stinson 2007.

¹⁰³ E.g. paintings from VI 1,7 (House of the Vestals), VI 2,4 (House of Sallust).

¹⁰⁴ Scagliarini, Coralini, and Helg 2013: 116.

the nymph depicted in the house VI 2,4 (Casa di Sallustio)¹⁰⁵, and stretch it so that it fits with the Bazzani's painting. I also slightly changed the bowl and the pedestal.

The other two pillars are decorated with bunches of palm branches in some kind of a vase (Bazzani's watercolor is too imprecise for determining exactly what it was), with a *tondo* in the uppermost part. I used palm branches depicted on a fresco of an unknown provenience.¹⁰⁶ Since none of the palms I have found fitted within the pillar, I decided to use photo editor software (Adobe Photoshop CS4) to create my own palm branches. On the watercolor there are some indications that all four pillars were also adorned with ivy leaves painted at the bottom – I included them as well. Finally, I multiplied the *tondo* to all the pillars – without them, the space above the nymphs was rather empty.

Painted marble imitations were also adorning the *nymphaeum*. According to the detailed *corpus* of painted marble imitations from Pompeii compiled by H el ene  ristov, there were four marble types present on the wall.¹⁰⁷ I used the remaining paintings, as well as references from other houses¹⁰⁸, and Bazzani's watercolor¹⁰⁹, to create a bitmap for the *nymphaeum* wall.

Faint traces of colors inside the niches¹¹⁰ suggest the existence of some sort of garden or landscape paintings there which were creating a background for the fountains. Given other garden frescoes found in the vicinity, we should not assume that the paintings were of an exquisite quality like the famous ones from Villa of Livia in Prima Porta. I cut out small parts of other frescoes that captures only a few branches and a bird.¹¹¹

As for the colors of the other parts of nymphaeum wall, the eastern tympanon has *cymae reversae* cornices painted red. We do not know how the inside was painted. There are remains of red and yellow marble imitation in the corners. There are also faint but visible lines, perpendicular to the triangle of the tympanum, but closer to its center, incised into the plaster (fig. 07).

¹⁰⁵ Drawing from Niccolini 1890: tav. III.

¹⁰⁶ Jashemski 1993: 391.

¹⁰⁷  ristov 1979: 712.

¹⁰⁸ Paintings from VI 15,1 (House of the Vetti), VI 16,7 (House of the Golden Cupids).

¹⁰⁹ Scagliarini, Coralini, and Helg 2013: 116.

¹¹⁰ Staub 2013: 168-169.

¹¹¹ I used paintings from VI 17,42 (House of the Wedding of Alexander).



Fig. 07. Tympanum over the west niche, detail (T. Staub). The arrows indicate courses of the incisions (editing: M. Perlińska).

These could be the remains of the reference lines for the painter and would suggest that the center had a different decoration than the outer parts. But, since this can be considered a circumstantial evidence only, and we have no definite proof, I used the same marble imitation in the middle as well.

One of the most difficult parts is the reconstruction of the wall paintings of the peristyle. Since there are absolutely no remains whatsoever (except the small note from Mau, which hardly gives any information), I took the liberty of creating my own textures (figs. 08-09).

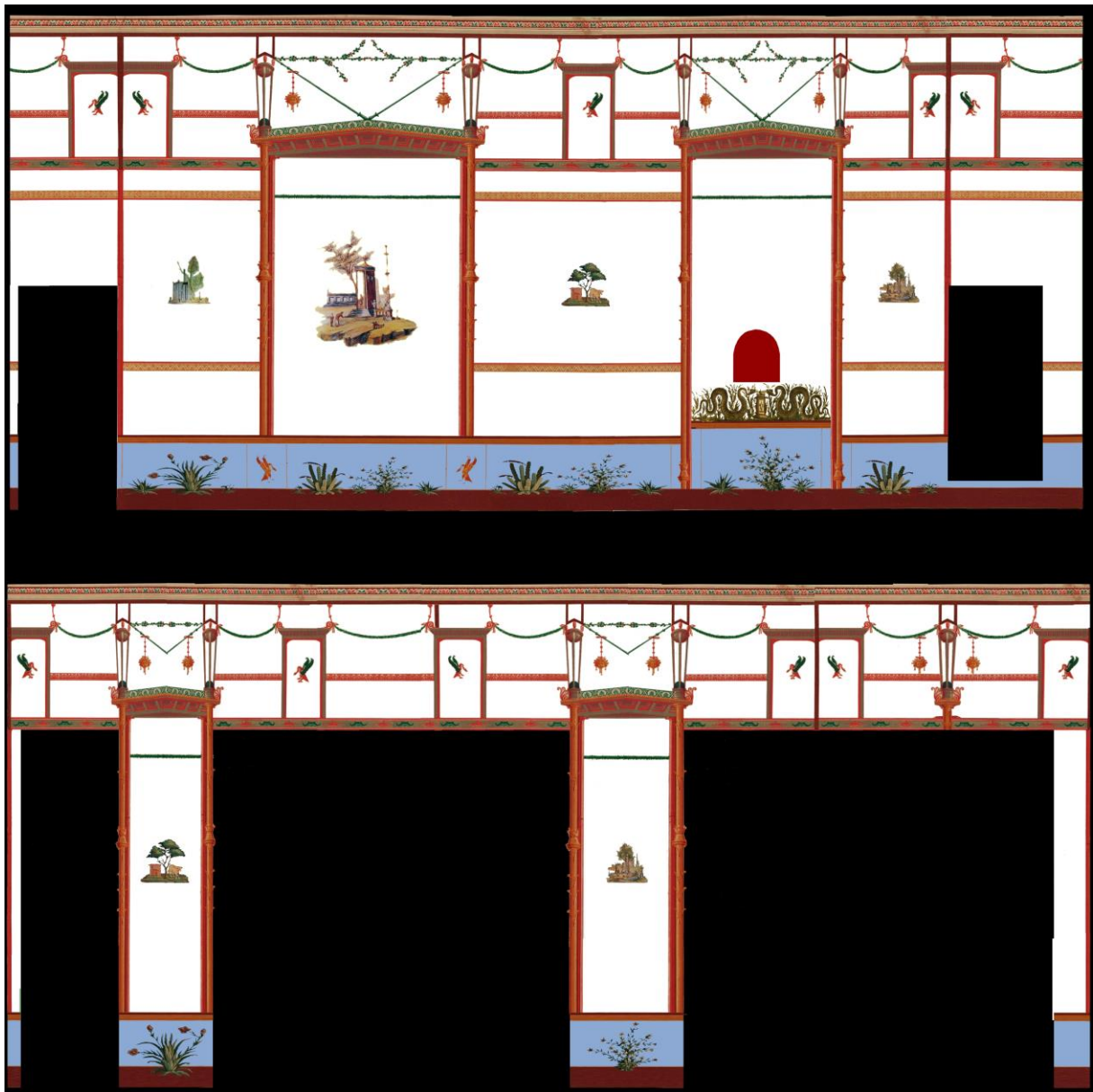


Fig. 08. Eastern (top) and southern (bottom) wall painting texture (M. Perlińska).

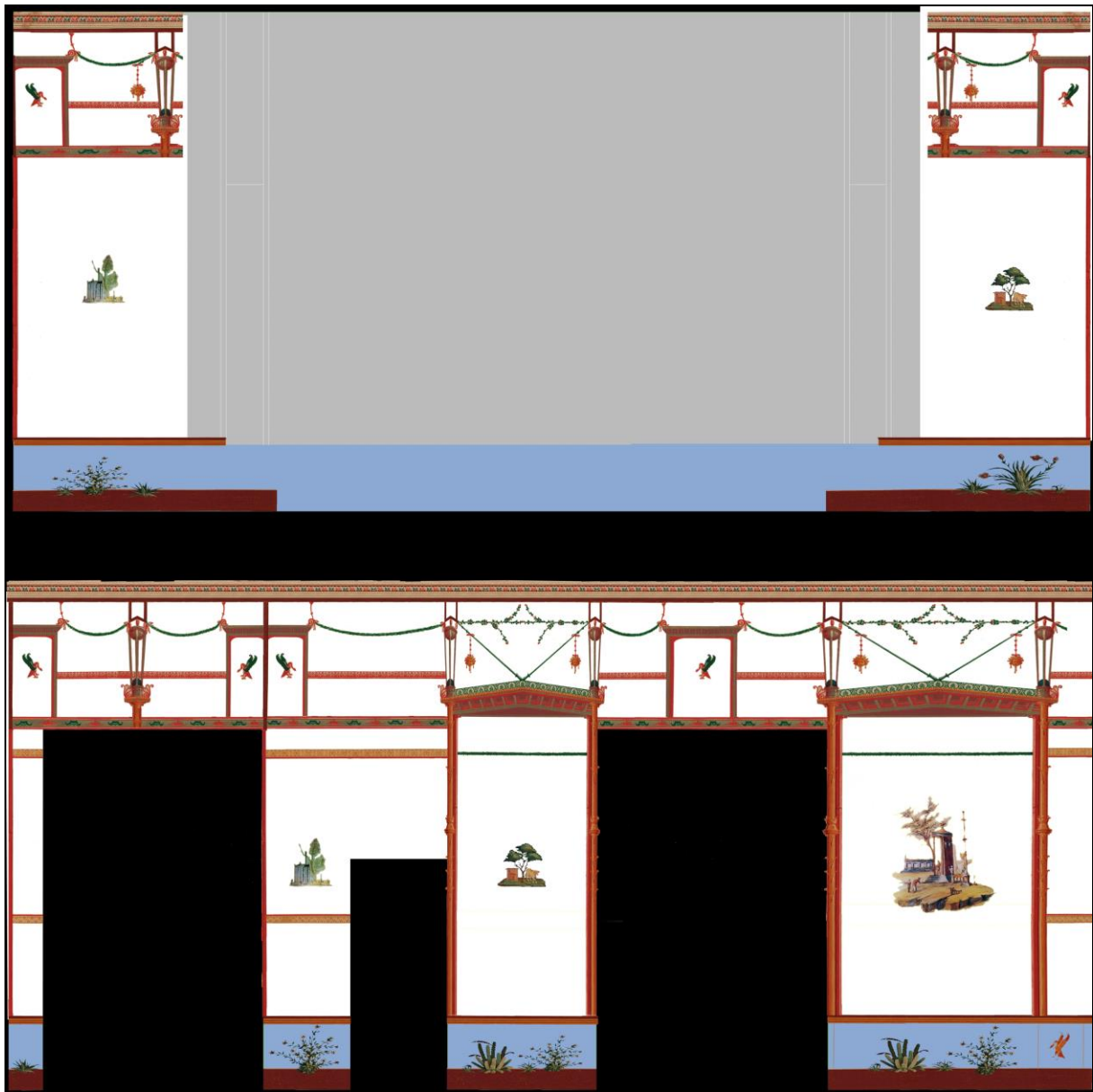


Fig. 09. Western (top) and northern (bottom) wall painting texture (M. Perlińska).

I used some of the drawings made by Zahn¹¹² as a template (background, framing), and I added elements such as plants and landscape paintings. I tried to achieve that the wall decoration becomes a logical continuation of the features in the peristyle – the lower strip in the paintings resemble the frescoes on the rim of the basin (fig. 06) and in the upper part the garlands are mimicking the ones that hang between columns. In that way, the wall decorations create a logical correlation with other elements. This logic contributes to the aesthetical reception of the paintings.

According to Staub, the floor consisted of two parts: one was *cocciopesto*, which was laid over almost the entire floor.¹¹³ It was fairly easy to prepare in Photoshop, since it is still widely used today. The other was a *lavapesta* floor, placed in the two northernmost corners of the room.¹¹⁴ It is more greyish than *cocciopesto*, because its main component is crushed black lava pieces. The gutter was probably painted blue, as remains suggest.¹¹⁵

Mosaics

All the mosaic panels, two smaller ones under the steps and three bigger ones underneath the niches, were quite difficult to model. They are of an unusual type, where tesserae were used alongside with irregular shreds of multicolored glass on a yellow pumice background, with inserted shells and glass rods of different color. It is hard to grasp the aesthetic idea that lay behind it. The deterioration that took place even before the excavations¹¹⁶ led to the state where all shells are lost, all glass pieces except some small fragments are nothing but the empty impressions, more than half of the tesserae are colorless, and the only thing that is still in incomparably better condition are the glass rods.

In this situation, I decided to pursue the following line: firstly, I created the picture where all the symmetrical mosaic elements were put in place, taking the remaining tesserae as a reference. I colored the pumice yellow, without changing anything else. With that I was finished with the tesserae and the pumice. I tried to fill in the missing glass rod pieces as well – their shape was pretty easy to recognize through the deep imprints, which the missing parts left behind.

In corresponding place on both the westernmost and easternmost mosaics, there is a distinctive row of impressions, which were probably made by invertebrate shells.

¹¹² Zahn 1898.

¹¹³ Staub 2013: 173-174.

¹¹⁴ Staub 2013: 173-174.

¹¹⁵ Staub 2013: 166.

¹¹⁶ In my opinion, the mosaics were partially destroyed by the eruption. It is such an extraordinary type of the mosaic that would surely be mentioned in the excavation report otherwise. On the other hand, there is no mention about the entire *nymphaeum* wall neither.

The impressions allow to determine the direction of the relief patterns on the shells, their oval section, and that they had some kind of protrusions in the form of spikes (fig. 10). From Jashemski's catalogue only one species matches that description – *Murex* (= *Bolinus*) *Brandaris* L.¹¹⁷, otherwise known as dye murex, from which purple color was obtained for dyeing clothes.



Fig. 10. Comparison between impressions in mosaic remains (a) and a shell of *Murex* (= *Bolinus*) *Brandaris* L. (b) (a – T. Staub, b – Wikipedia, editing: M. Perlińska).

On the borders of the two side mosaics there are some very faint impressions after shells of another species, more likely of the *Pecten* genus. The details are unrecognizable, both concerning the exact species and their arrangement. Taking other mosaics with shells as an example (House of Hercules and Amphitrite in Herculaneum), I assumed that these shells were placed on both sides of the mosaics, as a sort of frame. I added them to the pictures which I made before. These were the textures which I used as background.

Afterwards, I proceeded with the geometry. I created a small, irregular geometric shape in place of each of the shells, to give it a more realistic look on the renderings –in close-up, it is well visible. I formed all the glass shreds as separate elements, to keep the glass as realistic as possible. Each piece of glass has a different texture, opacity and reflection map. Opacity and reflection depends on grayscale versions of the texture bitmaps, where black color is more translucent and less reflecting, and white is more opaque and shiny. I had to make complicated materials, because many of the glass shreds that were used in the mosaics were probably made in mille-fiori technique¹¹⁸, which is very difficult to create in VR. As a reference for the round plates in the middle of the mosaic and for the round plates on the two smaller mosaics, I used round brooches found in England. Their construction (mille-fiori elements embedded in copper frame) fits with the remains, although the dimensions are much smaller, ca. Ø 4 cm (fig. 11).

¹¹⁷ Jashemski and Meyer 2002: 296-297.

¹¹⁸ Staub 2013: 170-171.

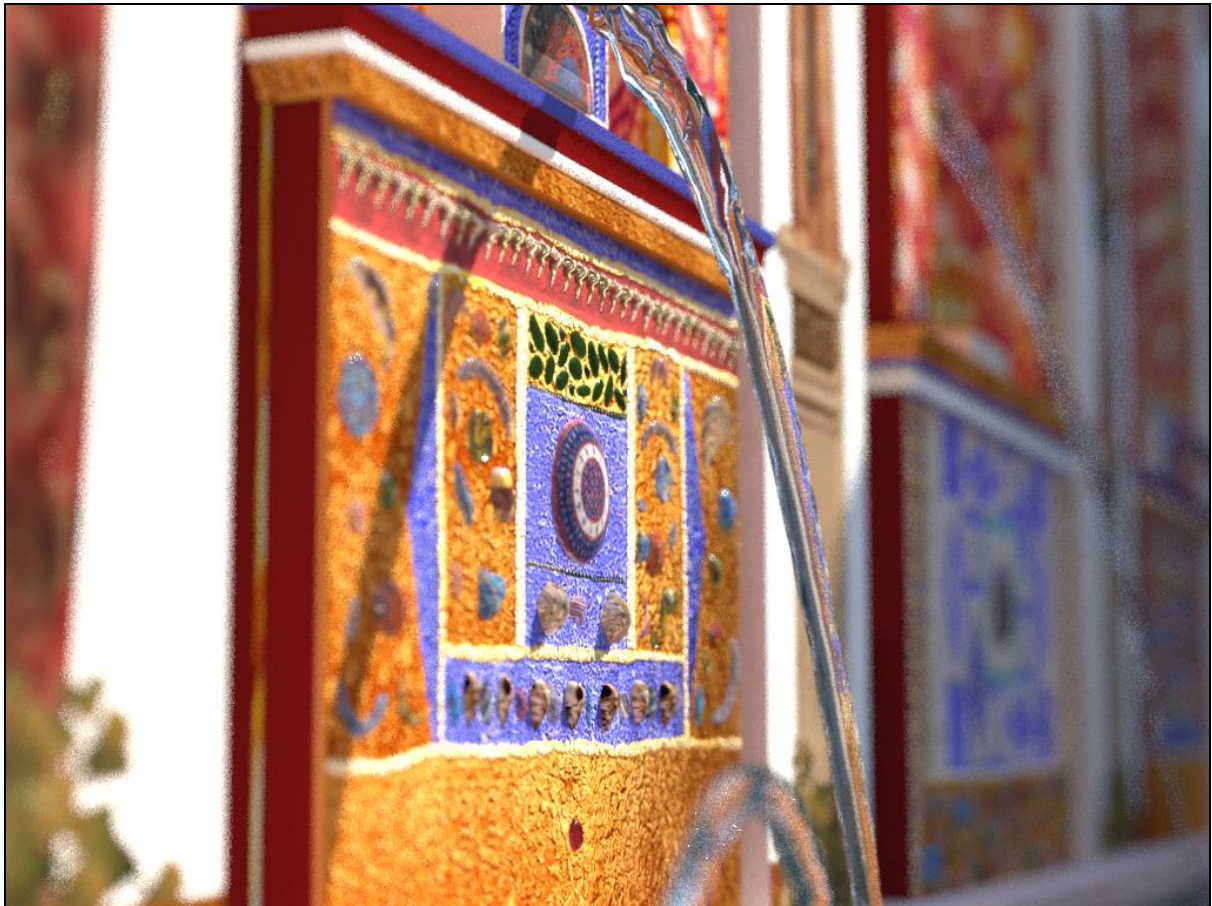


Fig. 11. Brooch found in England fit in the middle of the mosaic – the other one is visible in the upper part of the picture (M. Perlińska).

It is very probable that the plates were not so adorned, probably some less elaborate design was used. Also, their position might have been different from the ones of the VR model (not all impressions are preserved). The impressions were very dim, and it was difficult to determine the precise shape of many pieces (figs. 12-14).



Fig. 12. Present day remains and the virtual model of the westernmost mosaic (M. Perlińska).



Fig. 13. Present day remains and the virtual model of the middle niche mosaic (M. Perlińska).



Fig. 14. Present day remains and the virtual model of the easternmost mosaic (M. Perlińska).

Taking all of the above said into consideration, I can safely assume that the VR mosaics do not have so much in common with the ancient ones. They should be treated more like a reference to the aesthetic values that these ancient mosaic certainly had, and as an effort to trigger the similar visual experience as in the antiquity.

Roof

There is nothing preserved from the original ceiling and the roof. I had to rely solely on the references from other houses. I modelled the architrave using the sections from Blid's drawings.¹¹⁹ It is a simplified version of the architrave depicted by Bazzani¹²⁰, and it was probably drawn from the restored parts which now support the highly unaesthetical, modern protective roof, as it lacks some rims. But even with that much critique, it is more useful than the watercolor, simply because it is impossible to deduce the section of the architrave from the latter (due to the distorted perspective). Remains of the white plaster suggest that the entire feature was painted in this color. I also added a palmette ornament that I used for the cornice decoration on the inner side of the architrave, inspired by a similar feature on the Ara Pacis. It was a very popular motive, reoccurring throughout antiquity, and I think that it enhances the visual impression of the upper part of the model.

The next parts were the beams. There are many different types of the ceilings, and I choose not to cover it, so that when the viewer looks up, he sees all the beams that run parallel to the roof. The roof consists of simple, wavy polygons with red tile texture on it. I modelled antefixes based on one owned by the Los Angeles County Museum of Arts¹²¹, and then I tried to find a matching acroterion – that had to be one that would also have a face on it. I found one in the Archaeological Museum of Piraeus.¹²² It does not fit into the period of interest, and it is bronze, but it really fits into the overall impression. The influences from Greece are well-documented, and it is fairly easy to model a flat surface like this in the software.

Simas were modelled based on the bronze lion heads that are in the possession of the Metropolitan Museum of Art.¹²³ They are dated to 100BC-100AD, which makes them a suitable candidate for use in this model. The roof is presented in fig. 15.

¹¹⁹ Drawing of the elevation of the *nymphaeum*, made by J. Blid for the Swedish Pompeii Project.

¹²⁰ Scagliarini, Coralini, and Helg 2013: 116.

¹²¹ LACMA.

¹²² AMP.

¹²³ MMA.

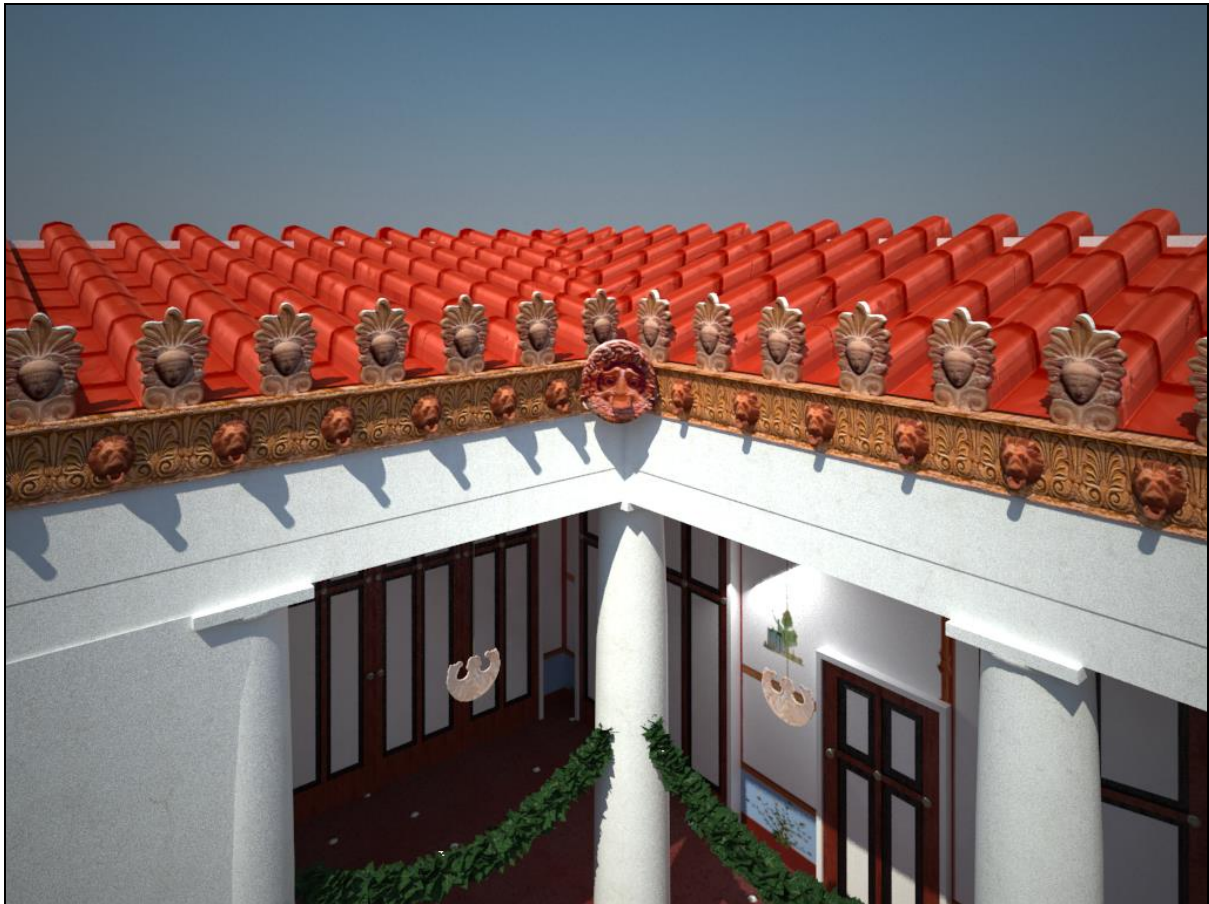


Fig. 15. Modelled roof over the peristyle (M. Perlińska).

The entire roof structure was given the lowest level of plausibility. One of the reasons behind that was that I did not model the roof according to any tile measurements, which can be justified by the fact that only very small part of the roof is visible from the peristyle, hence there is no need for detailed modelling. The only element that surely bears resemblance to the original is the red tile texture.

Water

Water was a very important element in Roman gardens, and the early Augustan aqueduct that provided Pompeii with water led to a complete change in how gardens looked like. According to Jashemski¹²⁴, before the aqueduct was constructed gardens only had plants that were not so water demanding, trees for instance. But with the introduction of the running water, there was a boom on gardens, and their variety is what still astonishes everyone. Fountains were giving freshness and coolness, both for plants and inhabitants, while being a source of a calming trickle. Plants also constituted an important part of the visual design and a source of pleasure,

¹²⁴ Jashemski 1979: 32-33.

by providing shade, but they were also reflected in the water. That must certainly have given life to the still image of the garden. The reflections were perhaps making the water surface more interesting, as the image was constantly in motion, and thus visually affecting the straight edges of the basins.¹²⁵ In some houses, they were also used for watering the garden.¹²⁶ In the house V 1,7 water had multiple functions.

The *tablinum* and *cenatio* fountains were both framing the view axes. Visitors and inhabitants, while being in room **g**, *tablinium* **13** or *atrium* **4**, had the opportunity to see the garden between two water jets, like a pleasant picture within moving frames (figs. 16-17). The marble fountain provided a pleasant view, but was probably also providing fresh moistured air for the plants nearby. The intensive whiteness of the wet marble basin was contrasting nicely with the tufa stones, thus creating an interesting feature right in the middle of the garden. The mosaics and the rim fountains were just the icing on the cake. Its uniqueness and exceptionality, as well as the interesting decorations, probably made it a central feature of the house, and a very eye-catching highlight.



Fig. 16. A view on the peristyle from room g (M. Perlińska).

¹²⁵ Landgren 2004: 141.

¹²⁶ Plin. *Ep.* 5.6.20.



Fig. 17. A view on the peristyle from tablinium 13 and atrium 4 (M. Perlińska).

The last water outlet, small and inconspicuous, but also made in a professional way, is the water tap on the column. It is very interesting feature. It needed a bucket to fill it with water, which was later used for the purposes we can only assume. Its *raison d'être* is very puzzling. Its position is not connected with the kitchen area, even in a remote way. Maybe the water was used in the small niched basin next to it? If so, why not lead the water directly to it, especially since the basin already had a drain¹²⁷? Maybe the water was used for watering the plants, but then it might have been as well taken from the *nymphaeum* basin. Anyhow, we will never know what purpose drove the owner of the house to install this water tap. Still, it is no poke in the eye – the pipe was ingeniously hidden underneath the plaster of the column.

Creating the water turned out to be a very demanding task, but the overall effect increased the aesthetic value of the room (fig. 18).

¹²⁷ Staub 2013: 160. The drain was still visible on the photograph in Sampaolo 1991: 527.



Fig. 18. Renderings of the model with (right) and without (left) the water (M. Perlińska).

I created the water using Phoenix FD Plug-in for 3DStudio Max to enhance the visual presentation of the model. It was once more a quite challenging task, since it is very difficult to model any fluids in a realistic way. A water jet itself consists of four parts, which are modelled as individual particles, and then transformed into a mesh – the water jet, the surface with which it interacts, splashes and foams. At the end, the water material is added (fig. 19).

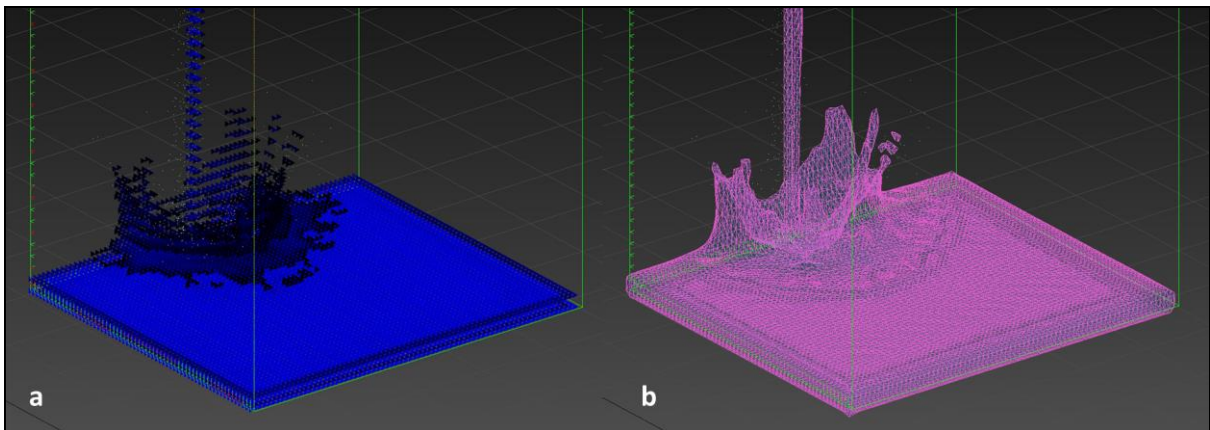


Fig. 19. Water modelled in 3DStudio Max as particles (a) and as a mesh (b). The small green and white dots are representing foams and splashes, which are later transformed also into a mesh (M. Perlińska).

The lack of any of these parts gives an unrealistic effect, often looking like oil splashes. However, because of the restricted computing power I was using, I had to resign from splashes and foams. But after ascribing the proper water material, I am still pleased by the result. In this case, it was better to have a good material than a good geometry.

Garden

This element I created without any remains whatsoever. Firstly, an important issue to consider here was whether or not the garden had been accessible – that is, if it was equipped with paths of any kind. If we take into consideration the fact that the entire area was delimited by the fences, and the only available passages were between the two pairs of fountains placed in two of the *intercolumnia*, then it seems improbable that it was a garden meant for pleasure strolls.

On the other hand, there are some features that would indicate at least a sporadic interaction with the garden space. One of them is a flower pot was found in the NW corner of the garden, found during the first field campaign of the Swedish Pompeii Project. I added a second flower pot symmetrically to the first one in the NE corner. Also, close to the western column of the *tablinum* fountain, there is a water distribution box with water taps that provides water for different parts of the house and the garden. To operate on it, one must enter the garden.

There is absolutely no way to resolve this issue. I think that the space did not have any paths¹²⁸, or that there was just one path that went around, so that both the flower pots and the water distribution box were accessible. Neither version is more probable, so I arranged the garden without any paths.

I tried to use the method proposed by Gleason and Malek.¹²⁹ They suggested that the garden paintings, instead of being treated as an illusionistic “extension” of the garden, can be viewed as a mirror that reflects the plants of the garden. Following this logic, I put some flower plants and ivy mounds in such a way that the view axes were framed more or less symmetrically (fig.20).

¹²⁸ I agree in that matter with Thomas Staub (Staub 2013: 37).

¹²⁹ Gleason and Malek 2014.

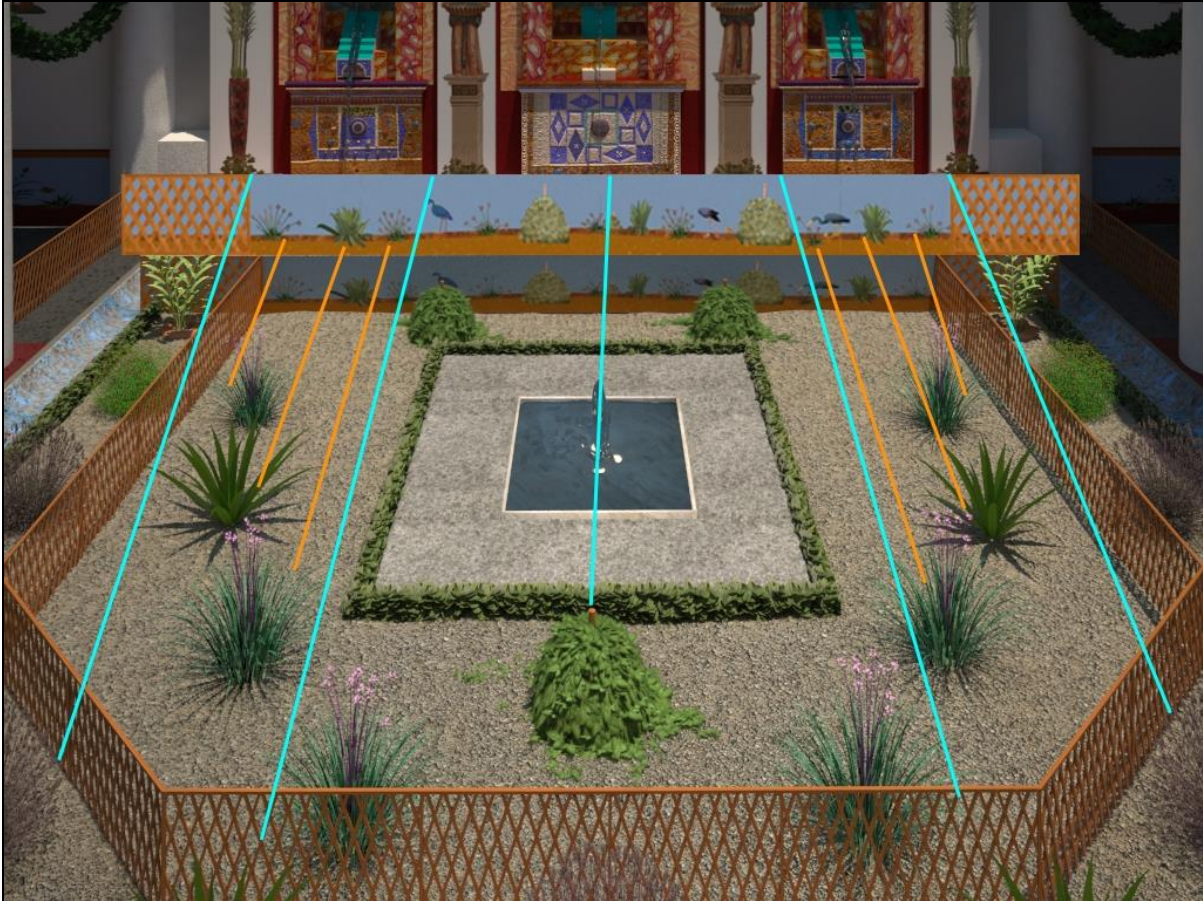


Fig. 20. Rendering of the garden, showing its relation with the fresco on the rim of the basin (M. Perlińska).

For creating ivy mounds, the gwIvy generator was used. It is a very simple plugin for 3DStudio Max where the user places the root, and then simulates the growth of the ivy up to a certain moment.

Probability map

After completing the model, I created a separate file using the same model as a reference. Then I substituted all the textures with the correct probability level color, according to the scale I presented at the beginning of this chapter. The scale was simple: green (level 1), yellow (level 2), orange (level 3) and red (level 4). The probability map is shown below in figs. 21-22.

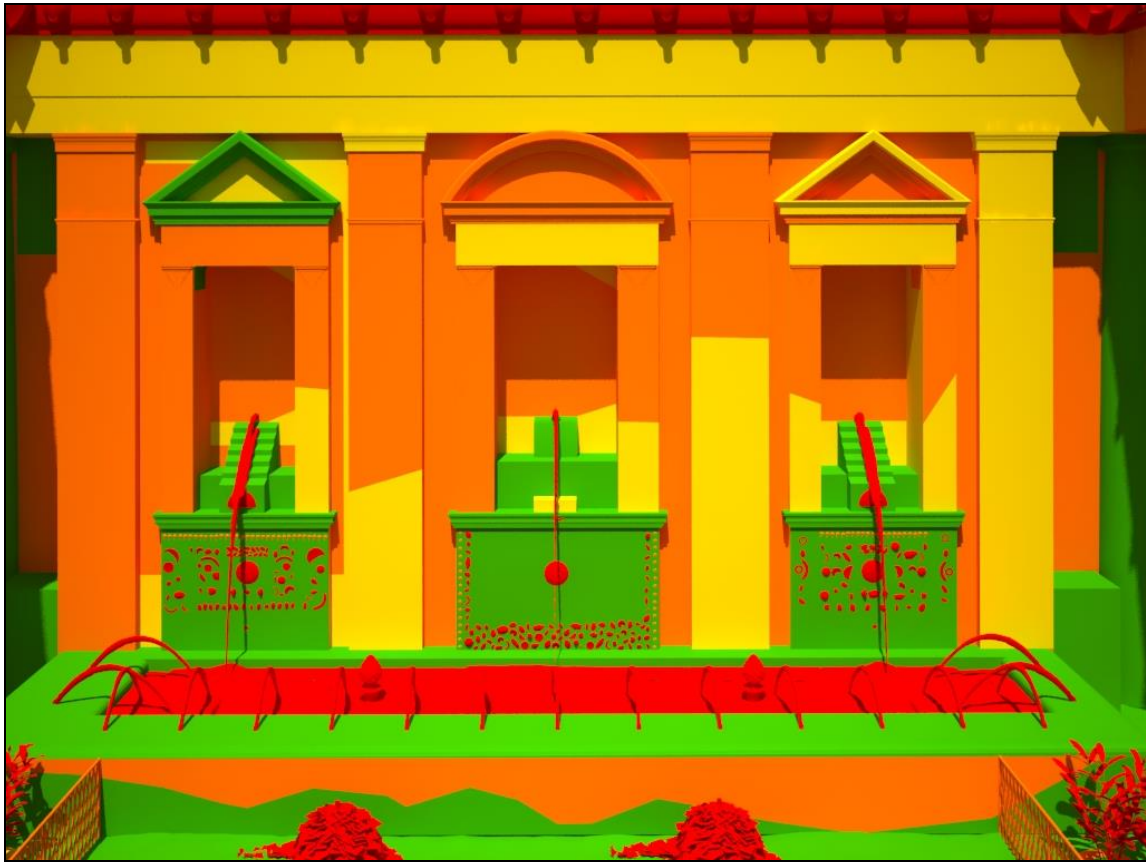


Fig. 21. Probability map realized and visualized in 3DStudio Max (M. Perlińska).

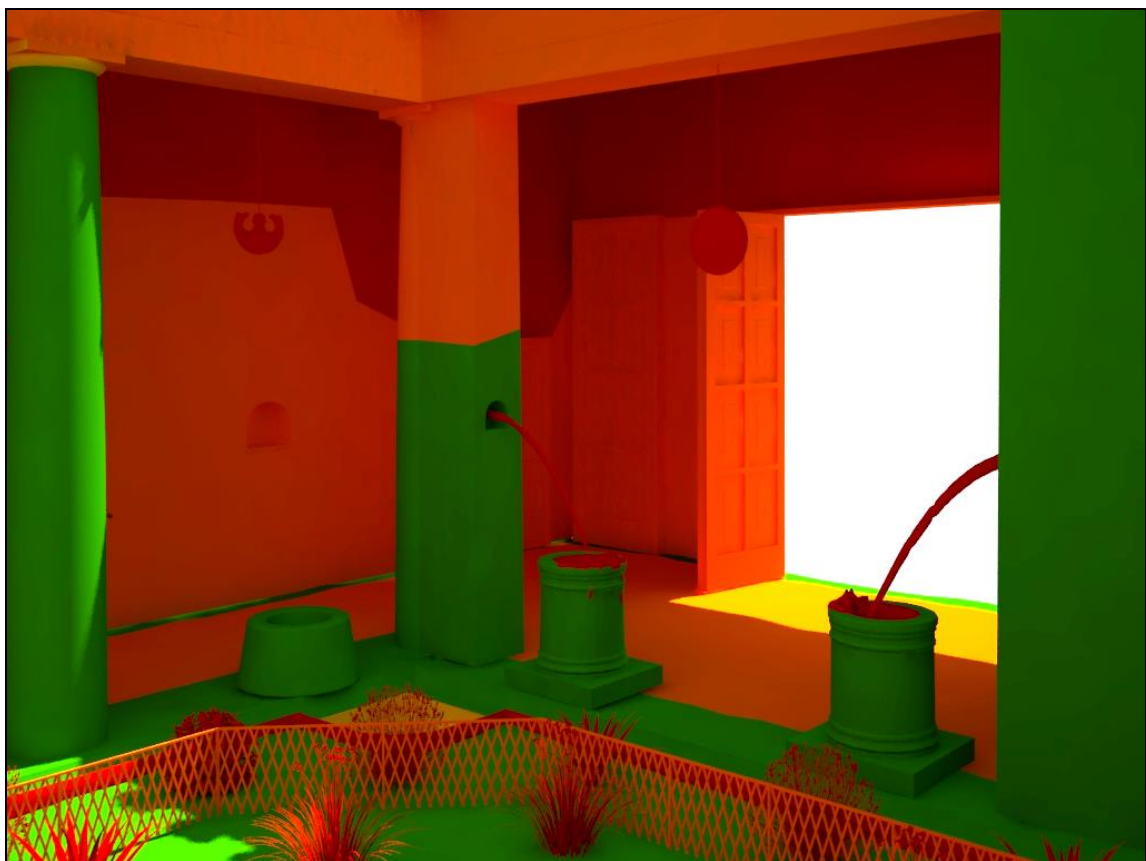


Fig. 22. Probability map realized and visualized in 3DStudio Max (M. Perlińska).

In cases where the individual elements (like columns) consisted of two or more probability levels, I tried to delineate the boundary between them as close to the actual situation as possible (fig. 23).

The probability map shown here and used in the later stage of this work is only describing the plausibility of the modelled decorations. In fact, in order to present all the information, two probability maps should be created: one for the geometry, and one for the decorations. It is impossible to show both these information on only one layer, since they overlap each other (e.g. the nymph is adorning the wall, so both the decoration and the architecture beneath it will have a different probability level). The probability map designed in the frame of this work is a kind of mix between both maps – when there is a decoration, the probability map is presenting its reliability. But in cases when there are no important decorations (like plaster on the columns), it shows the reliability of the geometry.



Fig. 23. Detail of the probability map with the photo overlapping it (photo – T. Staub, rendering and editing – M. Perlińska).

Summary

The model provides a detailed impression about the original condition of the space. All the elements that compose the space are connected with each other, as I tried to stress throughout this chapter. The garden constitutes a central spot, and all the features within the room are referenced to it. The fresco on the rim of the basin mirrors the garden, and it is framed by lattice – as the real garden is. Furthermore, the wall paintings are continuing that illusion, depicting also plants without the fence – to create the impression that they grow “behind” the fence. The garlands are also following a similar logic. Everything is closely related, for the greater amusement of the spectator.

As for the modelling, it was not as difficult as I originally assumed, although it was often difficult to find suitable comparable elements for the missing parts, caused by the lack of a proper Pompeii database that would incorporate all the available materials. The work “Pompei: pitture e mosaici” has been a very good source, but almost all its photos are in black and white, which makes their use as a base for modelling very restricted – especially when vivid colors are one of the goals of the project.

In the following chapter, I will describe the process of importing and merging the model and the probability map into a 3D GIS and I will present the database related to the probability map. Furthermore, I will present in detail how the database has been structured and I will discuss the impact of such an instrument for both researchers and the general public.

CHAPTER 4. PROBABILITY MAP IN GIS

In the previous chapter, I described the modelling process in 3DStudio Max, and the creation of the probability map. In this chapter, I would like instead to focus on the description of the workflow established to define and connect the database with the model. This experiment has been developed focusing only on a small part of the model, with the aim to suggest a new methodology. Hopefully, this procedure will allow researchers and scholars to make 3D “reconstructive” models more “transparent”. The results of this process will be discussed in the following chapters.

Data preparation

Importing the models into ArcGIS has been a difficult task. In fact, the GIS software allows for models to be merged into the geodatabase only if they consist of one geometry¹³⁰ and one texture. However, the models developed in the frame of this thesis are characterized by a complex set of textures, and therefore resulted in a failure to import them directly into ArcGIS. A possible solution would have been to entirely re-parameterize the texture coordinates of the model, but this operation would have prevented the import of the materials used for the visualization (i.e. different opacity levels, different reflection maps, etc.). This, in turn, would cause a significant decrease of the photorealism of the scene. For this reason, I decided to import only the probability map into the GIS.

In order to visualize the model in ArcGIS, a reduction of the geometry that characterized the original simulation was performed using the modifier “mesh optimizer” in 3DStudio Max. Then, I re-defined the projection of the model’s textures in order to enable its visualization in ArcGIS. Due to the low number of colors to display (the reliability map is composed of only 4 colors) this process was fairly simple.

After importing the probability map into ArcGIS (version 10.2.1), I georeferenced it using the data from Swedish Pompeii Project (fig. 24).

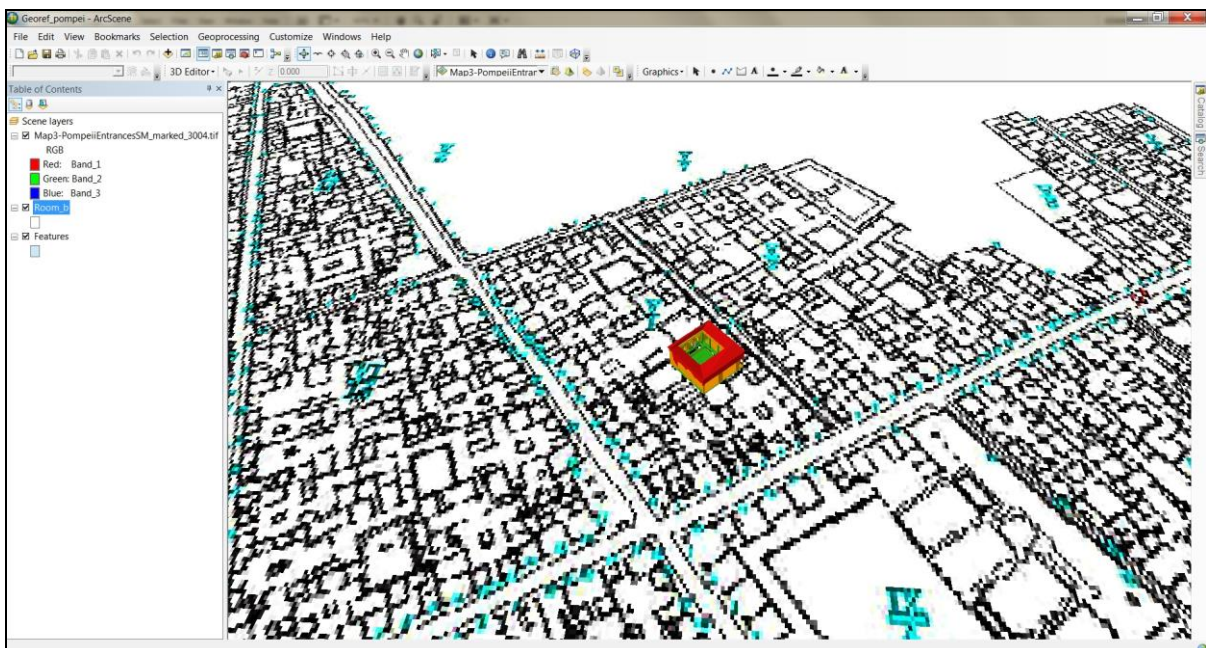


Fig. 24. Georeferenced model in ArcScene, with the map used for the georeferencing (M. Perlińska).

¹³⁰ That means that all the elements have to be merged together.

Description of the layers

In order to be able to link a database to the model, the individual features, for instance a pillar or the marble basin, had to be “re-drawn” in 3D using an appropriate file format, i.e. Shapefile. It is a special type of file that represents the vector data as points, polylines or polygons, and facilitates the attachment of a database to each of these elements. It is a format widely used in GIS software. To do that, I created a new Shapefile layer using the 3D editing tools intrinsic to ArcGIS. Individual elements of the model were delineated with polygons. What is important to recognize is the difference between the 2D and 3D polygons. The latter ones have internal divisions, which make them look like more than one polygon – however, they are still behaving like one object (fig. 25). Furthermore, each polygon corresponds with one element in the model and has an attribute table entry as shown in the figure below (fig. 26).

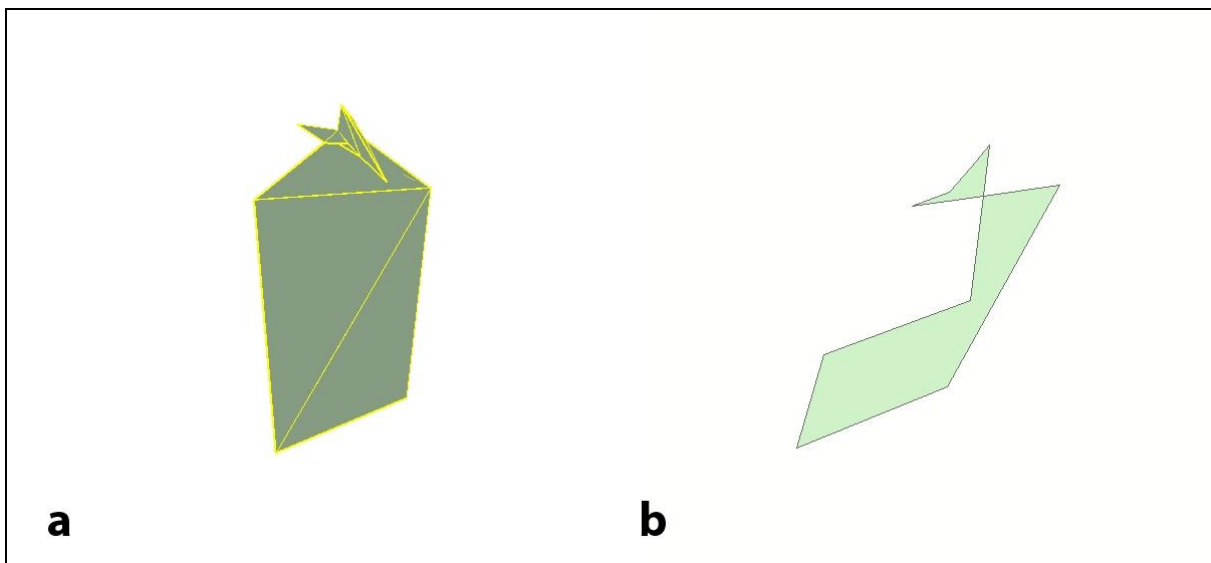


Fig. 25. Screenshot from ArcGIS, showing the appearance of the same polygon in a three-dimensional (a) and two-dimensional (b) space (M. Perlińska).

Unfortunately, the 3D editing tools intrinsic to ArcGIS still need much improvement. In fact, redrawing all the elements previously created in 3DStudio Max would have been very time consuming.

Description of the database

After creating the polygons, I linked a database to the model, and I designed an attribute table capable of hosting the metadata used to build the simulation. The expanded system of searching and navigating intrinsic to the software allows the user to select, for example, only the objects with certain properties. Furthermore, ArcGIS allows to analyze them in many ways.

Attribute table with the reasoning references

This attribute table has been designed to provide a straightforward connection between the single elements that compose the virtual “reconstruction” and the sources used as a reference during the modelling process. This tool allows for selecting a specific part of the model, and getting information about the interpretation process instantly. In order to achieve this result, the database has been structured as presented below (fig. 26).

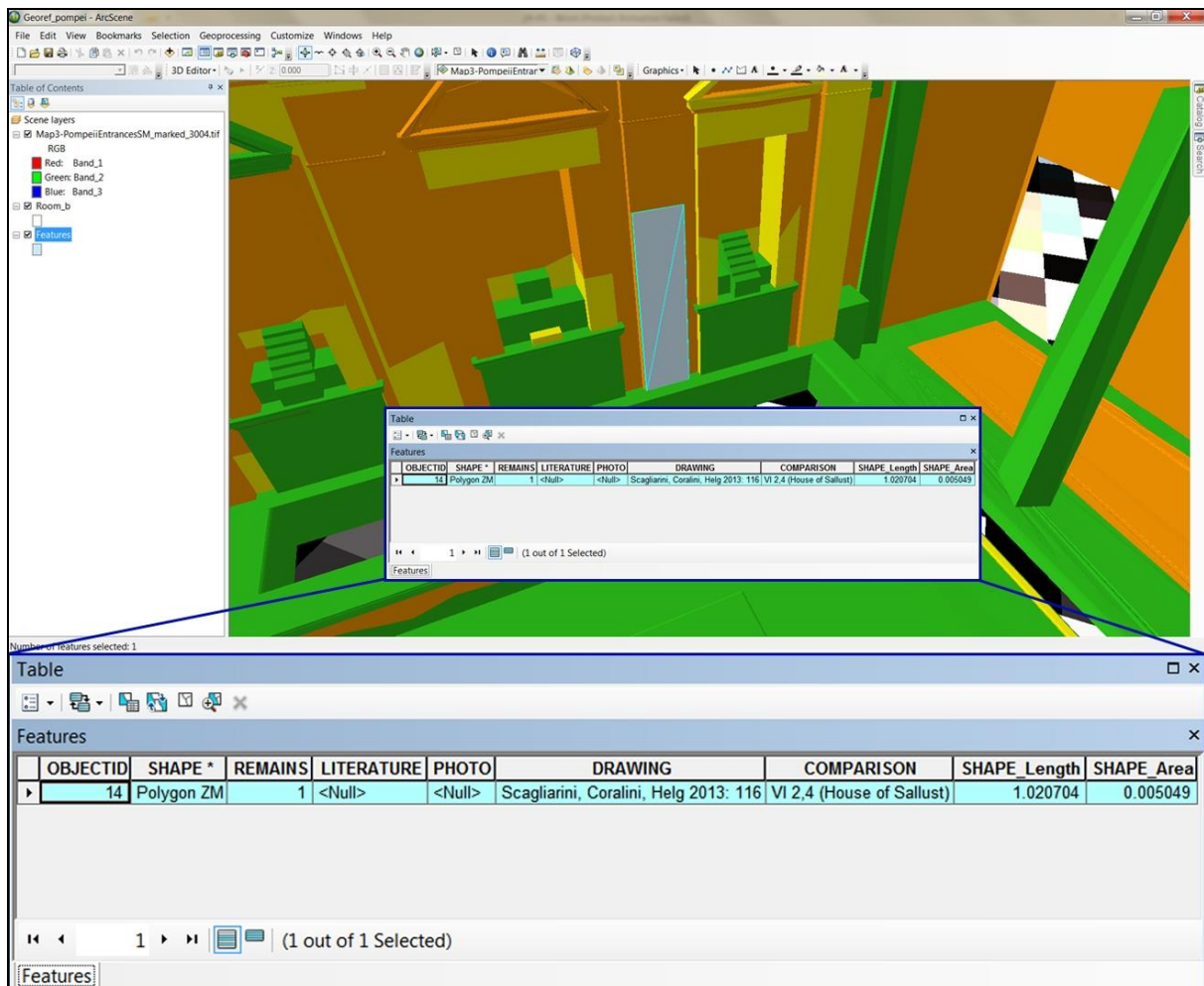


Fig. 26. View of the attribute table for one of the probability map objects, delineated with a light blue line (M. Perlińska).

Each polygon highlighted on the model has a unique ID number, which, in future implementations, could correspond to the real unit number assigned by the archaeologists to the physical structures of the house. The table is composed of five columns designed to host the information used to model various virtual structures.

The first table column is called “remains” and it indicates whether real structures have been used as a reference to digitally construct that specific element of the house. This column is a binary field described by two values. Value “1” means that there were remaining physical structures, e.g. walls or the marble basin that have been used as a reference to build the model. Value “0” means that there were no such remains preserved.

The following three columns contain information such as older and modern written sources, photographic materials and drawings. The sources have been recorded in the database using the reference system adopted in scientific papers: name of the author, year of the publication and pages.

The last column was added in order to provide comparative information about other houses with structures similar to those in the house V 1, 7. The comparisons were used as a direct reference for modelling specific parts of the virtual simulation. If that was made, there is an indication about the “address” code of the house and its name in the table.

[Attribute table with the bibliography](#)

As shown below in fig. 27, there is one separate table which has no spatial connection. It contains the bibliographical information used in the database. This bibliography is structured according to a reference system, but it can be referenced in a format different than used in this implementation. The references used in the attribute tables connected with the individual objects, such as the one presented in fig. 26, can be found in the left column of this table. In the right column, there is a full length entry concerning bibliographical information of the specific publication. In this way, it is possible for a user to track the sources used for modelling the individual features. Also, it keeps the individual attribute tables short and simple, since the full bibliographical information would blur these tables’ structure with very long and repetitive entries.

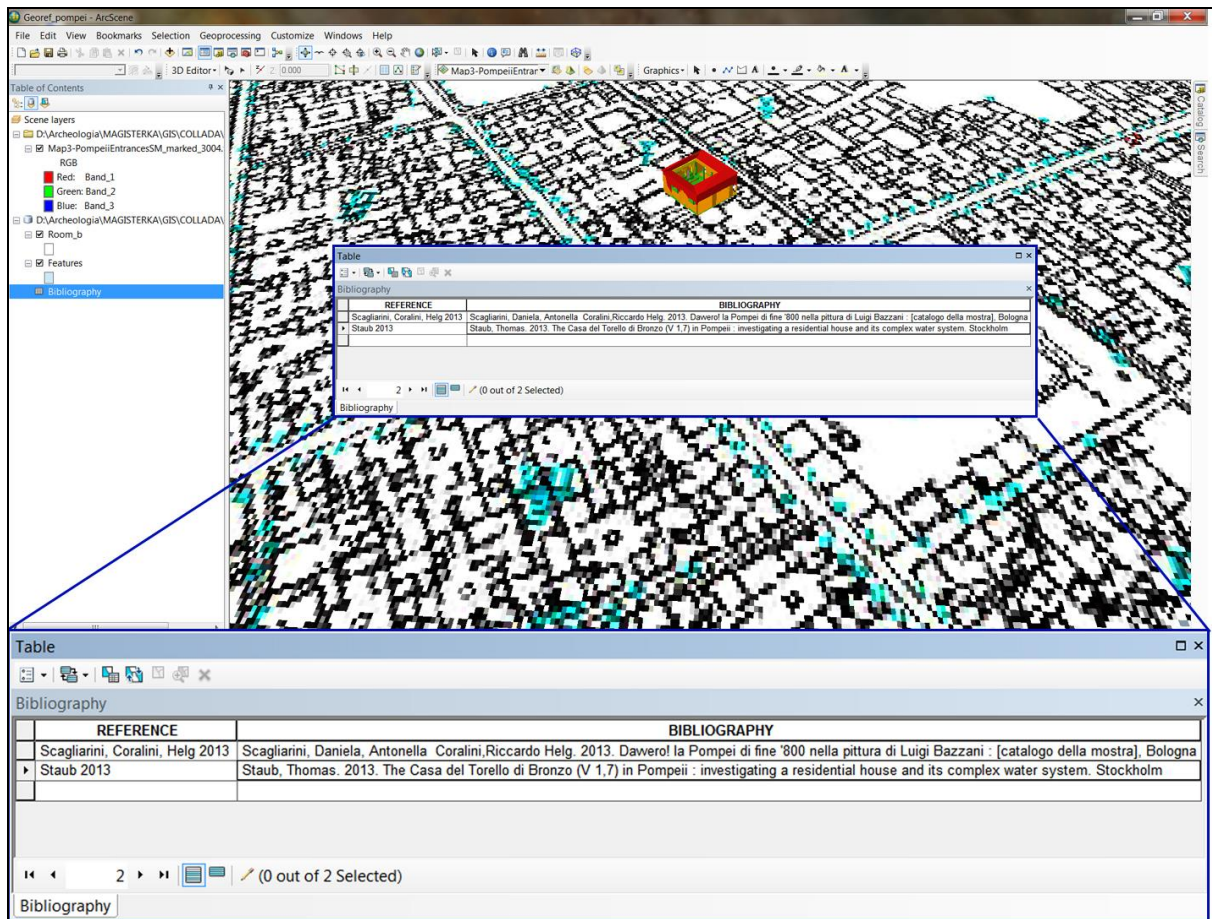


Fig. 27. Table with the bibliography (M. Perlińska).

CHAPTER 5. RESULTS

In the previous chapters, I presented the modelling process and the creation of the probability map. In this section, I would like to present the results of these operations.

Results of the virtual simulation

The model done in 3DStudio Max is a photorealistic simulation of the peristyle appearance prior to the eruption in AD 79. Every element has been constructed using sources belonging to one of the four levels of confidence¹³¹. Moreover, in order to enhance the visual reception of the model, vegetation and water has been added in the scene.

¹³¹ See chapter 3.

The model did not add any substantial information to the overall state of knowledge. However, it helped to research how the particular garden features were contributing to the general reception of the entire scene. Even when the existence of the fountains have been acknowledged, their visualization surprisingly changed the area. A similar case can be observed with the garden plants. We know that there must have been plants, but it was challenging to imagine them without the model. It is also difficult to realize how much life those elements add to the environment, and how strongly they are connected with the garden paintings. That is, in my opinion, one of the most important aspects of these typology of simulations – to create a persuasive archaeological image of the place, that will appeal to the senses of the visitors. Equally important is the necessity to share this image with others. At the same time, it is essential to subject it to criticism. I present the following statement: a model without the critical discussion does not belong to the scientific dimension.¹³² Therefore, it is essential for the models to be well-documented and published – in that way, we can create a space for discussing it.

Results of the probability map

After the modelling, the next step was to add the probability information to the model. This was done by ascribing one of the four colors to each of the elements, which corresponded to the four confidence levels assumed earlier.¹³³ After the creation of complicated materials for the features like water and glass, this part seemed to be both simple and quick.

Afterwards, the model was imported into the 3D GIS, georeferenced and then attached to a database that would show all the references for each of the elements. This is a very important novelty compared to the other implementations of VR “reconstructions”. Once visualized in a GIS environment the model became extremely useful for real time scientific discussion, because it allows for querying the system in an easy way and producing a quick result. Another solution would be to present the information in a textually descriptive way, with no spatial connection to the corresponding element. This, however, would cause a substantial slowdown of the discussion, because information provided in that form would be very difficult to search.

¹³² A paraphrase of the well-known paradox originating from the works of the 18th century philosopher, George Berkeley: a falling tree in the woods does not exist without a person listening to it.

¹³³ See chapter 3.

In summary, I think that I have managed to realize the aims of the project. I would like to discuss its impact on the archaeological discipline, especially on the domain of archaeological “reconstructions”, in the next chapter.

CHAPTER 6. DISCUSSION

This work has been very important for achieving a deeper knowledge on the questions posed at the beginning of this thesis. The most pressing one is the problem concerning the lack of referencing in 3D “reconstructions”. Furthermore, the way in which these models are presented to the public (from the perspective of an omniscient archaeologist) is also questionable. The methodology presented in this work helps to solve these issues. Whereas it has only been applied to a small part of the house, this implementation could be extended to the entire house in future work.

The incorporation of the database into the model allows the user to easily track the references, and that adds to the overall transparency of the modelling process. This is very important also when we look at the massive amount of data being produced by archaeologists – the possibility to quickly reach a desired information is indeed a huge improvement. Furthermore, the database enables a real-time discussion between the scholars. Nowadays, it is within the reach of archaeology to create a website that contains both the model and a database. This means that the results of projects like this can be made accessible to the public in a very short time.

The computer techniques are gaining more and more importance in archaeological practice and theory, but we are still using software that was designed for other disciplines. Therefore, it is impossible to avoid limitations that often result in irritation for archaeologists. But this is the price we have to pay for our independence from the professional IT scientists. I noticed many aspects of the project that could have been improved with a different approach or with more advanced tools. One of the problematic issues that remains is the lack of communication between the different companies’ software – probably caused by economic interests. To import a model from one software to another is very difficult. A further example can be recognized in the actual limitation of the GIS software in managing the multitude of the

materials created in 3DStudio Max – as I mentioned before, ArcGIS only accepts models with one geometry and one texture. As a consequence, the file imported into the GIS software does not display the full qualities of the model created in 3DStudio Max. This implies that this methodology, in order to be implemented on a larger scale, requires the use of at least two different software platforms – one for the realistic environment, and one for the visualization of the database connections. I hope that in the future it will be possible to manage most of the operations employing a smaller number of tools.

There are other examples of “reconstructions” that have been connected with metadata, and I would like to discuss them here. These were not created in a GIS environment, but were created instead in a software called Virtual Reconstruction Console.¹³⁴ VRC was created using Macromedia Flash¹³⁵, and it was designed as a general tool for developing interactive environments, in which the user can choose her/his own interpretation. It provides several fixed views on the model on the right side of the window – while on the left side, there is a variety of elements, grouped in classes (e.g. statues, shafts, etc.), from which the user can choose the most appealing selection. Each element has a description that specifies what archaeological sources were used. After choosing the entire set (e.g. base, shaft and capital of the column), the software calculates the probability of the created model. One of the disadvantages of the VRC is, however, that it does not allow the user to add new data. Once the VRC is programmed, it is not editable. In circumstances when new material would be found, the only solution would be to reprogram it again. Another drawback is the lack of control over the calculation process – there is no possibility to access the algorithm that the VRC uses to calculate probability. In fact, the user does not know how the output probability has been calculated. I think that the GIS implementation presented in this thesis is more straightforward and transparent than the VRC.

The reference system used in this project is more useful than the descriptive system made in the VRC. Through the connection of the visual information with a database, it is possible to detect and analyze data instantly. This option allows to use the system to promote a real time discussion concerning, for example, different aspects of the model – without the necessity to go back to the documentation and search for references. It is easier to search and navigate through the references in the GIS system (e.g. to find all elements modelled with the use of Bazzani’s drawing) than it is through the continuous text with the description. Moreover, the VRC has no such tools. Taking all of the above into a consideration, I think that using 3D data in the GIS environment really enhances the possibilities for scholars to enrich the results of their analysis, and improves communication between the researchers.

¹³⁴ See Pollini, Dodd, and Kensek 2006, Kensek, Dodd, and Cipolla, 2004.

¹³⁵ Pollini, Dodd, and Kensek 2006.

Another important problem that has not been solved yet is the difference in confidence levels of the overlapping objects, i.e. the architectural elements and its decoration.¹³⁶ One solution would be to have two or more separate layers, with probability maps for the different elements, such as geometry and decoration. This can easily become problematic, however. Not only because of the technical limitations, but also because of the troubles with deciding what probability level to assign. So far the reliability maps proposed in the literature tend to group elements of different types together. In the future it would be interesting to customize these maps more and more.

The 3D GIS implementation remains very difficult to use in a museum environment. This aspect generates an important question of whether the public is interested in having access to those kinds of information – or, even more crucially – whether the public should have an influence on what archaeological information are shared with them. This is a broader problem, connected with the deepening crisis within the humanities sector which can be observed nowadays in many different contexts. A particularly impacting question therefore could be: *is archaeological knowledge a sort of commercial product, whose form can be dictated by the demands of the market?* This is a question I cannot answer, but with the sustained trend, these issues can become very pressing.

The last issue I want to touch upon here is the terminological chaos concerning digital applications in archaeology. It can be easily seen in this thesis, where I try to use different denominations for a simple action of reconstruction, but also in the theoretical section, where I struggle with a proper word for the probability map. In my opinion, the *plausibility* map should be used instead, and I want to stress it here again because it is an important distinction to be made. The nomenclature should be established once for all, so that different denominations in different applications do not cause any confusion, as it takes place now. The scholars appointed to do this should be those archaeologists specialized in the field of 3D modelling, because it is important that such experienced and knowledgeable individuals set the standard for all other non-specialized archaeologists who intend to utilize these implementations in the future.

I hope that the problems outlined above will add to a wider discussion on the handling of 3D models in general. There have been many articles that contributed to this debate already, but there is no unified methodology to follow. Perhaps the possibility to achieve multivocality through the different implementations of these typology of virtual simulations is a sign of the postprocessualism era in which we are positioned now. Its theoretical foundations allow

¹³⁶ See chapter 3.

for many equally justifiable implementations to be used at the same time, without one standardized solution.

CHAPTER 7. CONCLUSION

The study presented in this thesis was primarily aimed to create a photorealistic 3D simulation of the peristyle of the Pompeian house V 1,7 (House of the Bronze Bull), and to make a probability map which would show the level of reliability of every element of the model. I designed it in order to make these levels explicit and the methodology of its construction transparent. Also, the thesis was aimed at a discussion about the limits and potentials of implementing such a probability map into a 3D GIS system. In today's shift of importance towards visual media, the questions about communicating and sharing research results are an increasingly important issue. This shift is already pushing the scientific community towards an increased transparency of the research process, and the importance of paradata.¹³⁷

In the future, it would be a good idea to extend both the modelling and probability mapping onto the entire house, to capture the aesthetical idea behind disputable elements. It would also be good to apply the methodology presented here to other case studies for further improvement and development.

Moreover, it would be interesting to be able to model the entire water pipe system in the house, and to simulate the water flow in water simulation software such as Realflo. The use of these advanced systems would allow to control the water pressure in the pipes and – through the distribution boxes – in each individual nozzle. This would show more realistic shapes of the water jets, justified by the laws of fluid dynamics. The implementation of such simulation would contribute to the understanding of the visual concepts that stood behind the astonishing water system of the house V 1, 7.-

This project proved how invaluable it is to implement VR tools into archaeological methods. They open up an entirely new scope of research, facilitating the communication between scholars and researchers. It also underlined the necessity of extending this

¹³⁷ See Bentkowska-Kafel, Denard and Baker 2012.

communication into the public sphere. Delivery of knowledge is, after all, the main purpose of archaeology's existence as a science.

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LIST OF FIGURES

- Fig. 01. Plan of the house V 1,7 in Pompeii, with the peristyle area marked in green (plan: H. Boman, editing: M. Perlińska).
- Fig. 02. Workflow of the modelling: mesh realized after the acquisition campaign (left), modelled geometry (middle) and geometry complete with the textures (right) (M. Perlińska).
- Fig. 03. Nymphaeum wall before and after the modelling (M. Perlińska).
- Fig. 04. Garland modelled in 3DStudio Max as particles (a) and as a mesh (b) (M. Perlińska).
- Fig. 05. Remains of the fresco on the rim of the nymphaeum basin; scale: height ca. 50cm (editing: M. Perlińska, original photos: T. Staub).
- Fig. 06. Texture showing the basin fresco, used in the VR model; same scale as in fig. 05 (M. Perlińska).
- Fig. 07. Tympanum over the west niche, detail (T. Staub). The arrows indicate courses of the incisions (editing: M. Perlińska).
- Fig. 08. Eastern (top) and southern (bottom) wall painting texture (M. Perlińska).
- Fig. 09. Western (top) and northern (bottom) wall painting texture (M. Perlińska).
- Fig. 10. Comparison between impressions in mosaic remains (a) and a shell of *Murex* (= *Bolinus*) *Brandaris* L. (b) (a – T. Staub, b – Wikipedia, editing: M. Perlińska).
- Fig. 11. Brooch found in England fit in the middle of the mosaic – the other one is visible in the upper part of the picture (M. Perlińska).
- Fig. 12. Present day remains and the virtual model of the westernmost mosaic (M. Perlińska).
- Fig. 13. Present day remains and the virtual model of the middle niche mosaic (M. Perlińska).
- Fig. 14. Present day remains and the virtual model of the easternmost mosaic (M. Perlińska).
- Fig. 15. Modelled roof over the peristyle (M. Perlińska).
- Fig. 16. A view on the peristyle from room **g** (M. Perlińska).
- Fig. 17. A view on the peristyle from *tablinium* **13** and *atrium* **4** (M. Perlińska).
- Fig. 18. Renderings of the model with (right) and without (left) the water (M. Perlińska).
- Fig. 19. Water modelled in 3DStudio Max as particles (a) and as a mesh (b). The small green and white dots are representing foams and splashes, which are later transformed also into a mesh (M. Perlińska).

Fig. 20. Rendering of the garden, showing its relation with the fresco on the rim of the basin (M. Perlińska).

Fig. 21. Probability map realized and visualized in 3DStudio Max (M. Perlińska).

Fig. 22. Probability map realized and visualized in 3DStudio Max (M. Perlińska).

Fig. 23. Detail of the probability map with the photo overlapping it (photo – T. Staub, rendering and editing – M. Perlińska).

Fig. 24. Georeferenced model in ArcScene, with the map used for the georeferencing (M. Perlińska).

Fig. 25. Screenshot from ArcGIS, showing the appearance of the same polygon in a three-dimensional (a) and two dimensional (b) space (M. Perlińska).

Fig. 26. View of the attribute table for one of the probability map objects, delineated with a light blue line (M. Perlińska).

Fig. 27. Table with the bibliography (M. Perlińska).