The Harpy Tomb

An Experimental Visibility Analysis

Peter Fänge

LUNDS UNIVERSITET

Department of Archaeology and Ancient History
Master's Thesis in Archaeology
Advisors: Henrik Gerding & Nicolò Dell'Unto
June 5th, 2014

ABSTRACT

A study done on the Harpy Tomb at Xanthus in ancient Lycia. This study is an experimental visibility analysis, the purpose of which is to explore to what extent the geometry of the bas-relief panels would be visible. Aspects which are taken into consideration for this purpose include distance and varying positions, as well as time of day. Using modern laser scanning technology and 3D processing software, the plaster cast copies of the original marble panels were digitally recorded and their geometry preserved as a digital record. These were then implemented into a virtual reconstruction of the Harpy Tomb and its immediate urban surroundings which was then used to conduct the experimental visibility analysis. The results of these analyses give some idea of how the monument may have been viewed. The results also encourage further research on this subject.

Keywords: The Harpy Tomb; 3D models; Xanthus; Lycia; digital acquisition; visibility; digital reconstruction, Blender, Meshlab.

ACKNOWLEDGEMENTS

First and foremost I would like to thank my supervisors Henrik Gerding and Nicolò Dell'Unto. Without your support, advice, guidance, and encouragement this thesis would not have been possible. I also want to thank you for the same level of support, advice, guidance, and encouragement you have shown me throughout my studies here in Lund.

From Humanistlaboratoriet I thank Stefan Lindgren for lending his help and expertise for the digital acquisition of the plaster cast panels at the LUHM Gastelyckan warehouse, and Carolina Larsson for taking the time to hand over the scanning data.

I also wish to thank the staff at the LUHM Gastelyckan warehouse who took the time to bring the plaster casts off the shelves and display them so that we could start with the scanning and photographing immediately.

Last, but certainly not least, I thank all my friends who I got to know during my time at Lunds Universitet. You are too many to name, but you know who you are! My time here has been great, to say the least, and it would not have been the same without you

Contents

INTRODUCTION

By combining hard scientific data with interpretations grounded in research, virtual environments can offer a glimpse of the past which can be more easily identified with than what text, tables, and figures can do alone. 3D models obtained through techniques of digital acquisition are essentially copies of the original objects and can be considered artifacts in their own right as according to the UNESCO Charter on the Preservation of Digital Heritage.[1] They can be studied in the same way the original would have, but they can also be used for so much more. Using computer-based technologies, they can be experimented upon in ways that the original could not. As digital copies they are also made more available for access by researchers who no longer have to wait for the original to become available for study. The possibilities are many, but this level of accessibility does not free us from responsibility, the digital revolution within archaeology and cultural heritage should not be considered a no-holds-barred scenario. Responsible research should be conducted and it should not be assumed that every situation of cultural heritage research or communication requires the use of computer-based visualization.[2]

In the case of this study, digital acquisition and computer-based visualization provided the right techniques by which a study, otherwise not possible, could be accomplished. Doing so without these techniques would most likely have required a greater investment of time and money (the computer-based visualization programs used in this study are open source and do not need to be purchased) than was possible within the frame of this course.[3]

This study was done on the Harpy Tomb, an early 5th century BC Lycian pillar tomb. The bas-reliefs which sat on four sides at the top of monolithic pillar were removed by Charles Fellows in 1842 and brought to the British Museum where they can still be found today. They can be found in the same room as the more famous Nereid Monument which is partially reconstructed to show it more or less as it was found. However, the Harpy Tomb is sitting at roughly eye-level height, which makes it easier to appreciate up-close the detailed reliefs, but it is not the way it was intended to be viewed. The reliefs were meant to sit high up on a pillar, and even though cement copies are now present at the original site it is not seen by as a large an audience as the originals are. This visibility analysis can perhaps lay some groundwork for an improved presentation of the Harpy Tomb.

---

[1] UNESCO Charter on the Preservation of Digital Heritage.

[2] London Charter for the Computer-based Visualization of Cultural Heritage, Principle 2.

[3] See the chapter 'The Harpy Tomb: A Digital Realization' for an explanation of what an open source software is.

RESEARCH QUESTIONS

The questions which are central to this study concern digital documentation and reconstruction for the purpose of an experimental visibility analysis. The first question asked is, 'How can the geometry of the plaster cast panels of the Harpy Tomb be accurately recorded using methods of digital acquisition?'. This lead straight to the next questions which was, 'How should the digital models of the plaster casts be positioned for the purpose of a visibility analysis?'. Both questions were best answered in the form of a case study which was developed by first carrying out a digital acquisition campaign followed by a process of digitally reconstructing the Harpy Tomb – the central object of the case study – using free, open source software.

The processes of digital acquisition and reconstruction are the stepping stones if this thesis. Without this first stage the second would not be possible. Once reconstructed, the digital model is then used for the purpose of visibility analysis. The first question asked at this stage is, 'At what distance is the geometry of the Harpy Tomb reliefs still visible?' This is answered using the same open source software that is used to reconstruct the monument. The next question asked is, 'From which positions in the immediate urban surroundings was the Harpy Tomb and the geometry of its panels visible?' This is answered using the same method as for the previous question with the addition that some of the ancient surroundings are added.

The results of both these analyses are presented in the discussion which follows. Here I will allow myself to speculate based on the results of the analyses and to explore some further questioning such as, 'Was polychromy required on statues placed up high to make them more visible?' Even though the subject of polychromy is not covered by these analyses it is still important to discuss as it connects the next question which will be answered in the conclusion: 'Were the Harpy Tomb reliefs meant as propaganda for people or were they meant for the gods?'

THE THEORETICAL FRAMEWORK

Zubrow has declared that post-processual theory is incompatible with digital technology.[4] The interpretive, deconstructive, and narrative nature of post-processual archaeology stands in stark contrast with digital archaeology's analytic, reconstructive, and measured nature, he claims. However, the study in this paper is of an interpretive, analytical, and reconstructive nature and therefore contains elements from both theories. Graham declares that "[d]igital visualization can be based on both hard and fast numeric data and on interpretation."[5] It is a balancing act, and as

[4] Zubrow 2006, 14.
[5] Graham 2012, 4.

long as interpretive and experimental archaeology are rooted in fact they will yield relevant results because the science of archaeology "rarely encounters a comprehensive record."[6]

The accessibility and flexibility of a digitized cultural artifact whose geometry has been recorded in high detail is unmatched by any museum piece or solid copy thereof. Such a 3D model can be studied and analyzed even if it was made unavailable due to restoration or if it was loaned to another facility. Multiple groups of researchers could simultaneously study the same object without the need for waiting for the item to become available, they could even be on opposite sides of the globe. A 3D model can be subjected to a wide array of experiments, such as colorization and/or reconstruction, and it could be done on a much smaller time scale than if the same experiments were done with solid copies. However, as Beraldin *et al.* state, it requires time and effort to acquire the expertise that is needed to take full advantage of the available technologies.[7] Another thing they point out is that "[i]f the only purpose is the generation of photo-realistic images for visualization, then purely image-based rendering techniques offer a general solution".[8] This is precisely what has been done for this study, the purpose of which is to conduct an experimental visibility analysis, but because of the chosen methodology the vital geometric data of the objects has been captured and can be used to conduct further studies.

The London Charter, which has the goal of "[e]stablishing internationally-recognized principles for the use of computer-based visualization by researchers, educators and cultural heritage organizations", is important to take into consideration in order to maintain a certain level of professionalism and to ensure ethical research.[9] For this study in particular, Principle 4.4 of the Charter is important. This Principle deals with the fidelity of reconstructions and tasks the author to make clear to the user what the computer-based visualization seeks to represent. The case study developed for this paper relies on three forms of computer-based visualization to represent a final model; 1) accurately captured 3D geometric data, which can be said to be a high fidelity representation; 2) evidence base reconstruction for the purpose of adding surrounding urban structures; 3) hypothetical reconstruction of some of those urban structures. Making the user, in this case the reader, aware of these facts is vital in enabling them to approach the model critically.

METHOD

For the purpose of this study two distinct investigative methods will be employed. A top-down approach will be used to assemble the necessary information needed to become familiar with my

[6] Graham 2012, 4.
[7] Beraldin *et al.* 2006, 148-149.
[8] Beraldin *et al.* 2006, 141
[9] http://www.londoncharter.org/ - 2014/05/26

case study as well as on subjects of digital archaeology, virtual reality, virtual exhibitions, and 3D modeling. A bottom-up approach, implemented in the form of a 3D-model gained through acquisition in the field, will serve as a visual aid of the case study and act as an anchor which the audience and/or the reader can use to connect to the top-down approach. Staying true to the reflexive perspective both research approaches will be conducted simultaneously to approach the problem as holistically as possible.

First it was necessary to become acquainted with the case study. As a starting point, through studying the context of the Harpy Tomb — both the historical, cultural, and the geographical context — I aimed to gain a better understanding of the object in question and how to conduct my study in a manner that is both efficient and comprehensive. The primary means by which this was accomplished was by reading literature on the subject of Lycian history, culture, art and architecture.

The drawings and photographs of the site of Xanthus were invaluable for the purpose of understanding the position of the Harpy Tomb in the urban landscape of ancient Xanthus. The drawings accessed were mainly those found in the literature, while the pictures are from more recent visitors and excavations.[10] A simple Google image search also provided ample material. Something I just stumbled upon and which I consider a stroke of extraordinary luck is the possibility to use the globe-trotting powers of Google Maps, which let anyone with an internet connection travel the world while remaining quite stationary. In this case not only is the viewer afforded a top-down view of the site, but they are also able to have a 360° view of the agora at Xanthus which includes a view of the remains of the theatre as well as the two towering tombs next to it, one of which is the Harpy Tomb. All you need to do is find Xanthus in the south of Turkey and zoom in enough to go into what Google calls 'Street View' by placing the icon of the orange man on the blue dot which appears on the site of Xanthus.

The data required to make the 3D model was captured during an acquisition campaign which was conducted at the archaeological warehouse in Gastelyckan, Lund on the date of 28/02/2014. The objects to be captured were plaster casts of the original Harpy Tomb bas-reliefs which are housed in the British Museum in London.[11] Two techniques of digital acquisition were used so that if time allowed it a comparison between the techniques could be made. The two methods of acquisition were a 3D scanner of type Faro Focus3D 120, and digital photographs for the purpose of photogrammetric 3D reconstruction using Agisoft Photoscan software.

[10] See n. 85
[11] Catalogue number: Sculpture B287.

A Background to The Harpy Tomb: An Early 5th Century BC Lycian Tomb

In this chapter, information on the Harpy Tomb will be presented so as to place it within its historical and cultural context. This information will in no way be comprehensive, but hopefully it will offer the reader sufficient knowledge of Lycia to provide a greater understanding of the Harpy Tomb, which in turn will hopefully benefit in the understanding of the analysis in the next chapter. Another important aspect that will be touched upon is that Lycia was located at a cultural crossroad and was heavily influenced by both the Greek and Persian cultures — therefore this chapter will also touch on how this hybridization can be identified on the Harpy Tomb reliefs.

An Introduction to Lycia

Lycia was a geopolitical region in the south-west of Anatolia. It's location on a broad peninsula, surrounded on three sides by the Mediterranean and separated from its neighbors by mountains, left it a somewhat isolated region throughout antiquity and until modern times.[12] The central and eastern landmass of the peninsula are dominated by many small valleys divided by mountain ridges. Such terrain made travel over land difficult and the only easily accessible areas were along the coast and the long Xanthus river valley in the western part of the peninsula, but even this valley was most easily accessed by the sea. The geography of the region had a profound impact on shaping the Lycian culture and also controlled the extent of the Lycian sphere of influence. Authors Kirsten A. Gay and Thomas Corsten have explored to what extent this influence reached in the North by studying the similarities between rock-cut tombs from the region called Kibyratis with those found in more central regions of Lycia.[13]

A fact which has always remained undisputed is that the Xanthus river valley was the center of Lycian culture and that it had a long history of political unity.[14] The city Xanthus is situated roughly 10 km inland and sits on a rocky outcrop overlooking the river. Despite it not being the largest city in Lycia many consider it the most important and at times even the capital of a Lycian league. This is due in large part to the greater number of carved funerary monuments to be found here than at other Lycian sites, but also because when reading ancient authors Xanthus appears in many cases to be synonymous with Lycia. Another important clue which lends support to the importance of Xanthus is that the rulers of Lycia, referred to as 'kings' before the Persian

[12] Keen 1998, 15.
[13] See Gay and Corsten 2006, 47-60.
[14] Keen 1998, 58.

conquest and as 'dynasts' afterwards, minted their coins here.[15] In Classical times Lycia probably constituted a collection of city states under the leadership of the city Xanthus.[16]

The Origins of Lycia

The earliest mentions of the region we know as Lycia come from Hittite and Egyptian records during the Late Bronze Age (LBA). They refer to a group of people called the Lukka who lived in South-Western Anatolia and were, as suggested by Trevor R. Bryce and Jan Zahle, "a conglomerate of independent communities, presumably with close ethnic affinities", which were subject to the Hittites.[17] So far however, the earliest evidence of settlement in the region, which is at the site of Xanthus, dates only to the 8th c. BC, but Bryce and Zahle suggest that the populations inhabiting the region at this time may have been nomadic or semi-nomadic and that therefore their material culture was too fragile to have survived.[18] Whether that is true or not we cannot know, but one thing the majority of scholars can agree on is that there have been no systematic surveys of Bronze Age remains in Lycia and that we should refrain from jumping to any conclusions.[19]

Greek literary traditions tell that Lycia was settled by Cretan immigrants. Apollodorus tells a story of a quarrel between the brothers Minos and Sarpedon over a boy named Miletus, who favored the latter. Minos emerged triumphant which led both Sarpedon and Miletus to flee to the Anatolian coast. Miletus founded a new settlement and named it after himself, while Sarpedon was received by his uncle in Cilicia and was thereafter established as king of Lycia.[20] Another tradition claims that it was Sarpedon founded Miletus and named it after his own city origin on Crete.[21] The importance of Sarpedon's connection to Lycia is evident from other literary sources such as Homer's *Iliad* where Sarpedon and Glaucus lead the Lycian forces fight on the Trojan side, and from the Sarpedonion monument found on the acropolis in Xanthus. Bryce and Zahle point out the discrepancy of "the traditions which on the one hand represented Sarpedon as a participant in the Trojan War and on the other as a refugee from Crete", but as they also point out it was not unusual to connect the past (whether legendary or historical) to a local hero.[22]

Yet another tradition is recorded by Herodotus, who claims that the Cretan immigrants were known by the name Termilae and that it was the name the Lycians used for themselves while the Greek name for them was *Lykioi*, which is derived from Lycus, an Athenian who

[15] Keen 1998, 58.
[16] Keen 1998, 15; Atik *et al.* 2013, 225.
[17] Bryce and Zahle 1986, 4.
[18] *Ibid.*, 2.
[19] Keen 1998, 27; Bryce and Zahle 1986, 2.
[20] Apollod., *Bibl.*, 3. 1. 2.
[21] Strabo 12. 8. 5; 14. 3. 10 (quoting Ephorus).
[22] Bryce and Zahle 1986, 21.

sought refuge in Lycia.[23] According to Trevor R. Bryce, Trmmili, which is the un-Hellenised form of Termilae, can be found in a neo-Babylonian cuneiform inscription from Nippur dating to c. 420 B.C. in the form ta-ar-mi-la-a-a.[24]

Linguists who have studied the Lycian language have found that it is closely related to Luwian, an Indo-European language which in turn is related to Hittite and was widely used in this region during the LBA. The linguistic studies point to a high likelihood that some of the ancestors of the Lycians came from Western Anatolia.[25]

Historical Lycia

As seen above, Lycia is mentioned by several ancient authors, albeit usually it is just a quick reference. Herodotus is often accredited as being the first historical source we have of Lycia. He claims that Croesus, the Lydian king, subdued every people West of the Halys river except the Cilicians and the Lycians.[26] As it was in the LBA, Lycia was a collection of city-states which may have shared cultural similarities but did not possess any political unity. However the tendency of ancient authors to treat Xanthus and Lycia as synonyms indicates that Xanthus was perhaps the leading city in an alliance of city-states.

Lycia remained independent until the Persian conquest of Anatolia in c. 540 BC.[27] A Persian general named Harpagus lead the invasion of Lycia and defeated a small Xanthian force outside Xanthus. The inhabitants retreated to the acropolis and upon seeing that defeat was imminent the remaining men killed all the women, children and slaves, then burnt the acropolis before they committed themselves to a suicide charge against the Persian force. According to Herodotus only 80 families are said to have survived because they were away from the city at the time. After the Persian conquest a new Xanthian dynasty was established, sometimes called the Harpagid dynasty after the Persian general Harpagus.[28] It is also during this time that the location of the elite burial grounds changed. Some speculate that this change in location indicates a shift in power.[29] Following the failed Persian invasion of Greece in 480 BC Lycia was passed between the Athens (later the Delian League) and Persia several times in the following decades.[30] It is

[23] Hdt. 1.173. For a more detailed description of the different theories of Lycian origins see Bryce and Zahle 1986, 21-23.
[24] Bryce and Zahle 1986, 22-23.
[25] *Ibid.*, 2-3.
[26] Hdt. 1.28.1.
[27] Bryce and Zahle 1986, 99.
[28] See Keen 1998, 76-79 for a more detailed description of the theories surrounding the new ruling dynasty established at Xanthus following the Persian invasion.
[29] Keen 1998, 80-81.
[30] See Keen 1998, 97-135 for a more detailed description of the geopolitical shifts in the region during this period.

during this time that the Harpy Tomb was erected, but more on this in the 'Research History' section.

Perhaps the most significant urban development took place after the Romans took control of Lycia sometime in the middle of the 2nd century BC.[31] The Romans built extensively on the acropolis and most of the ruins excavated and visible today belong to the period of Roman rule, but Bean suggests that the Romans took care to preserve the old Lycian monuments.[32].

THE HARPY TOMB

Jan Zahle has divided the tombs of Lycia into four different categories. The most common type is the rock-cut house-tomb, followed by the gothic sarcophagus, the pillar tomb, and finally a handful of monumental heroön-type tombs. The pillar tombs are the earliest type and began to appear sometime around 540 BC.[33] As will be mentioned in the section on research history most scholars agree that the Harpy Tomb dates to somewhere between 480-470 BC and is considered to be a second generation pillar tomb.[34] This second generation comprises the tombs built after the Persian conquest, which lead to a new ruling dynasty taking power in Xanthus. The Harpy Tomb, located adjacent to the Roman agora and theatre stands in a prominent position today, just as it did in antiquity, and it commands a view of the valley below to the West.

The monument stands on a base carved from a solid block measuring 3.8 x 4 meters and rises 1.45 meters high. Upon this base the monolithic pillar which weighs ten tons stands at a height of 5.43 meters with a horizontal measurement of 2.5 meters on the East and West sides, and 2.3 meters on the North and South sides. The pillar still has large square lifting bosses projecting out from it on the North, West, and South sides. At the top of the pillar is a grave chamber which is walled in on four sides by carved marble panels. These panels, three on each side which makes twelve in all, are carved with bas-relief in the large-grained marble and stand 1.03 meters high. For the horizontal measurements of each panel see the top of next page.

[31] See Bean 1978, 26-30 for a more detailed description of the Lycian relationship to Rome.
[32] Bean 1978, 55.
[33] Keen 1998, 182.
[34] Draycott 2008, 146.

Panel	Measurement	Designation using naming convention designed for this study.[35]
East centre panel	127 cm	E2
East left and right panels	60 cm	E1 and E3
West centre panel	86 cm	W2
West "cow" panel	41 cm	Part of W2
West left panel	57 cm	W1
West right panel	61 cm	W3
North centre panel	108 cm	N2
North left and right panels	61 cm	N1 and N3
South centre panel	108 cm	S2
South left and right panels	61 cm	S1 and S2

A more thorough description of the bas-relief carvings in the panels will follow. Topping the monument is a capstone in the shape of an inverted pyramid with three steps which forms a three step entablature on each side, and a final step in the shape of a smaller block with a height of 0.5 meters. The capstone also acts as the roof of the grave chamber. All these parts combined give the pillar tomb a total height just shy of 9 meters, but different sources offer different heights.[36]

The reliefs were acquired by Charles Fellows in 1842 under commission of the British Museum where they are still on display today, but this will be covered in more detail in the next section of the chapter. Fellows also gave the monument its current name upon recommendation from a friend.[37] The winged figures were at first presumed to be Harpies, therefore the name of the tomb, but more recent opinions identify them as Sirens carrying away the shapes of children which are meant to symbolize the souls of the dead.[38]

CHARLES FELLOWS AND HIS TRAVELS TO TURKEY

The Harpy Tomb of Xanthus has been one of the most prominent objects of study during this last century and half of Lycian studies. The history of research on the Harpy Tomb is a long one and it begins with Charles Fellows (1799-1860), the man who first brought ancient Lycia to the attention of the European (mainly the British) public. Fellows fondness for travel and adventure, combined with his classical education, led him to journey extensively in Italy and Greece during

[35] The naming convention will be used in the section 'A Description of the Bas-Reliefs'.

[36] Shahbazi 1973, 23; Bean (1978, 56) ignores the base when stating that the height of the monument is 25 feet (7.62 meters). Also the British Museum states that the total height of the monument is 8.84 meters (https://www.britishmuseum.org/explore/highlights/highlight_objects/gr/r/harpy_tomb_relief_panel.aspx – 2014/05/23).

[37] Draycott 2008, 146. This will be described in more detail in the section on Research History.

[38] Slatter 1994, 238. See the section on Research History for a more detailed explanation.

the 1830's while exploring many of the ancient sites along the way.[39] His fascination with the Orient coupled with his awareness of the classical remains in Turkey led him to a decision in 1838 to conduct the first of what would become four journeys to Turkey. Instead of taking the more common coastal route he opted for the inland route, a decision which led him to discover many of the cities of ancient Lycia and upon returning to Britain he published an account of his travels and discoveries in *A Journal Written During an Excursion in Asia Minor*.[40]

Fig. 1 A pencil illustration of Charles Fellows. Drawn by William Brockedon 1845.

In her book *From The Harpy Tomb to the Wonders of Ephesus* the author Debbie Challis writes about something she calls the 'traveler-archaeologist', a profession which emerged in the mid 19th century, and which constituted a bridge between the earlier 'marble-hunting' and 'Grand Tour' gentlemen archaeologists of the 18th and early 19th century, and the professional archaeologists of the later 19th century who adopted a scientific approach.[41] While not researching the monuments *per se* Challis looks at the men who conducted these journeys and excavations during the mid 19th century and she presents Charles Fellows as a prime example of a pioneer in what was a transitional stage for both archaeology and archaeologists. Enid Slatter, another scholar who has written a book about Fellows endeavors in South-West Turkey, also labels him a 'pioneer archaeologist'.[42] Another important aspect of the work of these pioneering archaeologists was that they published their discoveries. Literature on travel and exploration was becoming increasingly popular among the readers of the early 19th century and 'travel-archaeologists' like Fellows used this to their advantage to draw attention both to themselves and to their discoveries.[43] Another means of capturing the imagination and the interest of the public, which was becoming increasingly more common, was the use of illustrations, and it was for this purpose that Fellows had asked the artist George Scharf Jr. to accompany him in 1839 on his second expedition to Lycia.[44]

[39] Challis 2008, 23.
[40] *Ibid.*, 23.
[41] Challis 2008, 5 and 24; Slatter 1994, 221.
[42] Slatter 1994, 10.
[43] Challis 2008, 6.
[44] *Ibid.*, 33.

Already his first publication in 1838 succeeded in capturing the attention of the British Museum's Board of Trustees who set about organizing an expedition to bring back some of the Lycian antiquities, although it wasn't until 1841 that the Museum received written permission from the Ottoman Sultan to excavate at Xanthus. The Museum contacted Fellows to inquire about the location of the antiquities, but upon learning that no knowledgeable person would accompany the excavation team Fellows offered his services at his own expense to ensure that the objects of interest would be handled correctly.[45] Some important aspects of Fellows techniques was that he desired to label and record every piece of the structure before it was disturbed, and that he wished to preserve the entire structure instead of just stripping it bare of the sculpture which was common practice among earlier explorers such as Thomas Bruce, or as he is more commonly known Lord Elgin.[46]

Over the course of two expeditions in 1841-42 and 1843-44, both conducted under the supervision of Fellows, several monuments were brought to the British Museum. The largest of these monuments were the Nereid Monument (at first called the Ionic Trophy Monument), the Tomb of Payava (a Gothic type tomb), and the bas-reliefs of the Harpy Tomb which were all displayed in a 'Lycian Room' in the Museum between the years 1848-1878.[47]

The subject of repatriation being such an important topic in today's world of museology has meant that Fellows has been criticized for his role in the removal of the Xanthian monuments.[48] Now, before getting bogged down in the 'rights' and 'wrongs' of this topic I feel it is important to note that in this case it is clear that the expedition to remove the monuments would have gone ahead whether Fellows was in charge or not. As mentioned above, when he heard that the expedition did not include anyone with local knowledge he offered his services to ensure the safe excavation and transport of the monuments. Challis defends the methods of Fellows to a certain extent, pointing out that his methods, though undoubtedly destructive, were redeemed by his desire to retrieve the monuments in their entirety.[49] In a similar way Slatter dislikes the way that Fellows has been described to modern audiences and defends him from what she considers an unjust amount of criticism, the lack of accurate depiction of his accomplishments, and in some cases the complete omittance of them; such as his exploration of Lycia.[50]

---

[45] Challis 2008, 33; Slatter 1994, 7.
[46] Challis 2008, 34-35; Slatter 1994, 222
[47] Keen 1998, 3
[48] Challis 2008, 34
[49] *Ibid.*, 34-35
[50] Slatter 2008, 10

A DESCRIPTION OF THE BAS-RELIEFS

What follows here is an objective description of the Harpy Tomb reliefs. A written description of something like these reliefs forces an individual to take a long hard look at the object of interest and to become familiar with it. So the reason behind these descriptions is two-fold. On the one hand it is meant as a process of familiarization with the object of study. By making a detailed study of the reliefs and describing them with my own words I will be better equipped to conduct my analysis. The second reason is for the reader to go through a similar process of familiarization so that they will better be able to understand my analysis. At the end will also be a short section describing to what extent the panels were colored.

In order to make it easier for the reader to follow which relief is being described I will establish a naming convention. As the monument is aligned to the cardinal points of the compass it is only logical that each of the four sides be named after the direction it is facing: North becomes N, South becomes S, and so forth. Also each side consists of three panels of reliefs and these will be numbered 1 to 3 starting from the left as if you were facing that side. So if you are facing the North side and looking at the leftmost panel it will be referred to as N1, and the rightmost panel will be N3. I will describe each side in the order East, West, North, and finally South, while for each side proceeding from panel to panel in an order from left to right. My reasoning behind this is as follows: I begin with the East side because it is widely regarded as the main relief as it was the one facing the agora; and instead of proceeding clockwise around the monument I have opted to follow this with the opposing West side because I decided that the two remaining sides shared similarities and would benefit from being described in succession.

The East side

The East Side depicts five human figures and two animals in all. Panel E1contains two standing, right-facing, and bare-footed female figures wearing near ankle-length dresses which on the left figure can be seen to be constrained by a belt at the waist. Beneath the dresses other clothing are visible which reach all the way down to the ankles. Much of the detail in this panel has been lost due to weathering, but the folds in the dresses are still visible as are the fine vertical folds in the clothing underneath the dresses. Traces of hair are visible on the figures; the left figure has suffered much damage to the head so the hair is barely visible, while the right figure is better preserved and the hair can clearly be seen falling past her shoulder. These two figures are what is known as 'adorants' which are figures that face the main figure while bearing gifts or portrayed in a pose which comes off as showing respect. The theme of adorants in this panel recurs on other parts of the monument and is almost copied on the west side.

The left figure is grasping the dress at just below waist-height with the left hand while the right arm is held up with the hand curving towards the face. Due to the poor state of preservation it is impossible to see what the figure is holding in the right hand. The right figure is holding out her left arm slightly in front of her and is holding in her hand what looks to be a rope which is attached to a rounded object hanging just below the hand. The dress can be seen draped over the left arm up to the wrist from where it falls down to just below knee-height. The right figure is holding her right arm in a similar fashion as that of the left figure, except at a lower angle. While the left figure is lifting her arm up to bring her hand to her face the right figure holds the arm forward nearly at a 90-degree angle from the body with the hand curving upwards. However it is impossible to discern what action the figure is performing with the right hand.

Panel E2 contains of 3 figures: an imposing seated, male figure on the left side, and a much smaller male figure on the right side bearing the final figure, a rooster. The large male figure is sitting on an elaborate chair. The frame of the chair consists of a slightly backward leaning back rest onto which the figure is reclining; an arm rest attached to the back rest and held up at the front by a decorative figure in the shape of a bearded merman; and the front and back legs of the chair which are supported by a beam situated just above mid-way. A large portion of the back leg of the chair has been lost due to damage, but the front leg ends in a decorative lion's foot. The seating of the chair also looks to be cushioned.

The seated male figure is facing right and with the chair he takes up half the panel. His hair line and long beard are clearly visible but the detail have been lost due to weathering. His right arm is bent at the elbow and in his hand he holds a flower up to his nose. The flower is clearly pinched between his fore finger and thumb while his remaining fingers are extended. His left arm (the only visible parts being his wrist and hand because the rest is hidden from view by his figure) is resting horizontally next to him with the hand positioned in front of him and lightly placed upon a staff. The staff stretches diagonally through the scene, from the lower center of the panel where it extends in front of the figure to the upper left where it disappears behind the beard of the figure, presumably coming to rest on his shoulder. The bare feet of the seated male figure are mostly gone due to damages but the heels are visibly placed on some kind of foot rest. The clothing of this figure is similar to that of the figures in panel E1. He wears a long robe with large folds which reaches down to below knee-height and beneath that he wears another fabric with has much finer folds which reaches down to the ankles. The clothing can also be seen to cover the left arm up to the wrist.

The other male figure and the rooster are afforded much less space in this panel. Their position in the bottom right of the panel leaves much empty space between them and the seated

male figure as well as above them. The lower half of the smaller male figure has been lost due to damage so only the torso is visible. He is looking up at the seated male and is carrying gifts. The clothing is similar to those of the previous figures, but most of the details have been lost and only some folds are visible. The small male figure is holding his arms stretched out in front of him in an offering gesture to the seated male figure. In his left hand he is holding a rounded object and in his right hand he holds a rooster. The rooster is shown in a standing position but is being held under the belly by the small male. Now, either this is a well-behaved rooster standing (being held?) at attention or it could be a piece of art. We should not discount that it may also be a case of the sculptor clarifying that a rooster is being offered; whether it is dead or alive perhaps does not matter.

With regard to the size of the small male figure it can be argued that it is an extreme case of value perspective where the seated male figure is the more important of the two and is therefore depicted much larger. I do not agree with such an interpretation because none of the other adorant figures (panel E1 and E3), although visibly smaller than the seated male figure, are portrayed so much smaller. I am confident in saying that a male child is depicted. The rooster in panel E2 provides a direct link to Persian culture. Among Persians, the sacrifice of a rooster at the tomb of an illustrious man was a ritual that dated back to before the time of the Achaemenids.[51]

The final panel on the East side, E3 contains a male figure and a dog. The standing male figure is facing left and takes up the right side of the panel. His clothing is similar to that of the previous figures with the exception of a large bundle of fabric draped over the left shoulder. His hairline is clearly visible, as is his beard, but the details of the hair have been lost due to weathering. The figures left arm is held next to him with his elbow at a 90-degree angle so that his fore arm extends forward from waist height and in his hand he grasps a cane, which extends down to the bottom left of the panel. His right arm is held out in front of him and is slightly bent upwards, but his hand has been damaged and is mostly gone. Below him stands a dog which is shown behind the figure so it is standing to his right. The dog's head is turned upwards and is facing the human figure. (Fig showing the render of the East side is found at the top of page 15.)

[51] Shahbazi 1973, 208-209.

Fig. 2 A render of the East side. Rendered using Cycles render in Blender.

The West side

The West side depicts two animals and five human figures, two of which are seated at the extremes. Panel W1 contains a right-facing seated female figure and is overall relatively well preserved with the exception of the missing top right section. Much of the detail is still visible, such as the decorated clothing as well as the details around the head such as the hair-style and the crown-like headdress. The figure is wearing a long dress which reaches beyond her feet and extends backwards below the chair and the arms of the dress extend down on her forearms. Her right arm is resting on the armrest of the chair and in her hand she holds a plate forward. Her left arm is extended upwards diagonally and on her wrist a bracelet is visible, however the hand has been lost. Her bare feet are resting on a footrest. The chair she is sitting on is cushioned and is well decorated. The backrest has been lost but the armrest, which is similar to that of the chair in panel E2, is connected to the backrest and held up at the front by a decorative figure; this time a winged sphinx sitting on its haunches. The legs of the chair are narrow and are supported by a beam just above halfway down.

Panel W2 is the only panel which differs from the others in its shape. The bottom left of the panel has a hole which was used to gain access to the tomb chamber. The panel contains two animal figures and three human figures. The animal figures are positioned above the hole and show a cow being suckled by its calf. The head of the cow is missing due to damage to the relief. This small portion of panel W2 which includes the cow and the calf is cast separately from the rest of the panel and is also not included in the measurements of the whole panel. The three human figures are women and they are facing right and are moving in procession. The left woman's feet are missing but it is possible to see that the other two have bare feet. All three have the same hair style with long flowing hair that falls down the back and over the shoulders onto

the front. All three women have the same clothes, long ankle-length dresses with the arms of the dress reaching their forearms and they also have bracelets on both wrists. The woman on the left is grasping her dress at waist-height with her left hand and in her right hand she holds an egg-shaped object which she has raised to face-height. The center figure is holding a flower in her left hand which she has raised up to face-height. In her right hand she holds the same round object on the end of a string as the female figure in panel E1. The woman on the right has her left arm raised up in front of her at face-height but her hand is missing due to damage. She is using her right hand to grasp her dress at waist-height.

Panel W3 contains a seated woman much in the same style as panel W1. This panel has also preserved a great amount of detail and it has suffered less damage than its counterpart on the opposite end, thus giving it a slightly better state of preservation. The chair in this panel is of a much heavier build than the previous two. The overall design is similar except that the front of the armrest is not held up by a decorative figure and that the backrest is preserved which allows us to see that the top of the backrest ends in a swans head. The woman's hairstyle is different from that of the woman in panel W1 because it has larger folds and is gathered in a bun at the back of the neck. The dress is of the same length as that of the woman in panel W1, however the folds are slightly heavier. In her right hand grasped between her forefinger and her thumb is a flower which is held up to the nose. Her left arm held at her side and is bent at the elbow at a 90-degree angle which puts her hand out in front of her. In it she holds a rounded object.

Fig. 3 A render of the West side. Rendered using Cycles Render in Blender. The portion of panel W2 containing the calf was cast separately and therefore also captured separately through photography for the purpose of image-based modeling. However, the time frame of this work was limited and the inclusion of said portion of the panel will instead occur sometime in the future.

The North side

The North side depicts five human figures, two human-like figures and one animal figure. Panel N1 contains a left-facing female winged figure and a smaller human figure. The winged figure has a body in the shape of an egg with the head and arm of a human. Of the four winged female figures in the reliefs she is the only one that shows one human arm. The head has suffered from weathering but the hair style is still visible as braids that fall past her shoulder on the front, and her headdress could be a band, a diadem, or a crown of some sort but it is not clear. As with the other three winged figures in the reliefs she has tail-feathers and a pair of wings which are stretched back. However, her wings differ from the others because they do not bend at the joint in the wings as much as with the other three figures. Below the human arm can be seen an arm of more avian characteristics: it is more claw-like and bony. Using both the human and the avian arm she is grasping a smaller human figure which is facing the winged figure. The small figure wears a full-length dress and has her left arm stretched towards the face of the winged figure while the right arm is held loosely at her side. The small figure merges with the panels edge and is damaged to the degree that the head has lost most of the detail.

Panel N2 contains two human male figures and an animal figure. On the left is an armored male youth facing right. Although part of his head is missing, and the details have been lost, it is possible to see that he has no facial hair. His legs are bare from the middle of the thigh and down. At his side he wears a sword of which the scabbard can be seen sticking out behind him. In his left hand he holds a *hoplon* shield which is standing vertically and resting on the floor in front of him. His right hand is stretched out and he is holding onto a crested helm which is also held onto by the other figure in this panel. The other male figure is seated but even in his seated position his head is shown at the same height as that of the standing youth. In his left hand he holds a long staff which is positioned diagonally and stretches from the feet of the standing youth and comes up to rest on the seated man's shoulder. He also has two layers of clothing, a finer type underneath which stretches down to the ankles and one with heavier folds on top. The chair he is sitting on is cushioned or padded but is of a simpler type than the previous ones described above. It has no backrest or armrest and no supporting beam on the legs. Instead it seems to be a more a type of stool than a chair. Underneath the chair is an animal with a heavy build which is sniffing at something on the ground. It is difficult to make out due to weathering but the animal could be a pig, a boar, or a dog.

Panel N3 contains one female winged figure facing right, and two human figures. The winged female figure shares the same egg shape and avian arm as that of its counterpart in panel N1. This one shows two human arms; one wrapped around the back of the smaller female figure

she is holding and the other held beneath the buttocks to support the weight while at the same time grasping the legs with the avian arm. The hair style is different with the braids bunched up at the back of the head in a corkscrew position and she also wears the same type of headdress as the winged figure in panel N1. The smaller human figure which is being carried mirrors the one in panel N1. Below these figures is a kneeling female figure with both hands raised to the face and she appears to be weeping or mourning. The panel is damaged in the bottom left but judging by the other panels it is unlikely that a great amount of information has been lost.

Fig. 4 A render of the North Side. Rendered using the Cycles Renderer in Blender.

The South side

The South side depicts four human figures, two human-like figures, and one animal figure. Panel S1 depicts a left-facing female winged figure carrying a smaller figure. The hair style is different from the previous winged figures in that it is bunched at the neck but has more in common with the figure in N3 than the one in N1. She wears the same headdress as the two previous winged figures. Using both human arms and the avian arm she grasps the small figure in the same manner as that of the figure in N3. The smaller figure has her right arm raised to the shoulder of the winged figure while the left one hangs at her side but only the hand is visible where it appears below her. A piece of the panel is missing in the bottom right corner.

Panel S2 contains a right-facing, seated male figure, a left-facing, standing female figure, and a dove being carried by the female figure. The seated male figure has most of the head missing due to damages. He is holding objects in both his hands; in his left a clearly circular object while the one in his right hand is indiscernible due to the lack of detail. He has a staff on his left side which is leaning against him in the same fashion as that of the seated figures in panels S2 and E2. His clothing is also of the same fashion as previous figures and he is also barefoot.

The chair he is sitting on has a backrest but no armrest and a leg design which is similar to that of the chair in panel W1. The bottom left of the panel is missing and with it the back leg of the chair and much detail on the left side of the panel has been lost due to weathering. The standing female figure is wearing the same style of clothing as previous figures and is barefoot. In her left hand she holds a dove by its wings and her right hand is held up in front of her with her palm exposed and the fingers stretched out. Her whole head is missing with the top right of the panel due to damage.

Panel S3 depicts a winged female figure which is also carrying a smaller figure. Her hairstyle bears a resemblance to that of the winged figure in panel N1. Two braids of hair hand past her shoulder while more braids fall onto her back but disappear behind the shoulder. Her headdress is the same type as that of the three previous figures. Using two human arms and the one avian arm she grasps the smaller figure in the same manner as the winged figures in panels N3 and S1. The panel has suffered minor damage in the top- and bottom left corners.

Fig. 5 A render of the South side. Rendered using Cycles render in Blender.

Colored stone

Alireza Shahbazi reports that the Harpy Tomb was once richly decorated with colors, but that only patches remain visible today. The deterioration of the colors is likely due to a combination of repeated cleaning and general weathering. In his PH. D. dissertation he provides a short description of which parts of the marble panels were colored.[52] A bright blue color was used along the ground of the reliefs, and before it disappeared it was also visible under the wrist of the right figure in panel E1, as well as around the head and left hand of the figure in E3. Red was also a very common color as all accessories were painted red, as were parts of the shield in N2,

[52] Shahbazi 1973, 37-38. See this for a more detailed description of the color remains on the Harpy Tomb.

and on the sandals of the figures. Patterns were also present on different parts of the monument, those that survive can be found underneath the throne in panel E2 and on the throne in panel W3.

RESEARCH HISTORY

Since its rediscovery in the middle of the 19th century ancient Lycia has been studied by historians, archaeologists, numismatist, and philologists alike and their endeavors have greatly contributed to our understanding of this ancient culture. This broad scholarly attention shows what a rich and interesting area of study Lycia can be. One of the main reasons for this is because in many ways Lycia exhibits unique cultural characteristics which have been influenced by both the Near East and by Greece, and later by Rome. Some scholars strongly believe that studies on Lycia can contribute to their respective fields of research in Near Eastern and Classical studies.[53]

The Lycian Marbles caused somewhat of a sensation when the exhibition at the British Museum opened in 1848 and it drew artists, architects, and archaeologists from all over Europe who were interested in studying the marbles.[54] Among these was for example Georg Friedrich Grotefend, a linguist whose studies introduced Lycia to the German scholars. Other notable German scholars who followed Grotefend were Carl Wilhelm Goettling and Theodor Panofka.

After Fellows much of the academic investigation of Lycia was carried out by Austrian scholars who conducted several surveys of the region. However, interest in Lycia waned and for the first few decades of the 20th century not much investigation was carried out.[55] Work began again earnestly in the 1950's when French archaeologists began excavating at Xanthus.[56] Their excavations, which are still on-going, have provided much clarity to the chronological development of Lycian Xanthus.[57]

When introducing their two-volume compilation on studies of Lycia, the first of which was published in 1986, Trevor R. Bryce and Jan Zahle were pleased to note that scholarly interest in Lycia and publication of studies on Lycia had increased during the last two decades. They felt that the time was "appropriate to gather together the information now available", partially due to the new advances but also because the last time anyone had done something similar was just over a 100 years earlier by Oskar Treuber in his work *Gesichichte de Lykier*.[58]

[53] Bryce & Zahle 1986, vii.
[54] Slatter 1994, 330-331.
[55] Keen 1998, 3.
[56] Keen 1998, 3.
[57] Challis 2008, 29.
[58] Treuber 1887.

To be, or not to be, a Harpy?

At the time of the unveiling of the Xanthian Marbles at the British Museum the Nereid Monument, and particularly its statues depicting Nereids (hence the name), received the most praise for its aesthetic beauty, however it was still the Harpy Tomb which ended up sparking the most scholarly debate.[59] The longest standing issue surrounding the object of interest has been concerning the identity of the winged figures on the northern and the southern sides of the monument, but also the other figures in the reliefs have been much debated.

The monument received its name the 'Harpy Tomb' from Fellows after it was suggested to him by the sculptor Benjamin Gibson that the winged figures depicted were the harpies from the myth of the abduction of the Panderids.[60] Gibson arrived at this interpretation after consulting Strabo[61] who drew a connection between Pandareus of the Pandarid myth, and Pandarus from the *Iliad*, allegedly a Lycian hero who was honoured at the Lycian city Pinara. The harpy interpretation was quickly rejected by many scholars for several different reasons: the theme was deemed unsuitable for grave monuments; the framing winged figures bore no connection to the seated figures; the equation of Pandareus and Pandarus was deemed questionable; and the bird figures bore more resemblance to the established iconography for sirens.[62]

After a few decades searching for alternative interpretations by the beginning of the 20th century scholars had arrived at two possible interpretations. Writing in 1907 Oliver Tonks lists them as: 1) By now a very unpopular but still viable interpretation that the figures are harpies; 2) That the seated figures are infernal divinities receiving reverence from the dead souls and that the winged figures symbolize life because their bodies are egg-like.[63] In the end Tonks doesn't agree with any of them and instead presents his own interpretations in which he draws a connection between the iconographic style of the Harpy Tomb and that of Egyptian art. With this he then attempts an interpretation of the other human figures in the Harpy Tomb relief which he builds on work done by Curtius 40 years earlier, who saw similarities between the winged figures on the tomb and the Egyptian Ba-Bird, a figure which was in charge of transporting the soul of the dead in Egyptian religion.[64] His interpretation never gained much support.[65] Tonks makes no mention of an interpretation by Weicker who five years earlier in 1902 likened the Ba-bird to the sirens.[66]

[59] Slatter 1994, 236.
[60] Draycott 2008, 146.
[61] Strabo 14.3.5.
[62] Draycott 2008, 147.
[63] Tonks 1907, 321-322.
[64] Curtius 1869, pp. 10-17.
[65] Tonks 1907, 322.
[66] Weicker 1902.

Even though the Egyptian interpretation never caught on, the notion of the winged figures carrying souls and their likening to sirens did, and it also became the most popular interpretation. In the last 20 or so years it has come under fire as the discussion has resurfaced. First in 1998 Keen states that these figures are neither harpies nor sirens but he does not explain his reasoning.[67] Writing in 2008, Draycott suggests that the winged figures have more in common with harpies than with sirens.[68] She approaches the subject by placing the reliefs in the wider context of use of myth on tomb monuments. She has three main arguments for her reasoning: traditionally sirens have not been depicted as carrying souls of the deceased; and such a tradition is unsupported outside the Harpy Monument reliefs; furthermore the scene depicted on the monuments is clearly an abduction.[69] She concludes by saying that this choice of tomb iconography is unusual and cannot be explained simply by attributing the locating of the Pandarid myth to Lycia. Instead she suggests that it could be a similar myth to which we have no literary counterpart and that the inclusion of the abduction motif was a novel way of expressing the loss of a loved one.[70]

Whom did the tomb belong to?

F. J. Tritsch was the first Western European scholar to pursue a different approach in describing the monument. I say first Western European scholar because in the second footnote of his article, *The Harpy Tomb at Xanthus*, he mentions that a Turkish archaeologist by the name of Ekrem Akurgal championed the same line of thought as Tritsch, only he had published his work earlier that year. The new approach was to abandon the "well-trodden track" of mythological interpretation and instead attempt to connect the monument to a historical figure.[71] Another topic raised by Tritsch and which according to him has not received the attention it deserves is the location of the monument in relation to other urban features.[72] As such monuments were meticulously placed with regard to their surroundings it is reasonable to say that such knowledge is crucial for any attempt at interpretation. An example of earlier researchers disregarding this aspect of the monument can be found in Tonks who assumed that the west side of the monument was the chief one.[73] An error which I feel brings in to question whether he only analyzed the monument from an iconographic point of view and completely ignored its context in the urban environment; in other words: did he ever look at a map of Xanthus? The consensus

[67] Keen 1998, 204.
[68] Draycott 2008, 145.
[69] Draycott 2008, 149.
[70] Draycott 2008, 149.
[71] Tritsch 1942, 39; Akurgal 1942.
[72] Tritsch 1942, 40-41.
[73] Tonks 1907, 326.

among scholars today is that the east side of the monument, the side which faces the agora, is the more important side.[74]

Another topic which has led to much research is the question of who was buried in the tomb. This is a rather complicated topic that involves several branches of research. To avoid the risk of a long-winded description I will not go into too much detail, but will try to present a general picture of how this topic has been researched.[75] The question posed is a difficult one to answer because the monument shows no signs of any inscriptions. Surrounding monuments and structures also give no clue as to who could be buried in the pillar tomb. The only exception is another funerary monument known as the Inscribed Pillar which is located on the north side of the agora. It mentions someone by the name of Xeziga, who is the presumed founder of the Xanthian dynasty (as scholars have named it).

For the most part researchers have had to rely on a combination of art-historic dating and historical sources in their attempt to shed some light on the matter. By studying the style of the sculpture of the bas-reliefs on the Harpy Tomb scholars have been able to identify 5th century BC Attic influences and have therefore dated the tomb to 480-470 BC, an estimate which most scholars agree on.[76] When it comes to historical sources the scholars have come to rely on Herodotus to provide the name of the person in question. Building on the suggested dates of the tomb's construction it becomes clear to anyone with knowledge of ancient Greek history that we are dealing with a very well known period in time: Xerxes invasion of Greece. When Herodotus describes the expedition of Xerxes he lists several individuals by name and their origin, and one of the persons he names is Kyberniskos son of Sikas, of Lycia.[77] Keen points out a verbal suggestion made by numismatist J. P. Six that the name should be emended to Kybernis son of Kossikas, based on the abbreviations found on coins from the period.[78]

The reason that this amendment becomes interesting for scholars is because the Lycian name Xeziga, the dynasty founder mentioned on the Inscribed Pillar, can be translated to Greek as Kossikas.[79] This would mean that the Kybernis mentioned by Herodotus would be the son of the founder of the Xanthian dynasty. Furthermore this fits well with the dating of the pillar tomb to 480-470 BC through the study of contemporary Attic influences and the dates of Xerxes expedition to Greece. These various clues combined is what has led most scholars to identify Kybernis as the original inhabitant of the Harpy Tomb.

---

[74] Draycott 2008, 147; Tritsch 1942, 42.
[75] For those who are interested in a more detailed explanation I recommend reading Keen 1998, 79-90.
[76] Keen 1998, 90.
[77] Hdt. 7.98.
[78] Keen 1998, 87.
[79] Keen 1998, 81.

THE HARPY TOMB: A DIGITAL REALIZATION

This chapter will deal with a highly technical subject matter, but I will try and present it in such a manner so that even readers who have no previous experience with these techniques will be able to follow and understand the process. The aim of this chapter is to guide the reader through the process of digitization from the acquisition to the finished model.

METHOD OF DIGITIZATION

The digitization process for this case study included of two phases. The first was an acquisition campaign using a phase shift laser scanner to capture the objects' geometry in high resolution. We also photographed the panels to attempt a reconstruction using image-based 3D modeling techniques if there proved to be enough time. The panels had not been arranged in any order with regard to their original position on the monument. They were placed on pallet-stands which were spread out and facing in different directions. A fragment of the center panel on the West side (W2) [80], which contained the cow and the suckling calf, had to be photographed instead of scanned because it was in a position which made it difficult to scan. The second phase was to use the point clouds acquired with the scanner together with Computer-based Visualisation programs to virtually reconstruct the Harpy Tomb.

On-site acquisition

The acquisition campaign was conducted at the warehouse of Lunds Universitets Historiska Museum (LUHM) in Gastelyckan, Lund. It was conducted by myself with the help of my supervisor Nicolò Dell'unto of the Institute of Archaeology and Ancient History at Lund University, and Stefan Lindgren of the Humanities Laboratory at Lund University. The main interest of the acquisition campaign was to accurately record the geometry of the reliefs.

The material which was digitally captured consists of plaster casts of the original reliefs of the Harpy Tomb, which are housed in the British Museum in London. The objects had been taken down from the shelves by the staff of LUHM warehouse and positioned by leaning them against wooden stands set on pallets ready for us to set up our equipment and start capturing the data. They had not been placed in any particular order, and some of them were positioned sideways or even upside down. The available space where they could be positioned was also very limited with many of them being placed back to back on the same pallet stand. It required some tactical and practical planning on site to get the most out of the scans. In most cases we were able to capture several panels at once because there were multiple casts on the same pallet or they

[80] See my Description of the Tomb.

were facing each other with an open space in the center which was a perfect location for placing the scanner. The irregular placement and positioning of the panels did not in any way affect the post processing and the development of the model because the orientation of the digital recordings can be easily manipulated within the software. However, had the positioning of the panels been planned better the acquisition could have been completed much faster, but more importantly the extra time would have made it possible to do multiple scans of each panel which would have resulted in a more accurate recording of the geometry of the objects.

Fig. 6 The site of the acquisition campaign. Visible in this photograph are roughly half the pallet-stands holding the plaster panels. On the left side of the photograph are Stefan Lindgren in the red sweater and myself in the grey. The bright light next to Stefan is one of the diffuse lights used to provide lighting for the photography acquisition. Note that the plaster panel in the bottom right of the photograph is not part of the Harpy Tomb. Between this panel and the second diffuse light is the Faro Focus3D 120 on a small tripod. This photograph is courtesy of Nicolò Dell'Unto.

The process of digitally capturing the objects was done using a Faro Focus3D 120 laser scanner that uses a technology called phase-shift-variation which makes use of two laser beams. One beam is sent directly to a sensor while the other is sent out and when it hits a surface it reflects back to the sensor. The sensor then compares the two to find the distance to the reflected surface to an accuracy of ±2mm. This distance is measured by comparing the phase of the wave of light of the direct laser beam to that of the reflected one whose light waves have shifted ever so slightly due the distance travelled. This way a single point of reflection is recorded. To enable the machine to capture many points the laser that is sent out is reflected off a mirrored surface slanted at 45° which sends the laser beam in a direction 90° off from the point of

emission. This mirror then spins at a high RPM (revolutions per minute) and enables the machinery to take measurements in a vertical arch. Furthermore, the machine itself spins on its axis in 360° thus allowing it to capture its surroundings with the exception of the area just underneath the scanner itself. The xyz coordinates of each point are calculated with the help of the rotation data and when the process is complete a huge number of points have been recorded and compiled to form a 3D point cloud which is saved onto the on-board memory card. The scanner also captures the color data which it assigns to each point.

The number of points captured decides the resolution of the scan. A higher resolution usually translates as better detail, but a larger amount of data can also become too much to handle and it slows down the post-processing phase of an operation. For this case study we set the scanner to record 10 million points and always positioned it in such a manner so that it was facing the panels head-on. Due to the time constraint we only had time to do 13 scans, but many of these include several panels in the same scan so we managed to get two scans on certain panels. Despite these extra scans there were still some areas of the reliefs that were not as well documented as they could have been. This was due to the fact that the laser could not hit that surface, but more importantly the geometry of the panels was properly recorded and for the purpose of this study these scans would be sufficient.

Post-processing

The second phase of the digitalization of the monument was the post-processing phase in which the various point clouds were cleaned and remeshed to give them a surface structure. For this process a software called Meshlab was used. Developed by the ISTI-CNR (Istituto di Scienza e Tecnologie dell'Informazione - Consiglio Nazionale delle Ricerche), Meshlab is an open-source software which aims "to help the processing of the typical not-so-small unstructured models arising in 3D scanning, providing a set of tools for editing, cleaning, healing, inspecting, rendering and converting this kind of meshes."[81]

The point clouds were first processed by Stefan Lindgren of the Lunds University Humanities Lab who transferred them from the raw scanner data into manageable PLY (.ply) file-format. PLY stands for Polygon File Format and is a format designed to store three-dimensional data from 3D scanners. There were 13 .ply files in all and each one averaged around 275Mb in size. The first order of business was to create a back-up of the original .ply files. This was done to ensure that if the original files were corrupted or overwritten it would not lead to massive delay or the collapse of the entire study.

[81] http://meshlab.sourceforge.net/ - 2014-04-18.

Each file was individually imported into Meshlab and cleaned. The vast majority of the points captured by the scanner belonged to the surrounding warehouse. Depending on how many panels were in the scan, different initial approaches were employed. As mentioned previously, in many cases multiple panels were scanned at the same time and these had to be separated. This was accomplished by the very manual process of cleaning the point cloud. By using a box selection tool the points which made up the panels were selected. The selection was based mainly on color (the plaster panel had a different color than the wooden supports which held it up) but also on the faint geometry that could be discerned from the point cloud. Then using the Inverse Selection tool in the Selection menu all points except the panels would be highlighted and these would then be deleted.

Once the initial cleaning was complete there remained some traces of surrounding objects which were removed using the same technique as just described. The next stage was the meshing process which reconstructs the surface using the poisson remeshing tool. By using duplicate layers it was possible to isolate each panel by deleting the undesired points (even if these made up a panel) because they would still be present in the original layer. Through this process of duplication and deletion each panel could be remeshed individually. Reconstructing a surface from a point cloud is done by connecting the dots and creating triangles which are called 'faces'. Each face consists of three points, called 'vertices', connected by three lines, called 'edges', which make up the boundaries of the face. Once the remeshing process was complete the geometric pattern of the object became much clearer which made it easier to do some further cleaning around the edges. After every remeshing excess surface areas were created, and in some cases a 'bubble' would form, but getting rid of these was a simple task. By using the selection tool which can be found in the Selections menu (Filters > Selection > Select Faces with edges longer than..) a user is able to select faces with edges longer than a specified length. The default setting for this selection tool tends to select the majority of the larger faces. However for a better result it is best to proceed by trial and error and keep an eye on the selection. Once happy with the selection it is important to delete these faces using the delete option which deletes the selected faces and the vertices surrounded by them.

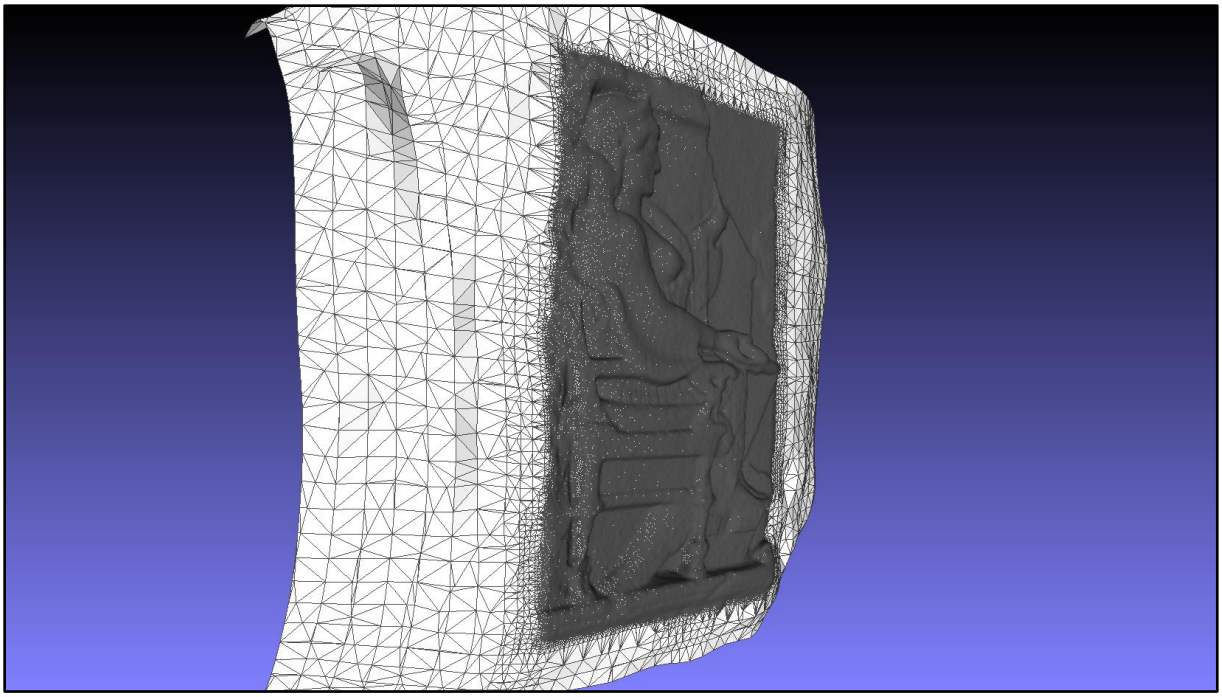

Fig. 7 A wireframe and surface view of a newly completed mesh using the 'Poisson Remeshing Tool'. This is also an example of when excess surface is created as an effect of the remeshing process. The darker area indicates where the point cloud is most dense and where the amount of faces is most abundant. The lighter area with the larger faces is the excess surface which was created as part of the process of remeshing and these were disposed of.

Once sufficiently cleaned the model was saved before proceeding to the next step. At this stage the model was too large to import into a 3D modeling software. As mentioned earlier the more vertices (or points) an object has the more complex the reconstructed geometry will be, but this greater amount of detail translates as a greater amount of data for any software to process, thus slowing it down and possibly leading it to crash. To reduce the amount of faces of each 3D modeled panel Meshlab once again provides a handy tool. By using the 'quadratic edge collapse decimation' tool the number of faces was significantly reduced while still maintaining the detailed geometry of the reliefs. The initial cleaned, remeshed, and cleaned again models exhibited a face-count in the range of 1-1.9 million which were reduced to 100,000 faces for most models and 250,000 for a few, all the while retaining a sufficient amount of detail.

Fig. 8 A comparison of one of the panels before (left) when it contained 458, 841 faces, and after (right) the use of the quadratic edge collapse tool when the face count was reduced to 100,000. The top two images show the surface of the model. Notice that the surface of the post quadratic edge collapse model looks blurry and that some of the smaller details have become harder to see or have disappeared - especially the folds in the clothing. The bottom images show the wireframes of the corresponding images above (when viewing a wireframe only the edges of the faces are visible). All images were made using the 'Snapshot' tool in Meshlab and for each image I chose to leave the background color on because in the case of the wireframe images it shows what a difference the quadratic edge collapse can make. Due to the high face count, the wireframe on the left is so dense that the blue and black background color is not visible, while on the right image with the lower face count the background is clearly seen.

The next stage was to digitally reconstruct the monument using Blender, "a free and open source 3D animation suite."[82] An open source software is a program or application whose design is available to the public. This allows anyone with sufficient knowledge of programming to enhance, modify, and/or fix their copy of the software and any features it contains. This is different from "propriety software", sometimes called "closed source", such as Adobe Photoshop and Microsoft Word who do not allow anyone else to copy or modify their software legally. This should not be considered a negative thing because propriety software, such as the two just mentioned, are very good at what they are designed to do. One weakness of propriety software is that when users accept the user license agreement upon installation they legally bind themselves to using it only in the particular way that its designers intended. Open source software is flexible because their users are not bound to the same constraints but are free to explore new ways or applications for the software. To acquire an open source software a user must also accept a term of license as they are required to do with propriety software, the only difference being that the open source license encourages sharing and collaboration. The open source license also ensures that programmers cannot charge a licensing fee for sharing any modification they made to their own copy of the software. To sum it up I will list the five values of "the open source way"; Open exchange; Participation; Rapid Prototyping; Meritocracy; and Community.[83] Scholarly research could benefit by adopting a similar philosophy, and it is for this reason that I chose to use Blender and not a closed source software.

The Harpy Tomb does not have a complicated shape — it is essentially a box. After setting the units of measurements to 'Metric' (which is done in the 'Scene' tab on the right panel) the first step was to model the base-pillar upon which the reliefs would sit. Its shape is that of a tall rectangular box with a height of 17ft (ca 5.182 m), but unfortunately the other dimensions are not given.[84] After this the cleaned and low-resolution (low face count) models were imported as they were; in .ply file format. Since each panel was a separate scan they had to manually be placed adjacent to each other. Operating from measurements would not have worked so it was a process of detailed manipulation to get each panel into place. Where the reliefs join at the corners of the monument were especially hard to get right. In some cases the corner edges of the outermost panels on each side were not always sufficiently recorded with the Faro 3D scanner which made it difficult to see how they should fit together.

[82] http://www.blender.org/about/ - 2014/05/05
[83] https://opensource.com/open-source-way - 2014/05/22
[84] Slatter 1994, 143.

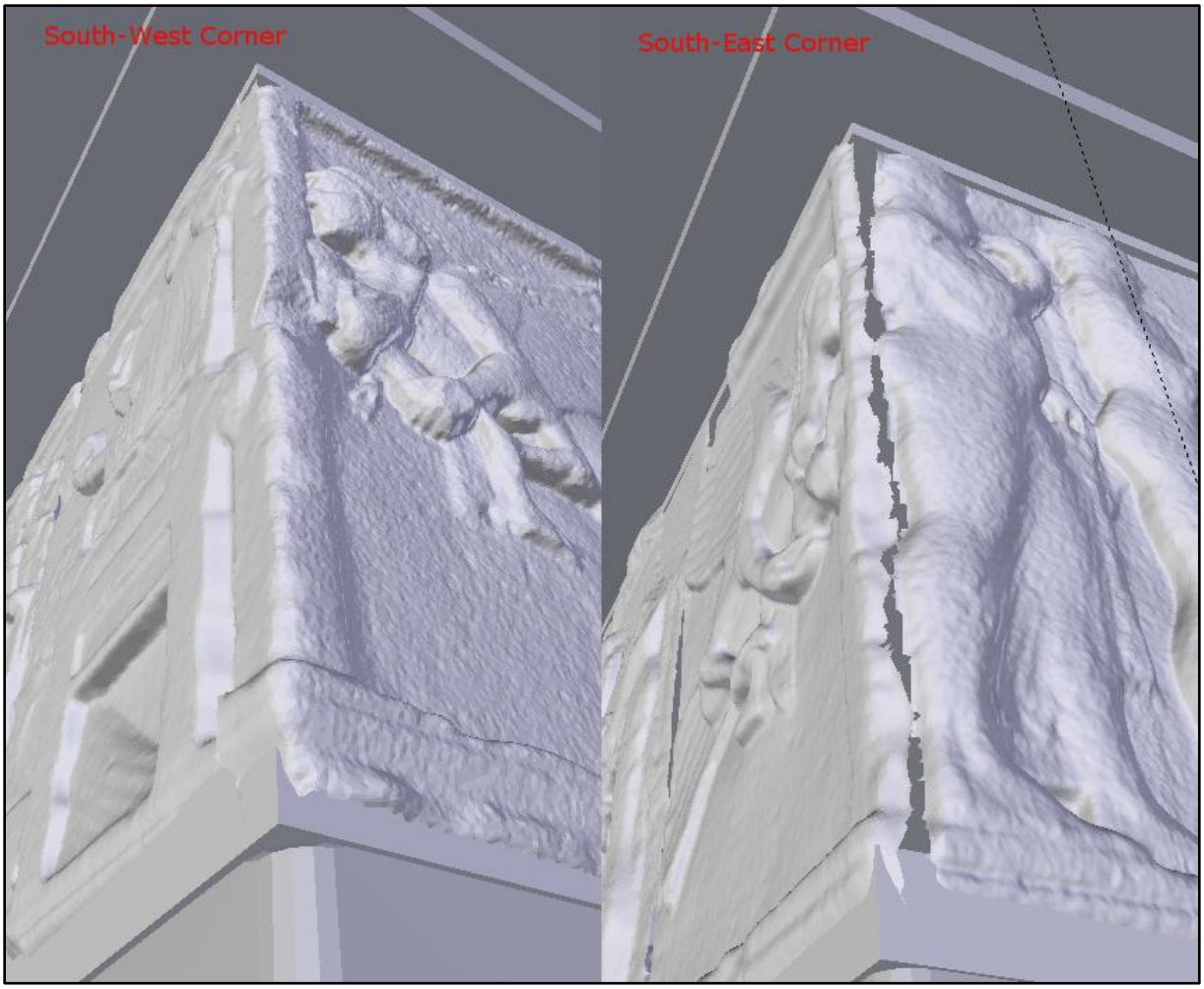

Fig. 9 A comparison of two corners of the virtually reconstructed Harpy Tomb. This shows the difficulties in fitting together some of the corners of the panels. On the left is an image of the most fault free corner of the virtual model. On the right is the most fault filled corner. This is mostly due to the panel on the right side of the image – panel S1. Why this panel is so far removed from its original is because the cast did not incorporate the left edge of the panel.

This problem can be attributed to that the plaster casts which were used for this study did not include the actual edges of the original panels. Images of the original Harpy Tomb panels in the British Museum, as well as the reconstructed version in Xanthus, were accessed through Google searches and greatly facilitated the process of puzzling together the panels with the troublesome edges. These images also showed how the pillar looked where it joined the reliefs and acted as a good reference to the shape and size of the capstone. The final step was to model the protrusions found on the North, West, and South side of the pillar using the extrude tool.

The next step was to assign materials to the objects. The pillar itself has a rough stone surface with some discoloration and many features of weathering. Recreating all that would have taken up a significant amount of time — something I couldn't afford at the moment. Nevertheless assigning the pillar some material would be favorable to leaving it a blank grey color. The primary goal now was to find a suitable texture which resembled the surface of the stone pillar; that the texture had the correct color was of secondary importance because the color

could be easily changed. A quick search on a website called cgtextures.com provided the ideal texture. Cgtextures is a huge database of images which is available for free, but as a free user you have a 15MB download quota which resets after 24 hours. To get the right color the texture was retouched using another free software called GIMP. GIMP (short for GNU Image Manipulation Program) is used for photo retouching and editing. A similar process was then done for the panels which were given a grainy marble texture and the capstone which was given a darker and slightly finer surface than the pillar. In the case of the pillar and the capstone they needed to be 'unwrapped' to apply the texture properly using Blender's UV/Image Editor. Unwrapping is a process by which each face of a 3D object is projected onto a 2D surface which is made up of the texture. This approach can ensure that the texture will not stretch on the object's faces and look unnatural.

VISIBILITY ANALYSIS

OVERVIEW

This chapter concerns the visibility analyses which were conducted using the digital model. First I will describe the process of setting up a scene and what rendering is. Following this are the two analyses; the first one was done without taking into consideration the ancient urban environment and was done solely for the purpose of experimenting with viewing distance; the second analysis views the model from different points in the immediate urban surroundings.

Without access to proper site plans it has been difficult to conduct any sort of reconstruction of the monument's surroundings and it also puts into question the accuracy of such an attempt. It should be made clear that apart from the Harpy Tomb every structure has been free interpretation based on visible remains. Another issue has been that the urban environment around the Harpy Tomb has drastically changed over time. Later buildings from the Hellenistic and in particular the Roman era have to a large degree erased or buried the buildings from earlier periods and the archaeological excavations have not yet been able to explore below these levels. I had first planned to reconstruct the immediate urban layout from when the tomb was first erected in the early 5th c. BC, however this quickly became impossible due to the reasons just mentioned. The only option really left to me, given the information I could obtain and the time constraint, was to model the surrounding structures from the Roman era. For this purpose I have made use of drawings and photographs of the site of Xanthus which I could find in my literature and internet sources, as well as using the satellite view in Google Maps to get a birds-eye view of the immediate urban layout.[85]

[85] Drawings of the site can be found in: Bean 1978, 54; Tritsch 1942, 40; Photographs can be found in: Bean 1978 (see photographs which begin at page 64); Challis 2008, 34; Tonks 1907, 324-325; Tritsch 1942, 42 (only of the East side and they are poor quality); Shahbazi 1973. (Unfortunately, due to permission of use, I could not include the satellite image of the site acquired through Google Maps in the final version of this thesis.)

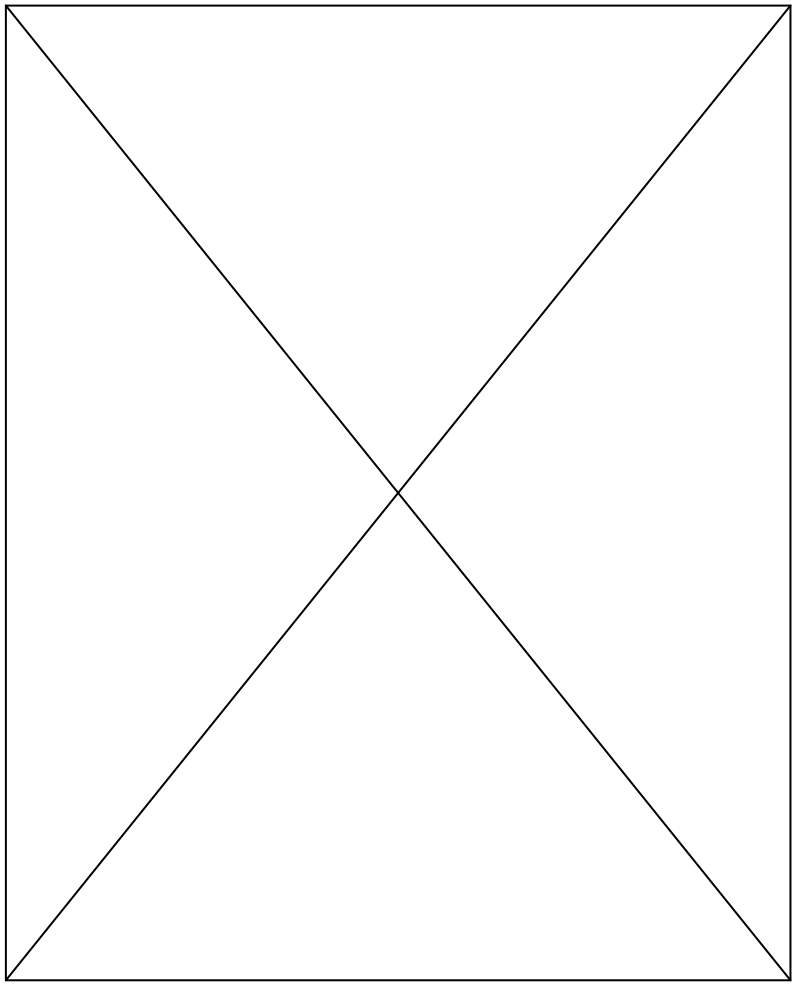

Fig. 10 Satellite image of site not included.

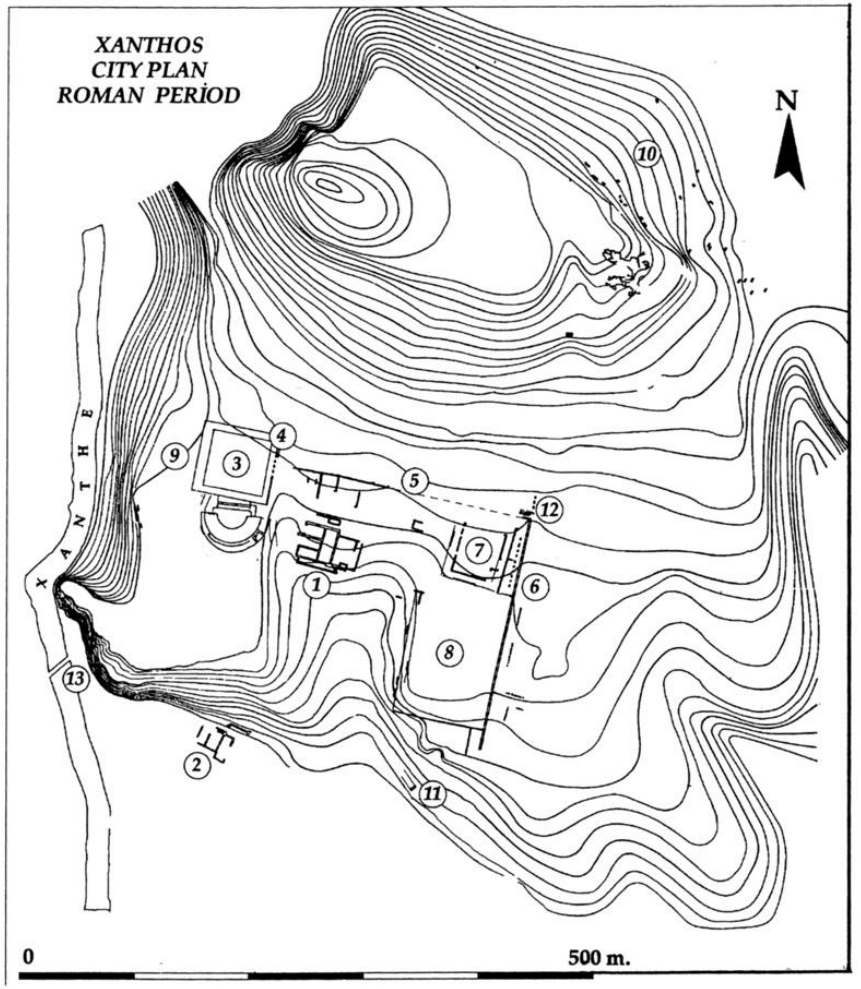

Fig. 10 A map of the city plan of Xanthos during the Roman period. The only numbered building in this map which figures in this study is the agora (nr. 3). The theatre is not numbered but is easy to make out just South of the agora. The Harpy Tomb, had it been included in this map, would be located just North-West of- and adjacent to the theatre; and just below the South-West corner of the agora.

Before starting the visibility analysis it was necessary for me to set up the scene. For the first analysis lighting was provided for each side by adding a plane with the 'Emission' property with a slightly off-white color and a lamp strength of 15. These were positioned so that they would cast light from slightly above the pillar and create some shadow effects. However, my aim was not to recreate the exact lighting conditions of the real object. That I saved for the second analysis which was done using the sun position tool which can recreate the lighting conditions of any place on earth during any specified time. The analyses would be conducted through the use of renders made using virtual cameras. The camera which would be used was positioned at various distances and placed at a height of 1.7 m above ground level (an arbitrary eye-level height).

For those not versed in the language of 3D modeling I will just take a moment here and explain what a rendering is. One way of putting it would be to say that the computer 'builds' a photograph. To just take a screenshot of the 3D model would be insufficient because it does a poor job of being photorealistic, and for the purpose of this study renders with a high level of quality were required. This is accomplished through a process called rendering by which a 2D image is created from a 3D model. Blender has a few different renderers and I chose to use one called 'Cycles Render'. Cycles Render uses a technique called ray-tracing, which means that it generates the image by tracing the path of light and calculates its trajectory as it interacts with the virtual objects. In the default Blender renderer light is emitted from lamps while in Cycles you have to assign an object a particular material called 'emission' which gives it the property of emitting light. Ray-tracing is a powerful rendering technique as it produces images with a high degree of realism as it realistically simulates the behavior of light but because of this it also requires greater computational power.

To increase the level of realism I at first wanted to create a scene background characterized by the presence of clouds. In order to achieve this effect I planned to use a photograph but because of the way materials and lighting work in Cycles Render it quickly became an insurmountable task. The background image, in this case a panoramic photograph of a sky dotted with clouds, is projected onto a surface, but to make it visible to the camera the surface is made to emit light which illuminates the object in the scene. This creates a very unrealistic lighting effect with the object lit from all angles, and more importantly, because the image is of a blue sky it emits the same color light and therefore discolors the object. Despite the potentials in using such approach it was not possible to develop such a visualization method in the frame of this

work. In the future, with a bit of tinkering, I may perhaps figure out how it can be done. However, for now in the interest of saving time I settled for using the default dark grey background.

THE FIRST ANALYSIS

The first analysis was conducted without taking into account the urban context. I came to the decision that two sides of the monument would be enough to attempt this experimental visibility analysis, and I decided on the East and North sides. My reasoning behind this was that the opposing sides bear similarities to each other and conducting the same procedure for all sides would be unessential for the purpose of this experiment. The East side is interesting because it is often interpreted as the most important side as it once faced the public urban spaces such as the agora. The North side is also interesting because it contains Harpies as well as a good selection of both small and large figures, and it partially faced public spaces as well. The South side of the monument faces another tomb which sits at a distance of approximately 6 meters from the base of the pillar, and is slightly shorter than the Harpy Tomb. The view of the South side is therefore obscured if the monument is viewed from straight on, but by shifting the viewing position East or West by a meter or two the view is not obscured. The West side of the monument faces the river valley and for nearly 50 meters the ground is flat in that direction until it drops steeply to the river below. The maps and images I have been able to access do not contain any information on remains of buildings to the West of the monument.

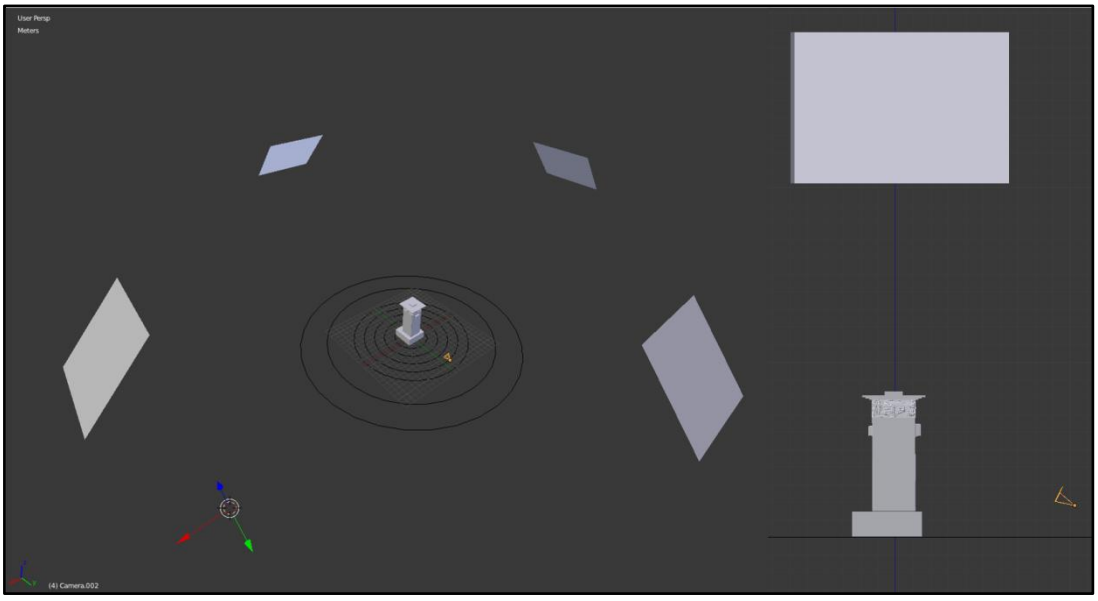

Fig. 11 An overview of the scene for the first analysis (left) and a West-facing cross section of a closer view of the scene (right). The four planes hovering above the tomb are the lights. One of the planes is visible above the tomb in the right image as well. The concentric rings surrounding the Harpy Tomb are the markers for the viewing distance. The small orange object near the tomb is the camera used for the renderings. The camera is placed 1.7 meters above the grid which represents the ground.

The East Side

Fig. 12 An image of the East side of the Harpy Tomb seen at a distance of 2 meters. The image is a render made using Blender's Cycles render engine.

Viewed at a distance of 2m the figures are somewhat distorted due to the steep viewing angle. Panels E2 and E3 are easier to make out because of the deeper carvings while panel E1 has flatter figures making it difficult to discern the details. The small male figure on the right in panel E2 is hard to recognize at this angle. The reason for this being that he is not as deeply carved as the seated male figure on the left. Because of the distortion some of the smaller details are not as easy to make out; for instance the merman holding up the arm rest, and the items held by the various figures. The black patches on the far left and right, as well as the spot on the left of panel E2 are due to the lack of surface data from the scan. Also clearly visible are the damaged sections on the panels seen on the bottom left and right of panel E2 as well as at the top where E2 and E3 meet.

Fig. 13 An image of the East side of the Harpy Tomb seen at a distance of 4 meters. The image is a render made using Blender's Cycles render engine.

At 4 meters the figures are already considerably less distorted. The figures in panel E1 can be made out more easily. The differences between the different depths of carving are not as apparent at this distance. However, the shadows on the seated figure in E2 and the standing figure in E3 are more prominent than with the other figures. Some details on the chair, such as the merman holding up the arm rest, are easier to make out at this distance. Similarly the items that the various figures are carrying are easier to identify at 4 meters than they were at 2 meters. The human figure in panel E3 is carrying a cane which is just visible beneath the dog but at this distance it is not visible where it sticks up above the dog's head to meet the hand because it's carved too flat.

Fig. 14 An image of the East side of the Harpy Tomb seen at a distance of 6 meters. The image is a render made using Blender's Cycles render engine.

At this distance some of the smaller details are becoming harder to make out. The merman is not as clearly visible and the cane in E3 is not visible at all. Due to the shallow carving the lower halves of the figures in panel E1 are not as clear as they were at 4 meters. The details on flatter surfaces are mostly invisible at this distance.

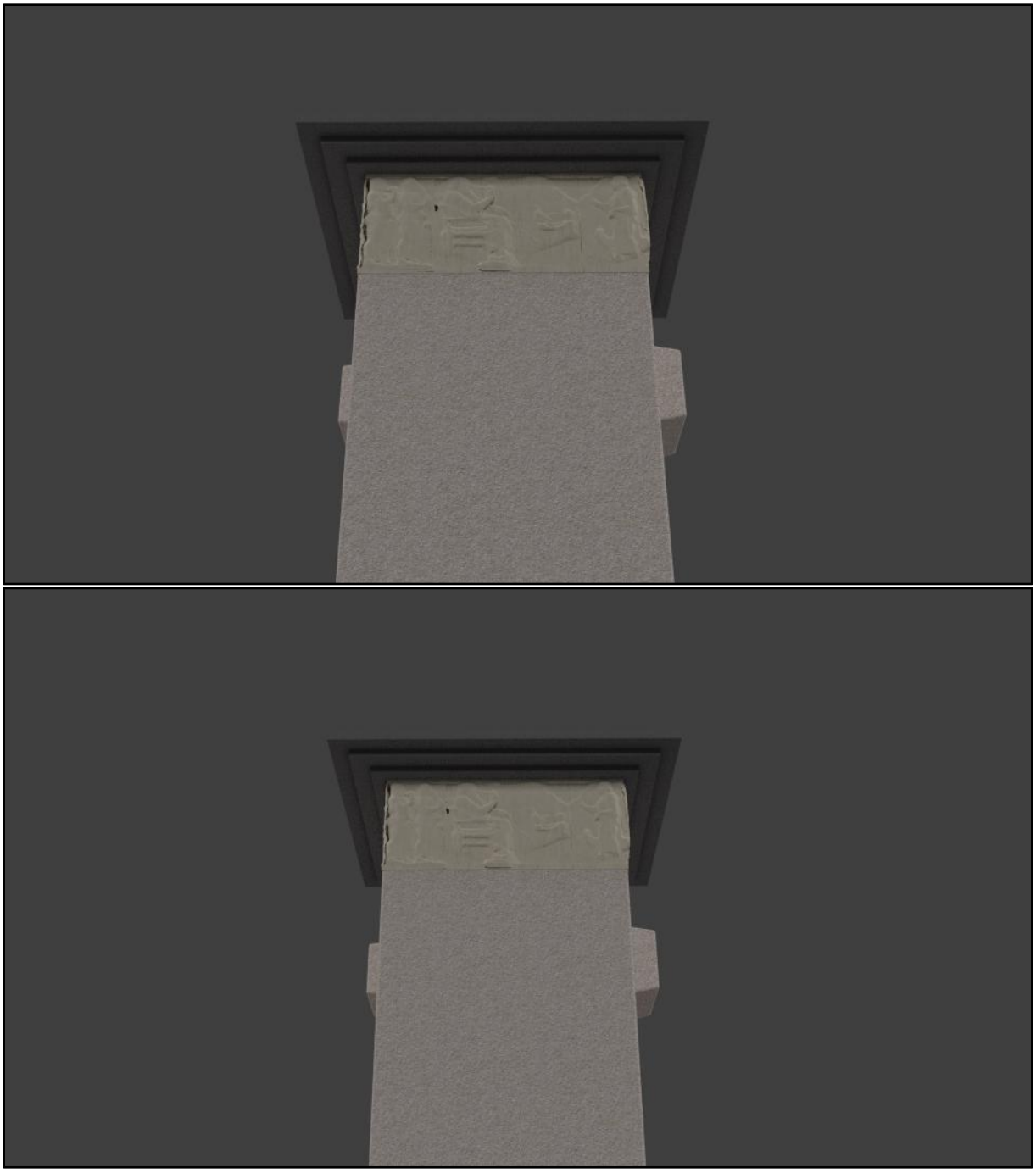

Fig. 15 An image of the East side of the Harpy Tomb seen at a distance of 8 (top) and 10 (bottom) meters. The image is a render made using Blender's Cycles render engine.

The detail visibly lost between the distances of 8 and 10 meters is not of a significant difference. The shapes of the figures can still be made out but details such as the merman is no longer visible and the only small object still discernible is the rooster. The larger figures of the seated man in panel E2 and the standing man E3 which are easiest to recognize due to them being more deeply carved. At both distances the left legs of the figures on panel E1 are becoming more difficult to see due to their more shallow carving.

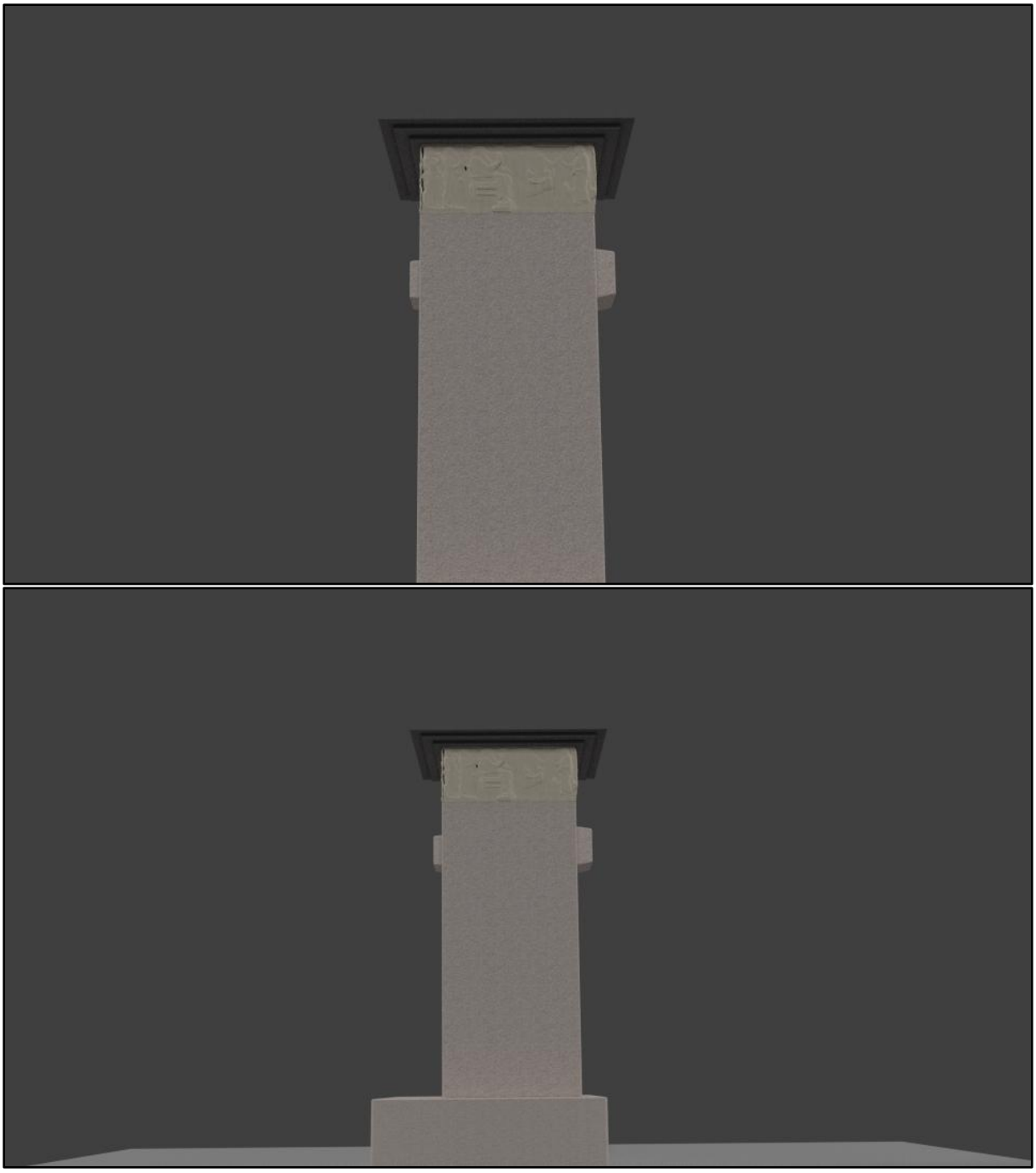

Fig. 16 An image of the East side of the Harpy Tomb seen at a distance of 15 (top) and 20 (bottom) meters. The image is a render made using Blender's Cycles render engine.

From 15 meters away the larger figures can still be recognized, but the same cannot be said of the smaller figures and certainly not of the details in the reliefs. The rooster is indiscernible and the same is true for any objects the figures hold. The legs of the dog are not visible from this distance and therefore make it difficult to identify the shape as an animal. At 20 meters the figures in panel E1 can barely be made out, and the same is true for the boy in panel E2. These two sets of figures have been carved more shallow than the seated male in panel E2 and the standing male in panel E3, which can still be recognized at this distance, but only just.

The North Side

Fig. 17 An image of the North side of the Harpy Tomb seen at a distance of 2 meters. The image is a render made using Blender's Cycles render engine.

At 2 meters the first thing that is apparent is that when the monument is viewed from the front the protrusion from the pillar blocks the lower half of panel N2. Due to this the dog underneath the chair is not visible. However, it is in the upper part of the panel where the important element of the scene can be found, namely the handing over of the helmet. Therefore it can be said that the protrusion does not affect the viewing at this angle to any great deal. The figures are distorted but it's only the figure of the grieving female in panel N3 that is hard to make out at this angle. The black patches seen in the bottom left and right of N1 are due to missing geometry.

Fig. 18 An image of the North side of the Harpy Tomb seen at a distance of 4 (top) and 6 (bottom) meters. The image is a render made using Blender's Cycles render engine.

The differences between 4 and 6 meters are not big. Compared to when viewing at a distance of 2 meters the grieving female figure in panel N3 is easier to make out at 4 meters and at 6 meters becomes even less distorted. The wings of the harpies in panels N1 and N3 are visible at 4 meters whereas at 6 meters the underside of the wing is not as easily discernible due to lighting angle and the shallow carving.

Fig. 19 An image of the North side of the Harpy Tomb seen at a distance of 8 (top) and 10 (bottom) meters. The image is a render made using Blender's Cycles render engine.

At 8 meters the harpies begin to lose more detail and at 10 meters it's hard to even make out the wings. Up to the distance of 8 meters the figures and the details in panel N2 have been clearly visible. However at 10 meters the crest on the helmet is beginning to be difficult to make out.

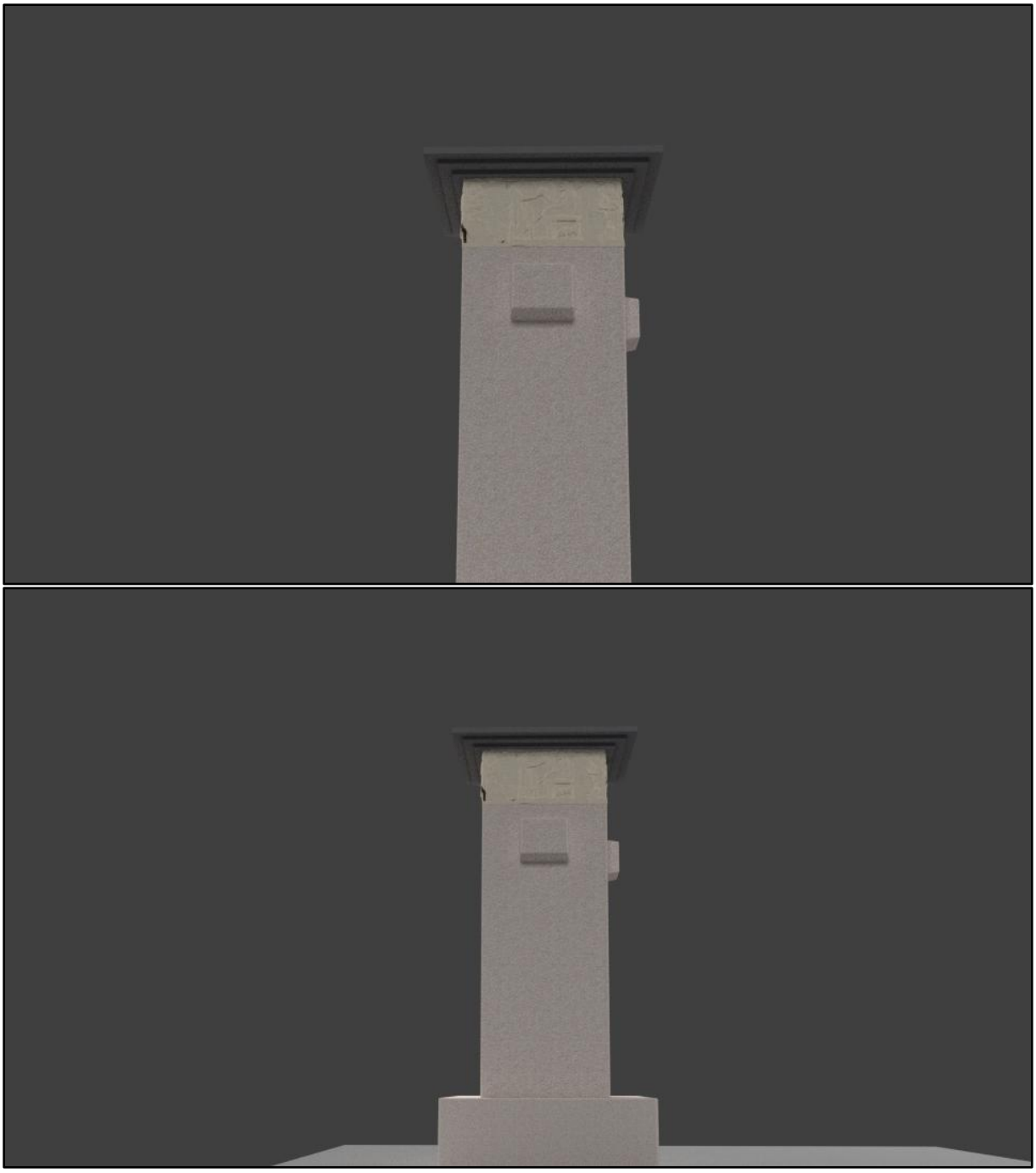

Fig. 20 An image of the North side of the Harpy Tomb seen at a distance of 15 (top) and 20 (bottom) meters. The image is a render made using Blender's Cycles render engine.

At 15 meters the harpies are beginning to be more difficult to make out and at 20 meters it has become nearly impossible to see the harpies. The figures in panel N2 are still visible at 15 meters but at 20 meters distance the amount of detail in the panel makes it difficult to separate the different elements.

THE SECOND ANALYSIS

For the second analysis some of the surrounding urban structures were modeled based upon the maps found in the literature and those found through Google image searches, as well as with the aid of Google Maps.[86] It is important to note that without access to proper site plans none of these buildings (except the Harpy Tomb) have the exact measurements and should therefore not be considered completely reliable. The colonnade and the roof of the agora are part of my hypothetical reconstruction based on the evidence of the remaining outline of the original building. Nonetheless, an experiment of this kind allows us to acquire knowledge about the level of visualization of the Harpy Tomb from remote positions that belong to "possible" spaces. For the purpose of this analysis I also added the sun position function which provides lighting in the scene based on the sun's position in the sky from a specified location on Earth and during a specified date and time. For most views I made renders at 09:00, 12:00, and 15:00 to view how the different lighting conditions during the different times of day affected the visibility of the monument.

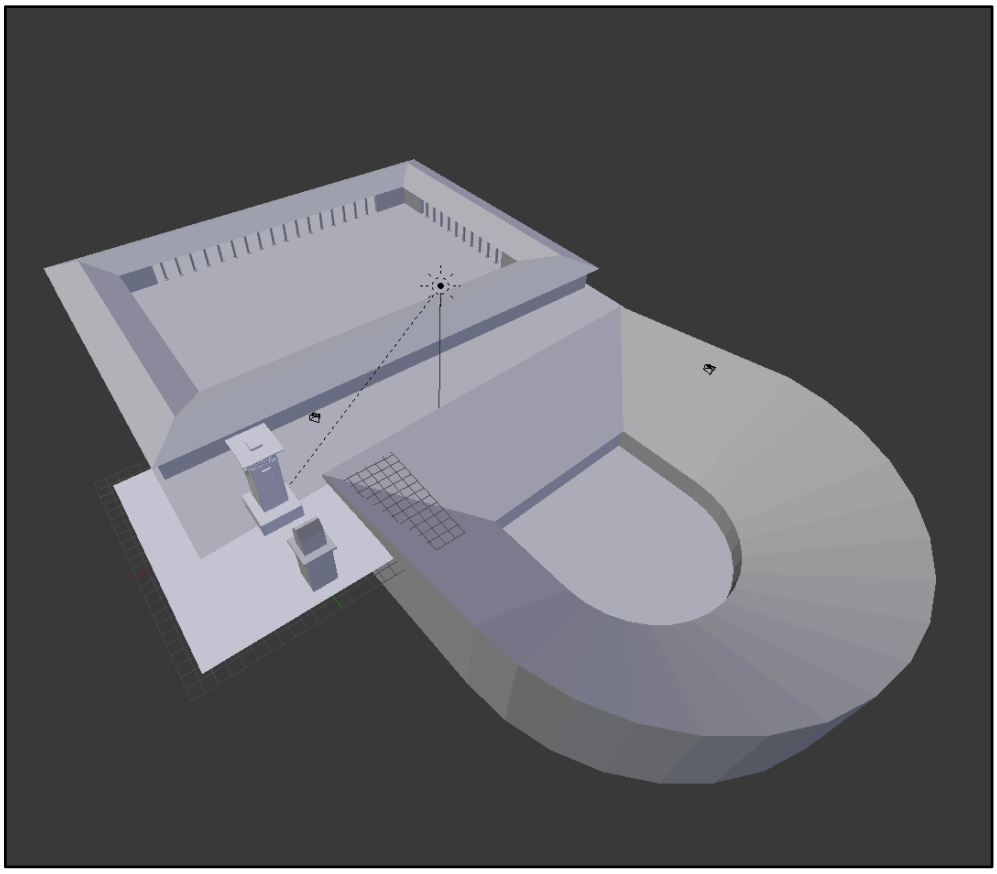

Fig. 21 A screenshot showing the reconstructed surroundings in Blender. The gray color on every object is just the standard color when they are viewed in "Solid" view. Had "Textured" or "Rendered" view been applied only the Harpy Tomb would have shown any texture as the rest of the structures remain un-textured. The Harpy Tomb can be seen center-left in the image, between the other structures.

[86] See n. 83 for references on site maps.

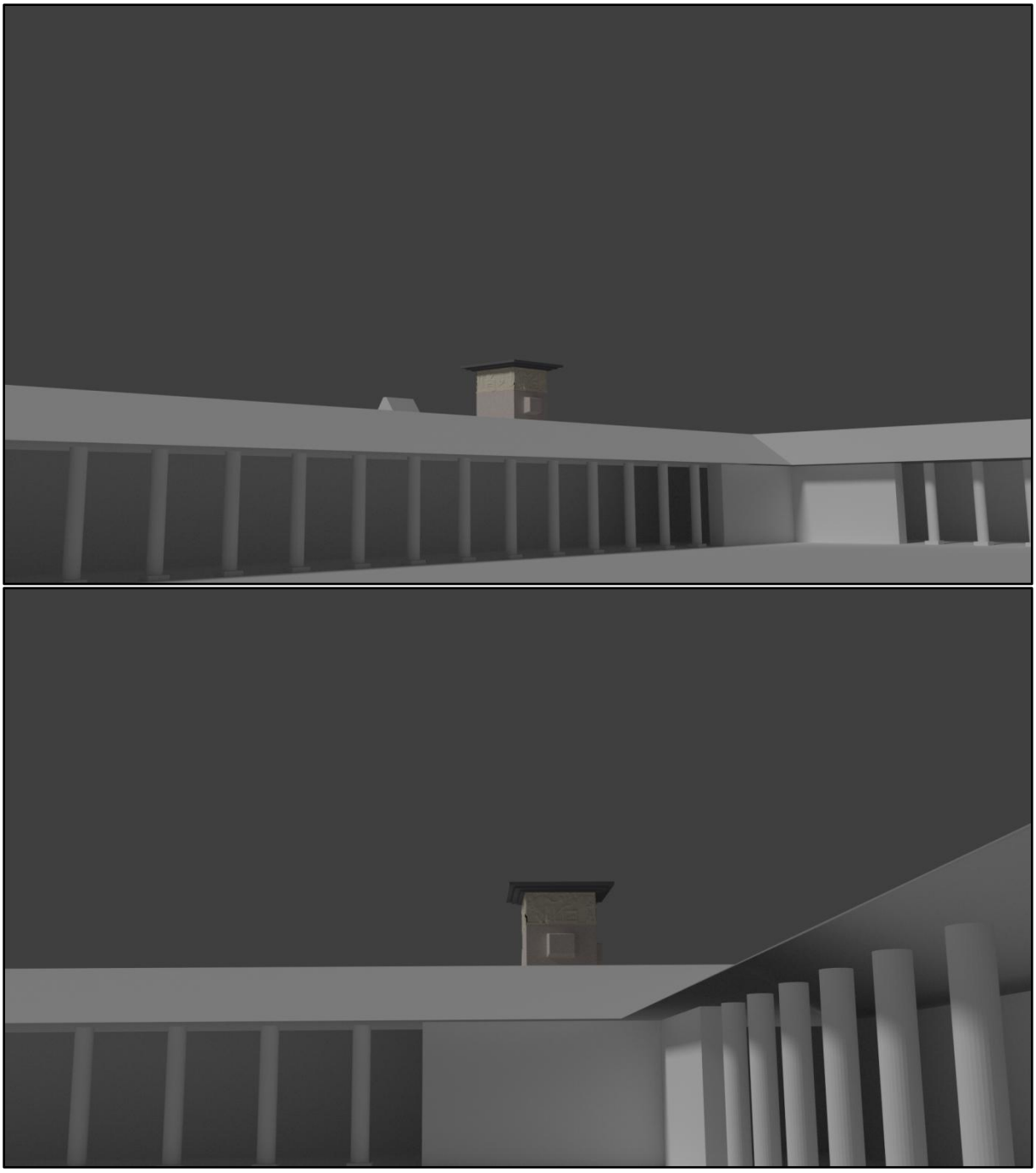

Fig. 22 Two images of the Harpy Tomb as viewed from the agora. Viewed from both the N-E (top) and the N-W (bottom) corner. The images are renders made using Blender's Cycles render engine.

Both these renders were done with the sun's position set to 09:00. As I mentioned before, the reconstruction of the surrounding buildings such as the agora are very rough and are not an attempt at replicating them as they were. For the purpose of this experiment it is interesting to see that when using this interpretation of the agora the Harpy Tomb is still visible above the roof of the agora in both images. However, at these distances the details are not visible although some shapes can be made out, such as the two figures in panel N2: the seated male holding out the helm to the young warrior. The Harpy Tomb's position in relation to the agora shows that the North and East side of the monument would have been visible from parts of the agora.

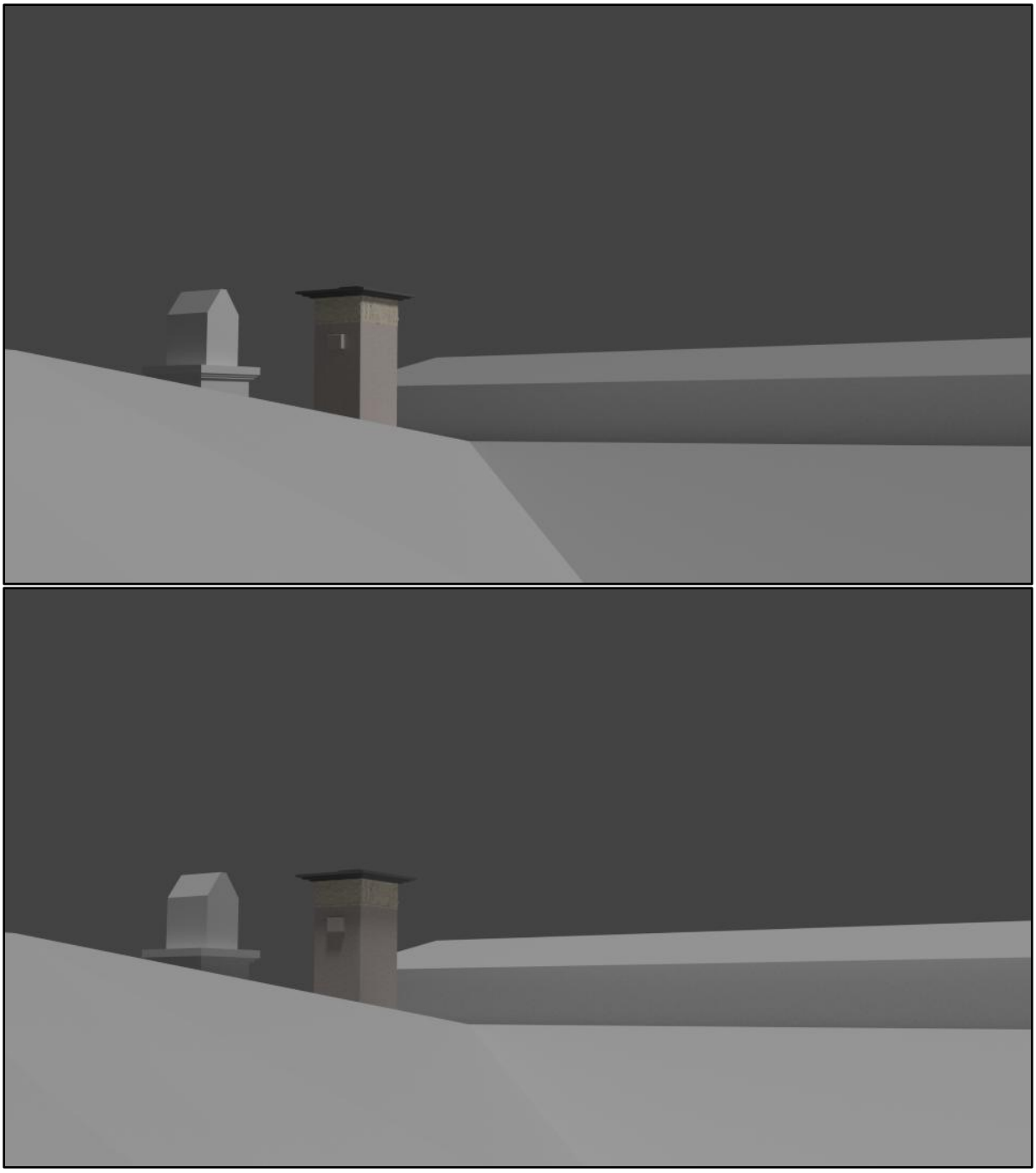

Fig. 23 Two images of the Harpy Tomb as viewed from the back of the seating area in the theatre. For this set of images two different times of day were employed (9AM on the top image, and 12 noon on the bottom image) to test the lighting conditions. The images are renders made using Blender's Cycles render engine.

The top render was made with the sun set at 09:00 and the bottom one at 12:00. These were taken from the south side of the Roman theatre near the top of the stands. From this angle a good view is afforded of the East and South side of the Harpy Tomb. The theatre is dug down into the hillside which holds the earlier acropolis and the seating stretches up to the walls of the acropolis. The tomb would have been visible from anywhere within the theatre.

The first analysis which tested the visibility of the geometry of the Harpy Tomb bas-reliefs provides some idea of the optimal distance at which the monument can be viewed. Remember that the monument is slightly less than 9 meters high and that at the optimal range a viewer would have to look up at an average of 45° to see the reliefs, and that is not a comfortable position to hold for any extended time. In a way, this analysis is incomplete because of the lack of polychromy. Clemente Marconi remarks on the coloring of the Parthenon frieze, saying that polychromy was used to make the figures more visible by compensating for the shallow depth and the frequently overlapping figures.[87] In the same way, the presence of color on the reliefs of the Harpy Tomb would do much to outline the subjects, thereby increasing the distance at which they could be recognized.

The first analysis showed that when based purely on the geometry of the bas-reliefs the optimal viewing distance is between roughly 6 meters to roughly 10 meters. When viewed any closer than this the distortion caused by the viewing angle warps the shapes of the figures. At 4 meters the shapes are still somewhat distorted and the angle is still sharp enough to cause certain more shallow features to be concealed by the deeper carvings. Additionally on the North side, it is first at 4 meters that the protrusion used for lifting the block no longer obstructs the view. After 10 meters finer details become more difficult to distinguish and at 15 meters the shallow reliefs are difficult to see and only the larger figures can still be seen. At 20 meters even most of the larger features become indistinguishable.

The second analysis, although hypothetical, has shown that the visibility of the monument was affected by the position of the Sun. At midday the panels fell into shade due to the capstone, and that the North and the South side were never illuminated by direct sunlight. The capstone, as we know, acted as a roof to the grave chamber, but it is also likely that the stepped entablatures protruded to such a degree to protect the reliefs from rain. Perhaps this was a conscious decision by the architect to protect the colorful bas-reliefs from deterioration.

The height of the monument is noteworthy. Certainly none of the surrounding structures, which to some degree or other survive today, exhibit any evidence of being of equal height. Therefore the Harpy Tomb must have been a significant urban landmark in ancient times. The evidence of the urban layout from the Roman period makes it clear that monuments from previous periods, such as the Harpy Tomb, were taken into consideration when the Romans began to remodel the urban environment. The experimental second analysis, with its hypothetical and rudimentary models of the agora and the theatre show that the Harpy Tomb was visible from

[87] Marconi 2009, 162.

both the theatre and the northern half of the agora. As can be seen from the image on the right in Fig. 21 the North side of the monument could not be viewed from the optimal distance if viewed from straight on. The East side would not have suffered any obstruction to viewing. The view of the South side is marginally obstructed by a tomb which is slightly shorter than the Harpy Tomb. The West side is freely visible, but due to a lack of proper sources, any possible buildings on that side were not reconstructed.

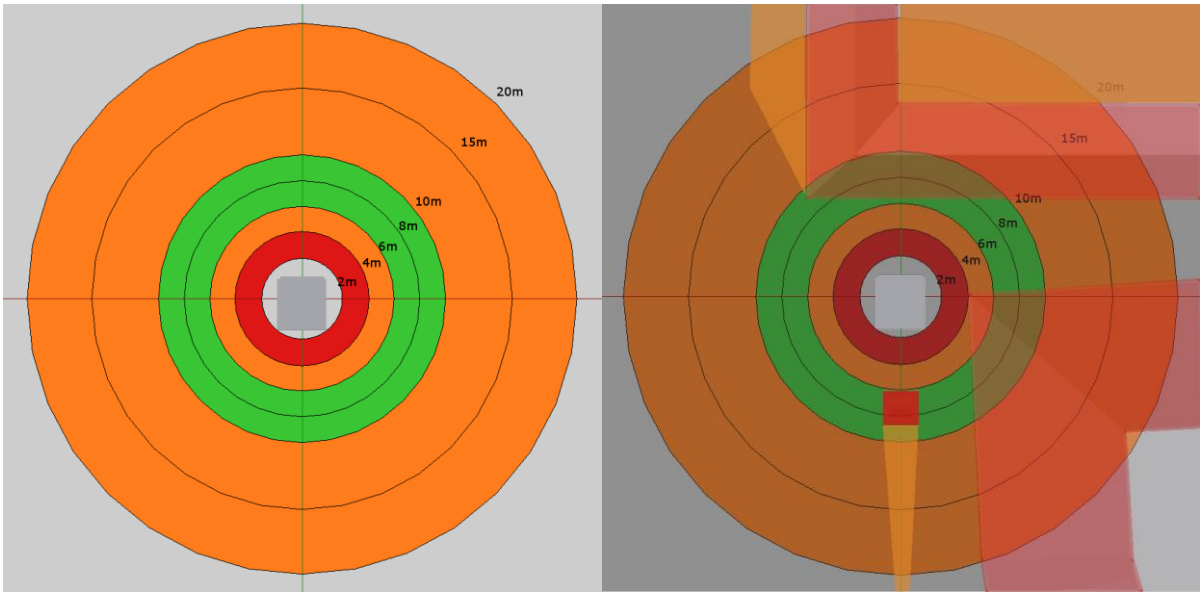

Fig. 24 Two images showing some results from the analyses. The left image is of the first analysis and the distances at which the cameras were placed for rendering have been numbered. It has been edited to show the optimal viewing distances based on the rendered images in the first analysis. The gray square in the center is the Harpy Tomb. The innermost gray zone is below the distance of 2 meters. The red zone is the distance between 2-4 meters and is not an optimal viewing distance. The inner orange zone (4-6 meters) is an acceptable viewing distance. The green zone (6-10 meters) is the optimal viewing distance with the least amount of distortion while still retaining the highest visibility of the details in the panels. Beyond that is the distance from 10-20 meters where distortion is becoming even less of an issue, but detail is successively becoming harder to distinguish. The second image (right) takes into account the surrounding structures from the second analysis. The large red areas as well as the small one to the south of the Harpy Tomb show the buildings. The light orange areas show where the view of the Harpy Tomb would have been obscured due to the buildings.

CONCLUSIONS

In conclusion, there is still much that can be done with this material. I would like to think that the groundwork has been laid and that more studies on this subject will follow. As stated in the beginning of this paper, the 3D models gained from the acquisition campaign for this study can become a source for a great amount of information and scientific data. For example, the geometric data captured at the beginning of this study can be used for further studies in surface analysis (as seen below in Fig. 25. A study of the finer surface details could provide more information regarding the sculptor, and combined with polychromy studies could offer clues to how color was used to enhance certain details in the reliefs. The Harpy Tomb has provided researchers with much discussion since its "discovery" a little over 170 years ago. With the help of digital techniques a new chapter of research on the Harpy Tomb can be opened. I hope this thesis has provided a glimpse of the potential of such techniques and the benefits they can provide for the study of artifacts.

Fig. 25 A comparison between three images of panel N2 showing the effects of Lit Sphere Radiance Scaling shader using Meshlab (Renders>Shaders>Radiance Scaling). The left image shows a mesh without any shading. The center image shows an image with the shader applied with zero enhancement. The right image shows what it looks like when maximum enhancement is applied. The various shaders supplied by Meshlab are powerful tools which can be used in many different ways to study 3D models – as in this case where surface detail unseen in the standard mesh becomes visible once a shader is applied.

Both analyses could be expanded upon by introducing polychromy studies and by applying a carefully realized texture (based on the color information from the reliefs) onto the geometrically accurate 3D models. The second analysis could also be improved upon if further work was done with reconstructing the surrounding structures. The current lack of archaeological knowledge of the area around the Harpy Tomb makes it difficult to speculate about the intentions of the one who commissioned the monument, as well as the intentions of the artisan(s) who worked on it. The later Roman structures have effectively buried the earlier remains and it is somewhat doubtful if we ever will be able to gain a better understanding of those earlier remains because that would involve some very destructive methods such as removing the current Roman remains, and that is not an option.

To answer that last question of whether to reliefs on the Harpy Tomb were meant for gods or for men, perhaps these final lines can provide some answer. "In Greek culture, the notion that sculptures are *mnema,* memory for generations to come, is an old one, one that goes back to the Early Archaic period."[88] After writing this line, Clemente Marconi mentions the alleged epitaph of king Midas which recorded that upon his tomb sat a bronze statue of a girl in mourning who would recite lines to remind passersby of who lay buried there. I want to point out that the image of the bronze girl bears a striking similarity to the kneeling female figure in mourning seen in panel N3 on the Harpy Tomb. Marconi suggests that "[t]he commemorative power of sculpture [...] is a critical layer of meaning in the Parthenon frieze."[89] Indeed, the people who commissioned such works placed great faith in the statues ability to last forever and to carry a message which would be passed down to the coming generations. It is a message which has passed down even to us. According to Marconi, in the case of the Parthenon, the visibility of the frieze was not the most important factor. What mattered was that the older generation could say to the younger one that the Panathenaic festival, which the frieze depicts, was "performed with dignity and nobility."[90] Although the differences between the Parthenon and the Harpy Tomb are numerous to say the least, the same principle can still be applied. Maybe it was enough that a father could tell his son that at the top of that pillar a great man lay interred.

[88] Marconi 2009, 172.
[89] *Ibid.*, 172.
[90] *Ibid.*, 172.

LIST OF FIGURES

SOURCES

Apollodorus, *Bibliotheca*, 3. 1. 2.

Herodotus, *The Histories*, 1. 173. 1-2.

Strabo, *Geographica*, 12. 8. 5; 14. 3. 10.

REFERENCES

Akurgal 1942 — E. Akurgal, *Greichische Reliefs des VI. Jahrhunderts aus Lykien*, Berlin 1942.

Bean 1978 — G.E. Bean, *Lycian Turkey: An Archaeological Guide*, London 1978.

Beraldin *et al.* 2006 — J.-A. Beraldin, M. Picard, S.F. El-Hakim, G. Godin, L.Borgeat, F. Blais, E. Paquet, M. Rioux, V. Valzano & A. Bandiera, 'Virtual reconstruction of heritage sites: opportunities & challenged created by 3D technologies' in *Recording, Modeling and Visualization of Cultural Heritage*, eds. E. Baltsavias, A. Gruen, L.V. Gool, M.Pateraki, London 2006, 141-156.

Bryce and Zahle 1986 — T.R. Bryce and J. Zahle, *The Lycians: A Study of Lycian History and Civilization to the Conquest of Alexander the Great Vol. I*, Copenhagen 1986.

Challis 2008 — D. Challis, *From the Harpy Tomb to the Wonders of Ephesus: British Archaeologists in the Ottoman Empire 1840-1880*, London 2008.

Childs 1978 — W.A.P. Childs, *The city-reliefs of Lycia*. Princeton 1978.

Curtius 1869 — E. Curtius, 'Zum Verständnisse des Sogenannten Harpyiendenkmals und Anderer Denkmäler Verwandten Inhalts', *Arch. Zeit.* 27-28, 1869, 10-17.

Draycott 2008 — C. Draycott, 'Bird-women on the Harpy Monument from Xanthus, Lycia: sirens or harpies?', in *Essays in Classical Archaeology for Eleni Hatzivassiliou 1977-2007*, eds. D. Kurtz, C. Meyer, D. Saunders, A. Tsingarida and N. Harris, Oxford 2008, 145-153.

Gay and Corsten 2006 — K.A. Gay and T. Corsten, 'Lycian Tombs in the Kibyratis and the Extent of Lycian Culture', in *Anatolian Studies* 56, 2006, 47-60.

Graham 2012 — C.A. Graham, *Applications of digitization to museum collections management, research, and accessibility,* M.A. Thesis, Lunds Universitet 2012

Keen 1998 — A.G. Keen, *Dynastic Lycia: A Political History of the Lycians and Their Relations With Foreign Powers C. 545-362 B.C.*, Leiden 1998.

Marconi 2009 — C. Marconi, 'The Parthenon Frieze: Degrees of Visibility', in *RES: Anthropology and Aesthetics* 55/56, ed. F. Pellizzi, Harvard University Press 2009, 157-173.

Shahbazi 1973 — A. Shahbazi, *The Irano-Lycian Monuments: The principal antiquities of Xanthos and its region as evidence for Iranian aspects of Achaemenid Lycia*, London 1973.

Slatter 1994 — E. Slatter, *Xanthus: Travels of Discovery in Turkey*, London 1994.

Tonks 1907 — O.S. Tonks, 'An Interpretation of the So-Called Harpy Tomb', *AJA* 11, 1907, 321-338.

Treuber 1887 — O. Treuber, *Geschichte der Lykier*, Stuttgart 1887.

Tritsch 1942 — F.J. Tritsch, 'The Harpy Tomb at Xanthus', *JHS* 62, 1942, 39-50.

Weicker 1902 — G. Weicker, *Der Seelenvogel in der alten Litteratur und Kunst: eine mythologisch-archaeologische Untersuchung*, Leipzig 1902.

Zubrow 2006 — E.B.W. Zubrow, 'Digital archaeology: a historical context', in *Digital Archaeology: bridging method and theory*, eds. T.L. Evans and P. Daly, London 2012, 8-27.