© Evelien Renders, 2018.
Cover: Konstantinos A | Dreamstime.com
All photos and illustrations, unless otherwise noted: Evelien Renders.
Layout: Evelien Renders.
“Every step is moving me up  
Moving, it's moving me up  
Every step is moving me up  
Moving, moving me up”

Each tiny, tiny move  
Is all I need and I jump over  
Every step is moving me up  
Moving, it's moving me up”

- Arthur Russel (version by  
José González)

FOREWORD

Having studied classics at Radboud University in Nijmegen for six years, I have acquired an interest in the practical reality of presenting classical heritage to the public. In the field of critical heritage, I participated in the course ‘Confronting the Classics’. In November 2016, six Dutch and six Swedish students spent one week at the Dutch Institute in Rome and the other week at the Dutch and Swedish Institute in Athens, to study the confrontation of heritage and contemporary life in these two cities. During our time in Rome, we visited the exhibition ‘ARA COMERA’ at the Ara Pacis museum. There, I experienced an augmented reality exhibition in practice for the first time. Inspiration struck, and this visit inspired me to write my final paper, comparing the augmented exhibition of colour on the Ara Pacis altar to the possibilities of giving colour back to the Parthenon frieze at the top of the New Acropolis Museum.

Back in the Netherlands, the subject of my Master thesis was conceived and with prof. dr. Eric Moormann as my supervisor, I was off with a head start. Without his guidance and endless patience, my thesis would not be in your hands
Now. He suggested to apply for a development scholarship at The Dutch Institute in Athens. In March 2017, I departed to do research for my thesis in Athens for three weeks at the beautiful Dutch Institute there. During my runs on the hill of the Muses, I got the chance to reflect on the jumble of ideas that had come up in my head. During my stay in Athens, I was able to do a skype interview with Dr Maria Roussou, who in turn introduced me to Dimitrios Christopoulos, to provide answers to my more technical questions. The visit to the immersive experience at Hellenic Cosmos to view the Foundation of the Hellenic World’s virtual reality productions, was impressive, despite not proving applicable in regard to the rest of my study. Also, the interview with the founder of Moptil, Michael Kokkinos, proved of immense value.

Back in the Netherlands, the opportunity to start my first job presented itself, and without a doubt, I started working at the International Office at Radboud University. During the first months of this new job, work on this thesis stagnated, and I was absorbed by my new working life. Around September 2017 a plan was devised to write my Master thesis in the ample vacation days of my job. Little by little I made progress, and after pushing the deadline, doubting if I will ever graduate, and eventually pushing through, I can only say that the proof of the pudding is in this thesis.

It would have been impossible to write this thesis without the unwavering support of my friends, family and loves. A special mention to the ones who let me write on cold early mornings made me breakfast, dinner and put up with me during my moments of despair. Thank you! My gratitude also to my colleagues, who kept asking when the BA would change to MA and encouraged me to keep going despite other serious work.
FOREWORD
# TABLE OF CONTENTS

Foreword ........................................................................................................................................1
Table of contents ..........................................................................................................................5
Introduction .....................................................................................................................................7

CHAPTER 1 | Digital cultural heritage.........................................................................................15
   1.1 Transition into the digital era .........................................................................................15
   1.2 Implications for the non-expert ....................................................................................18
   1.3 Implications for the expert ............................................................................................20
   1.4 Interpretation and presentation of cultural heritage sites: ICOMOS Charter ...............25
   1.5 Heritage evaluation in practice: Impact Playbook .......................................................27

CHAPTER 2 | Augmented reality ....................................................................................................31
   2.1 History of virtual and augmented reality .......................................................................32
   2.2 Defining augmented reality ..........................................................................................36
   2.3 Augmented reality in practice .......................................................................................40

CHAPTER 3 | The Parthenon .........................................................................................................47
   3.1 Historical debate on use ...............................................................................................49
   3.2 Debate on the sculptures ..............................................................................................52
   3.3 Debate on appropriation ...............................................................................................54

CHAPTER 4 | Presenting and Augmenting the Parthenon ............................................................59
   4.1 Presentation on site .........................................................................................................60
   4.2 Presentation in virtual reality .......................................................................................62
   4.3 Presentation in augmented reality ................................................................................67

CHAPTER 5 | Conclusions and recommendations .................................................................73

Works Cited ..................................................................................................................................77
"We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. Don't let yourself be lulled into inaction.” – Bill Gates

INTRODUCTION

Several times a week, three thousand tourists are unloaded from a cruise ship in the harbour of Piraeus and are brought to Athens by busses. They walk up the slope of the Acropolis under the searing sun and up there, for the first time, see the famous Parthenon. Due to time-consuming restorations already for many years, the monument is a working site where literally almost no stone is left unturned. Many of the iconic columns are surrounded by scaffoldings and thus partially hidden from sight. Standing on the hot slippery rock, some people gaze at the screen of a tablet. There they see a full-colour three-dimensional reconstruction of the front of the Parthenon. This digital presentation was built in two years by a company that saw a financial opportunity in offering the public more to look at: not only can people see what is temporarily hidden from the eye due to restoration, but also what is lost forever. The presentation they are looking at was built in two years, a strange contrast with the lengthy process of restoring the actual Parthenon that started in 1983.

Not much remains of the Parthenon now. The passing of many centuries takes a toll on objects and buildings. The older they get, the less remains of them. If nothing is done, the oldest ones are the first to turn to dust. If we put ourselves on some distance, it is quite strange to see that some of these old ruins are connected to high expectations and ideas in society that make up their “outstanding international value”: old stones
have become part of our ‘cultural heritage’. Especially some remains of our classical (Greek and Roman) cultural heritage are seen as the cradle of Western civilisation. Westerners are supposed to feel a sense of belonging or pride when looking at the remains of what we believe made our society how it is today. The Parthenon is considered an example par excellence of the western idea of democracy, architectural genius and artistic sculpture from the height of the Athenian empire all in one.

In the scope of this thesis, we will take for granted that the Parthenon is an important part of our Western cultural heritage and ask no further questions about how and why this is so. The tourists from the cruise boat did well to take the bus to the Acropolis. It is worth the effort of their climb in the hot sun, and still, there’s a lot to be seen from the remains. However, let’s also briefly look briefly at what they can see on their tablets.

Digital devices are rapidly becoming a principal instrument in presenting cultural heritage to the public. The recently built digital reconstruction of the Parthenon becomes a part of what we call ‘digital cultural heritage’. This term, in its broadest sense, refers to the digital presentation of existing cultural heritage as well as to cultural heritage that is only available in digital forms, like movies or digital artworks. The entire subject of digital cultural heritage is far too big for this study, and therefore we do not discuss examples such as digitisation of museum collections, digital preservation and technological tools for research purposes such as spatial analysis and data management. Throughout this thesis, the term ‘digital cultural heritage’ is used as referring to the digital presentation and interpretation of existing physical, cultural heritage.

As the example of the tourists from the cruise boat suggests, there is a real contrast between the intentions of the expert restorers of the Parthenon and the expectations of most visitors to the site. This thesis tries

---

1 Here I will not elaborate on what cultural heritage means and why an object or building is considered to be cultural heritage. For further reading on criteria for cultural heritage, see: UNESCO World Heritage Centre 2018.

2 For further reading on the different forms of digital cultural heritage criteria, please refer to the webpages by European Commission (DG Connect) 2017.
to establish a relationship between the experts on certain parts of our cultural heritage and the non-expert public, the typical visitors of a cultural heritage site. Pessimists have it that never the twain shall meet. However, here it is argued that new technological mediums such as augmented reality might help in bridging this gap between experts’ intention and layman’s expectation. One of the most significant challenges in digital cultural heritage presentation is the gap between expert and non-expert public. However, the last two decades have seen a growing trend towards research that explores the possibilities of augmented reality and the presentation of cultural heritage. Building on this literature the central question of this thesis will be: “What is the added value of using augmented reality at the archaeological site of the Parthenon?” With this question, the value of a digital presentation and interpretation of an important cultural heritage site will be tested, which is of certain academic relevance in these changing times.

In order to answer the central question, this study takes the reader on a journey via recent case-studies in the field of digital cultural heritage to the possibilities of augmented reality in the nearby future, to provide a deeper understanding of how we can present our archaeological heritage today and tomorrow. Chapter one begins by exploring the recent dialogues in the field of digital cultural heritage. With a focus on digital reconstruction of archaeological heritage, this chapter details how the Third Industrial Revolution led to the advancements and new research opportunities we face today. This thesis joins in with the discussions on digital cultural heritage which range from the question of how we perceive authenticity, to how interactive digital learning environments influence the educational experience of a visitor. We see that the tendency to adopt shiny new technology as a gimmick is slowly but certainly being accompanied by more evaluative research in which the claim of technological innovation is no longer a key factor in the final evaluation. Now the newness has worn off, the focus is put on determining the value of the medium.
Although value is inherently subjective, the methods by which we evaluate cultural heritage presentations are intersubjective, if not on the verge of the objective. To define the principles and guidelines in cultural heritage interpretation, the second part of chapter one refers to two documents that describe how we see ‘value’ in the heritage-sector; the UNESCO charter and an Impact Value Playbook, which was recently published by the Europeana Foundation. Through discussion of the criteria developed in these documents, we can establish some key principles for evaluating digital cultural heritage.

Zooming in on an upcoming medium for presenting our digital cultural heritage, chapter two discusses the history, terminology and uses of augmented reality. What exactly is meant by this term and how does it compare to virtual reality, mixed reality and indirect augmented reality? How was this technology developed in the digital age and what are its actual and possible uses? This chapter provides a basic understanding of augmented reality and will tickle the mind to think of new uses and possibilities in the heritage sector. The second half of this chapter introduces some case-studies which provide valuable insights into the current practical applications across different disciplines. These case-studies are introduced in relation to the three key-themes of value-evaluation that were specified in chapter one. In this way, an overview is given of how these themes have been elaborated recently in museums, at cultural heritage sites, and in particular at other archaeological sites. The chapters on digital cultural heritage and augmented reality constitute the conceptual background for digital cultural heritage and the evaluation of its values.

Chapter three discusses the case-study of this thesis, the Parthenon on the Acropolis in Athens. First, there is the question of why the Parthenon is such an excellent case to study in this context. We will see that if there is any possibility of additional value of an augmented reality experience, the archaeological site of the Parthenon provides ample opportunities to explore them. After that, a brief history of the Parthenon is given, with a focus on the discussions surrounding it. It is not the task of
this thesis to examine the Parthenon in all its archaeological, historical and social aspects. Instead, this study will focus on three points of scholarly debate, which characterises the versatility and liveliness of the monument. At the end of this chapter, we have a clear understanding of what information might connect a non-expert visitor to this heritage during their experience of the Acropolis, and in particular the Parthenon.

In chapter four, the current presentation of the Parthenon is put under scrutiny with regards to educational value, meaningful communication and sustainable conservation, the key themes from chapter two. The reader is taken on a tour via the information panels surrounding the Parthenon. Standing as it were on the slippery hard rocks, he sees what information is provided, and he can imagine how one of the thousands of daily non-expert visitors might experience this important archaeological site. We would expect that such a well-visited archaeological monument would make use of the latest techniques to captivate the visitors and engage them in a discussion of personal interest. However, we might say there is a disconnection between the digital presentation of the intangible and the tangible heritage on the Acropolis.

Drawing on the ever-growing database of case-studies of augmented reality in tourism and heritage that was introduced in chapter two, this thesis also speculates on different new ways of presenting the Parthenon in Athens. Chapter four looks at the possibilities of presenting the ‘informational’ discussions we found in chapter three and will challenge our minds to imagine a new digital presentation of this most important archaeological heritage site. The case studies from chapter two and the discussions from chapter three together form the basis of our thought experiment. Combining these chapters, we can now determine some realistic options for building a new experience for the non-expert visitor.

Answering the central question, chapter five describes in what way augmented reality could add value to the presentation of the Parthenon for the general public. The second half of this chapter will focus on potential future research. Keeping in mind Bill Gates’ warning about overestimation
of the short-term effects and the contrary estimation of what will happen
in the longer term, perhaps we are more successful when we look seven
years ahead. This timeframe gives us the opportunity to explore some
wilder possibilities which could become true in 2025.

All in all, after reading the conclusions, the interested reader with
a general background in the field of humanities and cultural heritage will
have a more thorough knowledge of the practical possibilities of
augmented reality at cultural heritage sites.
“Not everything that counts can be counted, and not everything that can be counted counts.”
– William Bruce Cameron

CHAPTER 1 | DIGITAL CULTURAL HERITAGE

As was explained in the introduction, this research aims to give a comprehensive overview of the possibilities of augmented reality on archaeological sites at this moment with a gaze into future possibilities of the medium. Before diving into the history of augmented reality and giving an overview of the status quo in the field, it is crucial to relay the underlying theories that will be used to build on in the following chapters.

1.1 TRANSITION INTO THE DIGITAL ERA

Since the industrialisation in the 19th century, our society has changed rapidly. Sociologists have called this process ‘reflexive modernisation’ and say we have entered ‘liquid modernity’: We have passed the ‘post-industrial society’ to come to the ‘information society’.3 Dutch transition specialist Jan Rotmans argues that we are now living in the period of change from the modern, industrialised era to the meta-modern and fully digital era. Soon, almost all of our information will be digital.

And these changes happen very fast. In his speech on ‘Reinventing Management for the 21st century’, management expert Gary Hamel states

3 See the works of sociologists such as Scott Lash, Ulrich Beck, Zygmunt Bauman and Anthony Giddens.
that “[w]e are the first generation in history that has to cope with an accelerated rate of change.” Hamel refers to change in the broadest sense: technological as well as social. After change in computer power had been a linearly increasing factor until roughly the 1960’s, the speed of change itself has changed radically. Now, we find ourselves no longer in linear development, but in a change curve, where computer power grows exponentially every couple of years. It means that the growth trajectory is doubling, and this happens at a set interval. In technology, this phenomenon is also known as Moore’s law. Exponential progress is something that feels counterintuitive to us, as we are used to linear progress and our ability to predict exponential growth is very much off.

Moore’s law is based on observation and states that in every interval, we make as much progress as we have made from the beginning until the present. Businessman Gordon Moore published his original ‘Moore’s law’ in 1965. He saw that the technological advancements made in the capacity of “micrologic” chips per dollar from 1959 to 1965, during the first years of chip production, formed a straight line when it is put on a semi-logarithmic scale. He extrapolated this line to make a rough estimate of what was going to happen in the semiconductor components industry over the next ten years – to 1975. His estimate was that the minimum cost per component would go down as they improved the complexity of the processing capability, at an exponential rate. To his surprise, this was a very accurate prediction, and in a paper from 1995, he looks back and wonders how even though he had the data and predicted the outcome, he still could not believe this growth rate.\(^4\)

Moore was one of the first to see the enormous changes that would (and will) happen during the Third Industrial Revolution, also known as the Digital Revolution. The term refers to the adoption and proliferation of digital computers and digital record keeping, but also to the changes brought about by digital computing and communication technology. These changes have already disrupted many businesses and traditional

\(^4\) Hamel 2011.
\(^5\) Moore 1995.
production techniques, and if we believe Gates, we are in for more unimaginable changes.

An excellent example of a disrupted field where traditional techniques no longer work due to digitalisation is education. Historically, learning has relied on students following linear speech structured by the educator from start to finish, in a classroom or in a book. This one-directional educational process depends on a monologue of the one and patient listening of the others. Digital technology has partly shattered this model. More and more, learners are now “nibbling”. They surf between Wikipedia and press articles to collect bits and pieces of knowledge. This way of gathering information is not always advisable, as the quality of learning depends on the trajectory. Experts describe this trend as the “granularization of knowledge”. Collecting bits and pieces and putting them together also has its positive aspects; it allows for active learning. Education should facilitate understanding and appreciation and should not be limited to factual learning.

A typical new form of digital education is Khan Academy, an online university providing free education in the form of Massive Open Online Courses (MOOCs) in a wide array of fields. On the topic of art history and cultural heritage in general, the most informative and engaging online educational material is made by Smarthistory. This small non-profit organisation is based in New York and reaches millions of learners around the world. In 2005 two art historians, Beth Harris and Steven Zucker started this “collaboration of […] specialists who want to make the highest-quality art history learning content freely available to a global audience.” Their tagline is “join the conversation”, which is very apt, because they provide you with a basic background on a topic which allows you to join the conversation immediately, thus proving that you do not have to be an expert to think about longstanding art historical debates.

If we look at learning from the experiential perspective, it is defined as “the process whereby knowledge is created through the

---

6 Harris & Zucker 2016.
transformation of experience”. This learning process is explained by Witcomb in a museum context as a result of making the act of interpretation an object of attention. Witcomb argues that multimedia art installations can behave like regular objects and don’t have to be seen in contrast to ‘real’ objects. This type of learning works through affective responses, which occur when a physical reaction to an object involves an emotional effect that leads to a higher degree of understanding.

1.2 IMPLICATIONS FOR THE NON-EXPERT

Not only do the changes mentioned above affect the way we learn, but they also have their implications for our entertainment and leisure and thus for the many tourists visiting the Parthenon. After all, tourism is a field where the non-expert has almost all the say in the matter of the presentation of heritage. If the tourist doesn’t like what is presented to him, he will not use it. Different studies on eTourism have already shown the benefits of using augmented reality to augment cultural heritage. Focussing on the popularity of augmented reality, these studies tend to jump over the problems of interpretation and presentation of our cultural heritage.

If we look further into what tourists are looking for on sites of cultural heritage, we quickly encounter the keyword ‘experience’. The notion of ‘experiencing’ heritage and the question of authenticity is closely connected. Business specialists James Gilmore and Joseph Pine argue that our ‘experience economy’ is driven by authenticity nowadays, while the normal world is almost entirely ‘fake’. People seem to visit sites of cultural heritage to gain an ‘authentic’ affective and emotional connection with the past.

Archaeologist and cultural heritage researcher Rodney Harrison states that the concept of experience has been important for heritage in two ways. Museums shifted from the collecting and mobilizing of cultural

---

7 Kolb 1984, p.38.
8 Witcomb 2010, p.41.
relics, to preserving them _in situ_. Heritage sites thus became places where non-expert could gain an ‘experience’ of the past. And secondly, intangible cultural heritage came to the foreground as a result of the 2003 UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage.

This concept of ‘intangible cultural heritage’ still needs an introduction. It is the most elusive aspect of cultural heritage because there is no direct visual remainder to relate to. Ideas, values and processes, for instance, the ideology behind a building or place, or specific events that occurred there in the past, are challenging aspects to show to the non-expert public. How can we present scenes of daily life in Pompeii in the period before the Vesuvius erupted? How can we provide an insight into the social aspects of gladiator fights in the Colosseum? What can we present about the politics behind slave trade on the central market square? The presentation of archaeological heritage on site generally focuses on the tangible aspects, the objects. Mostly, it leaves the intangible to a few sentences on an information panel, for instance describing the different uses the site once had. On some sites, much of the original building structures are still visible, while in others more is left to the imagination. There, the intangible cultural heritage of the site needs to be emphasized.

Next to that, the interpretation of heritage sites itself is undergoing a paradigm shift that started around a decade ago. Our cultural heritage becomes increasingly accessible in the virtual sphere; through the internet in the form of text, images and video, but also through photorealistic computer graphics in interactive displays. This influences the non-expert visitor, who is already used to living in an economy where we highly value authentic experiences. Authenticity thus becomes more of a feeling, a construct. The smart marketeer sometimes has more say here than the heritage expert. In some cases, this leads to the so-called ‘Disneyfication’ of cultural heritage. Many experts rightfully fear this Disneyfication. As a

---

12 Gable & Handler 1996.
result, the misrepresentation of cultural heritage and the lack of authenticity is a much-debated topic.

But there are also more hopeful recent developments. Research has reflected a shift towards dialogue and conversation, where public discourse is becoming more and more influential. The speed of feedback via social media is changing the way organisations and institutions are structured. Where the expert was once making and enforcing the rules, there are now more and more examples of bottom-up organisation structures that work well. These changes could also have their effect on presenting cultural heritage.

Archaeologist and historian, Neil Silberman, summarises these changes as shifting towards “process, not product; collaboration, not expert-only’ presentation; memory community, not heritage audience.”  

He recognises this change also in policy described in the ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites in 2008. Digital technologies were up and coming, and the influence of the public sphere on heritage interpretation was recognised. It is a shift from the unilateral approach of the visitors towards a reality inspired by the experience economy, where, if we do nothing, heritage sites are developed as revenue-generating entertainment venues.

1.3 IMPLICATIONS FOR THE EXPERT

The academic research of digital cultural heritage is situated within the broader field of digital humanities, and it overlaps in a few areas with the so-called digital classics and with digital archaeology. In the recent field of digital classics, research is being done into the field of electronically mapped literature. The field of digital archaeology focuses on the electronically mapped archaeological sites. Digital archaeologists do research on mining archaeological data digitally to create a better scientific understanding of the heritage. Another aspect of digital cultural heritage

---

13 Silberman 2013, p.31.
14 ICIP 2008.
15 Silberman 2005.
is Linked Open Data, where all data are connected in such a way that they
enhance each other. The organisation Europeana, whom we will come
back to later, plays a leading role in this system of data connection, which
links all digitised heritage data.

Most of the research mentioned above is being done for the benefit
of other expert users. However, there is need to present the outcomes to
the non-expert public. As Gabriel Bodard, a digital classicist, emphasizes
“the information and communication technologies allow us to tell stories
in ways, and accessible to people, that we have heretofore neglected.”16 This
is important for museums for instance, where the non-expert public is the
target audience.

The fire of innovation inflames many to explore how these digital
tools, methods and approaches offer new potential for communicating in
new ways, through new media, and to new audiences. The majority of the
discourse on digital cultural heritage is descriptive and introspective.17
Many of these discussions focussed on specific projects and their technical
considerations, appearing mostly in conference-bundles and on project
websites. Ten years ago Fiona Cameron and Sarah Kenderdine moved the
discussions from technology to the critical heritage narrative by focusing
on the parameters for future exchange between cultural organisations and
audiences.18 This shift from technology-driven research towards research
in social sciences and humanities is characteristic for the renewed interest
in digital culture.19

Although a positive outlook on the future of digital cultural
heritage is presented in many studies, there is a recurrent feeling of always
lagging behind innovations. "All we can do," says Gere, a specialist in
digital culture, “is map the changes we see in the hope of maintaining our
grasp on our rapidly changing situation”.20 Due to these quickly evolving
technologies, it is only logical most of the research is done with a focus on

16 Bodard & Romanello 2016, p.2.
17 Cameron & Kenderdine 2007, p.3.
18 Cameron & Kenderdine 2007, p.4.
19 Gardiner & Gere 2010.
20 Gere 2008, p.10.
specific short projects, without much eye for research of more comprehensive scope. With the first novelty wearing off, a few studies are going beyond the technical aspects and move on to more cultural considerations.

However, many discussions concerning the digitization of collections focus on anxiety about loss and disappearance. This was already the case in the early 1990’s when virtual images of artworks were believed to “somehow compete with or detract from actual objects.”21 The major concern of techno-pessimists in museums is “a loss of aura and institutional authority, the loss of the ability to distinguish between the real and the copy, the death of the object, and a reduction of knowledge to information.”22 Whereas museums do not feel the immediate need to present (digital) copies of their artefacts, archaeological sites often have less original objects to show. This is probably why the archaeological sector has taken to using digital representations for their sites much more often than museums do.

Where the non-expert seems to visit sites of cultural heritage to gain an authentic connection with the past in contrast to the ‘fake’ world around us, the experts are working hard to retain this authenticity at such sites. In the field of archaeology, anastylosis plays a part in recreating this authenticity. We will come back to this topic in chapter three when discussing the Parthenon. The views on authenticity logically differ per field. The perspectives from fields relevant to cultural heritage sites will highlight dilemma and thus underline the need for guidelines.

From the tourism and business perspective, Muchazonzida Mkono wrote a paper which focuses on exploiting the experience of augmented reality.23 Together with tourism sociologist Ning Wang, Mkono suggests three different approaches to authenticity: objective (museum-linked), constructive/symbolic (the result of social construction), and existential (the result of personal, participatory choice).

---

22 Witcomb 2010, p.35.
23 Mkono 2012.
activities). He argues that “things appear authentic not because they are inherently authentic but because they are constructed as such in terms of points of view, beliefs, perspectives, or powers”.24 For him, authenticity is as multiple colours projected through a glass prism, rather than a unicolour character.

From the field of contemporary archaeology, Paul Graves-Brown argues that the concept of authenticity, which pervades archaeology and cultural heritage, is problematic given in the paradox it generates.25 This paradox follows our inability to originate, which means that we cannot find out exactly where an idea or place came from. Therefore, it is not possible to evaluate its authenticity. However, Graves-Brown agrees with Gilmore and Pine “that authenticity is one of the primary drivers of our ‘experience economy’.26 He distinguishes three aspects of authenticity: pragmatic (what things do), natural (what things are) and historical (where or from whom things originate). The balance of these viewpoints, and thus their apparent importance, have differed over the years and between disciplines. In determining the exact nature of authenticity of something, this balance between these aspects is crucial.

Two more traditional views on authenticity still need to be mentioned here. Firstly, the materialist approach, that has a focus on the historical aspect of authenticity. It is still widely used in heritage conservation and assigns immutable characteristics to an object which can be identified and measured. Secondly and on the opposite side of the materialistic is the constructivist authenticity. Constructivism sees authenticity as a cultural product with no ties to materiality. As archaeologist Siân Jones says: “as if the layers of authenticity can be simply wrapped around any object irrespective of its unique history or materiality.”27 This last approach seems to correspond best with the digital world we live in, but it is up for discussion if that also makes it a desirable

26 Ibidem.
27 Jones 2010, p.183.
approach. As always, the balance should be found in exploring the middle ground.

To determine the value of cultural heritage and avoid the fear of walking blindly through this grey area, we create principles and guidelines to help us. Value applies to archaeological heritage sites, which are places of cultural significance, protected and preserved for future generations. Professionals can follow the international standard for heritage management made by ICOMOS (International Council on Monuments and Sites), which is closely linked to UNESCO. The ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites was first adopted in 1964 as the Venice Charter. The latest updated version is from 2008. This document is a guide meant “as a means of enhancing public appreciation and understanding of cultural heritage sites.”

Another important document in this respect is the Impact Playbook (For Museums, Libraries, Archives and Galleries) that was published in 2017 by the Europeana Foundation. This organisation was tasked by the European Commission with developing a digital cultural heritage platform for Europe. Europeana brings together the organisations that manage great heritage content with the people and sectors that want to research, share and create new things. Together with their partners and allies, they work to develop frameworks, standards, strategy and policy relevant to digital cultural heritage. Their research into the impact of digital cultural heritage at institutions resulted in the Impact Playbook, a step-by-step guide to making an impact assessment.

Let us look at the ICOMOS Charter and the Impact Playbook more closely in order to see how they can be of use in discussing the digital cultural heritage of the Parthenon.

---

28 ICIP 2008.
1.4 INTERPRETATION AND PRESENTATION OF CULTURAL HERITAGE SITES: ICOMOS CHARTER

Looking from a critical perspective, what should be our aim in interpreting and presenting an archaeological site? In 2008, ICOMOS gave an answer to that question in ‘The ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites’, which describes the overall goals for interpretation and presentation from an ethical and professional perspective.29 The definitions from the ICOMOS charter are the starting point for the framework of this thesis.

A cultural heritage site is defined by ICOMOS charter as “a place, locality, natural landscape, settlement area, architectural complex, archaeological site or standing structure that is recognised and often legally protected as a place of historical and cultural significance.”30

In the scope of this thesis, the interpretation and presentation of cultural heritage will focus on archaeological sites. ‘Interpretation’ refers to the full range of potential activities intended to heighten public awareness and enhance understanding of cultural heritage sites. The results of interpretation, such as research-outcomes, can be shown to the public via ‘presentation’, which is defined by ICOMOS as the planned communication of interpretive information in situ. This information can be conveyed through a variety of technical means, such as information panels, museum-type displays, formalized walking tours, lectures and guided tours, and multimedia applications and websites. Augmented reality is one of the multimedia application that can be used for presentation.31

29 Icip 2008.
31 The term interpretation is seen as “the full range of potential activities intended to heighten public awareness and enhance understanding of cultural heritage site.” Presentation “more specifically denotes the carefully planned communication of interpretive content through the arrangement of interpretive information, physical access, and interpretive infrastructure at a cultural heritage site.”
The ICOMOS charter describes seven principle objectives upon which interpretation and presentation should be based: 1. Facilitate understanding and appreciation, 2. Communicate the meaning, 3. Safeguard the tangible and intangible values, 4. Respect the authenticity, 5. Contribute to the sustainable conservation, 6. Encourage inclusiveness (in the interpretation) and 7. Develop technical and professional guidelines.\footnote{these can be found online Appendix II, or website:} In order to better understand what the ICOMOS stance is with respect to digital reconstructions, the subprinciples that specifically mention or are applicable to digital cultural heritage are expanded upon below.

The first principle focuses on facilitation of the learning experience. Subprinciple 1.2 states that the interpretation and presentation should “stimulate further interest, learning, experience, and exploration” by facilitating physical and intellectual access enhancing the personal experience. A personal learning experience can be created through the meaningful connection. Therefore, the presentation should encourage the public to reflect on their own perceptions of a site and assist them in establishing references to it. By taking an individual approach, a clear view of who the public is and how you can reach them can be created.

Moving to communication and meaning, subprinciple 2.2 emphasizes the need to include reflection on alternative historical hypotheses, local traditions and stories to create a meaningful interpretation. Especially relevant for digital reconstruction is subprinciple 2.4, which states that visual reconstructions should be based upon as many relevant sources as possible. It is explicitly mentioned that this scientific method of reconstruction is relevant for reconstructions “whether by artists, architects, or computer modellers”. At the end of this principle, it is mentioned that alternative reconstructions based on the same evidence, when available, should be provided for comparison. This is the first mention of multivocality in presentation and follows logically from the next principle on safeguarding the multi-faceted values of a site. On this subject, subprinciple 3.1 states that the significance of a site should be
explored “in its multi-faceted historical, political, spiritual and artistic contexts.” Furthermore, all time-periods and disciplines surrounding the cultural heritage site are deemed equally important and should be noted or incorporated into the presentation. The inclusive, multivocal and holistic approach in principle 3 might seem paradoxical compared to principle 4, regarding authenticity. Authenticity should be conserved, it says in subprinciple 4.2, by minimising disturbance to its cultural values or altering its fabric. There is no mention of the ‘digital fabric’ and how a digital alteration might affect authenticity.

Principle 5, 6 and 7, on sustainable conservation and guidelines, are closely related as they both concern the durability in planning and maintaining an interpretive infrastructure. Remarkable is the notion that any technological elements should also be adequately maintained. It reads like a warning for everyone who would fall head over heels for a ‘gimmick’ presentation via a new technological medium, which is not updated nor maintained after the newness wears off. This might waste money and could create confusion on site. Ideally, the plans for expansion or revision of interpretation and presentation programmes should be open to public comment and involvement, as is mentioned in subprinciple 6.3. This group is an often forgotten and hard to reach group for the heritage professional. According to principle 7, heritage professionals should create guidelines to ensure the continuation of research from the aforementioned good practices. It says the interpretation and presentation should not be perceived as the end station after which the cultural heritage site can be left to fend for itself. The interpretive infrastructure should be designed in a way that facilitates ongoing revision and/or expansion.

1.5 HERITAGE EVALUATION IN PRACTICE: IMPACT PLAYBOOK

More recently, Europeana created the ‘Impact Playbook’ to help museums, libraries and other types of memory institutions to make strategic choices.

---

33 Pagina 33 en die andere als appendix toevoegen.
to increase the impact of digital resources. In comparison to the ICOMOS charter, this manual for heritage evaluation provides step by step guidelines on how to make an impact assessment for a project. It describes for instance what language to use to discuss impact with stakeholders and which conversations to have with your team. Besides the direct outputs of projects – visitor numbers, Facebook, ticket sales – the Playbook wants us to dig deep into the outcomes that result from our work – changes of attitudes, new friendships, new ideas and values. Showing this indirect value of heritage more prominently might increase the relevance to society and thus decreases the change that “our sector is […] remaining seriously under-recognized as a major contributor to the knowledge-based economy.”

The practical approach of the Playbook creates an exciting addition to the somewhat stiff description of value in the charter.

The impact playbook method is founded on the principles laid out in the 'Balanced Value Impact Model' developed by Professor of Digital Cultural Heritage, Simon Tanner. This model is specifically meant to measure the impact of digital resources using evidence to advocate how change benefits people. "Tanner defines impact as: “Changes that occur for stakeholders or in society as a result of activities (for which the organisation is accountable).” To assess these changes the Playbook describes five different ‘Value Lenses’ through which we can look at the outcomes of a project: the Utility lens, the Existence lens, the Legacy lens, the Community lens and the Learning lens. These lenses reflect a more practical approach to the principles found in the ICOMOS Charter and can, therefore, be effectively applied to archaeological heritage sites, which can be seen as open-air museums.

Utility value is created when people use, change or develop resources and services. Was it useful for the public or stakeholder? Did it make their job easier? These are questions we can ask when looking through the Utility lens. Looking through the Learning and Community

---

34 Verwayen et al. 2017, p.4.
35 Tanner 2012.
lenses, we find out if people learned something from the heritage site, or if it made them feel more connected to a community. Even when people never set foot on the heritage site, they can derive value from the existence of it. The heritage site’s Learning value is based upon opportunities for formal as well as informal learning. The Existence lens reveals evidence of how important people find the conceptual value and prestige derived from the existence of the site. For example, even if a Brit has never set foot in the British Museum, he would still feel it as a slight to their ‘heritage’ if it was closed. Just by existing, the British Museum installs a proud feeling and connection with the British citizens. The extent of the existence value will differ wildly per site. But perhaps the most elusive lens is the one through which we look for ‘legacy’ value. It focuses on the understanding derived from passing forward thoughts and ideas about a site between generations and communities. The fact that there is a legacy to pass on is not dependent on the visitor actually setting foot on the site; the value is in inheriting and bequeathing (passing on) the resources.

Comparing these value lenses to the ICOMOS charter, a few aspects stand out. Education and learning are in both approaches separate and clearly defined principles. However, in the Impact Playbook communication and meaning are less practically described than is the case in the ICOMOS Charter. We see that individual connection to the heritage site, as well as the continuation of research, are important factors that create value at a cultural heritage site. These principles reflect the societal changes towards more holistic views, bottom-up approaches and attention for benefits for communities and people.

Neil Silberman, who was mentioned earlier as archaeologist and historian with a particular interest in public interpretation and heritage policy, connects these societal changes to the practice of heritage interpretation. He effectively challenges the much-quoted saying “Through interpretation, understanding; through understanding, appreciation; through appreciation, protection” by the US Park Service
official Freeman Tilden.\textsuperscript{37} Therewith he describes a new paradigm where heritage is interpreted through public discourse. His holistic and bottom-up views fit into the experience economy where public reactions to interpretation have significant economic consequences, and the audience is engaging in conversation rather than passively listening.\textsuperscript{38}

The ICOMOS Charter and also the Playbook attempt to facilitate a more extensive collaboration between communities, interested individuals and heritage professionals. Together they might plan, express and continue revision of interpretation, thus replacing the exclusive authority and monologue of the professional interpreter and giving way to new voices and themes. This new dialogue revolves around educational value as a collective reflection in the form of debate and discussion.

By combining the key-elements on value at cultural heritage sites from these two documents, this chapter has demonstrated that the key principles of value at a digital cultural heritage site are: the learning experience, meaningful, authentic communication and sustainable conservation. Moving forward the three key themes are used to assess the value of augmented reality in the presentation of cultural heritage.

\textsuperscript{37} Tilden 2007, p.38.
\textsuperscript{38} Silberman 2013, p.24.
CHAPTER 2 | AUGMENTED REALITY

This chapter introduces augmented reality: an innovative medium in which a digital layer of information is shown on top of reality. What if we could breathe new life into archaeological ruins by creating immersive 3-dimensional augmented reality experiences for the non-expert visitor? In essence, augmented reality is the umbrella term for technology that adds layers to real-life. The simplest way to think of augmented reality is this: it can be an application on your phone or computer that adds videos, graphics, and sounds to your environment. A perfect and well-known example of augmented reality is Pokémon GO, a smartphone application that was introduced in 2016. The app inserted Pokémon characters into the user’s surroundings via the camera. This meant that users were seeing cute and cuddly Pikachu’s appearing on their dinner tables, in local parklands and sometimes even on top of their friend’s heads. The augmented reality technology added a digital layer on top of the natural world.

Next, to now-standard devices such as smart-phones or tablets, it is also possible to view augmented reality on the - somewhat less familiar - portable head-mounted displays/devices, for example, the Google Cardboard or Gear VR, in which a smartphone can be inserted. A head-mounted device is, as the name suggests, a combination of holder and device, which is worn on the head. It places the screen of your smartphone directly in front of the eyes. A separator in the holder divides the display into two parts that show a slightly altered version for the left and the right
eye, creating the sense of 3-dimensionality in the brain. You can see it as a modern version of the stereoscopic photos.

This chapter provides a basic understanding of augmented reality and will tickle the mind to think of new uses and possibilities of this medium in the heritage sector. The second half of chapter four introduces the case-studies, which provide valuable insights into the current practical applications across different disciplines. The case-studies are chosen by relevance to the three key-themes of value-evaluation (educational value, meaningful communication and sustainable conservation) that were specified in chapter one. This way an overview is given of how these themes have been studied recently in museums, at cultural heritage sites, and in particular at other archaeological sites. The chapters on digital cultural heritage and augmented reality together, form the conceptual and practical background of this study.

2.1 HISTORY OF VIRTUAL AND AUGMENTED REALITY

The first illusion of being transported to another place and time was created in the early 19th century in the form of 360 degrees canvasses covering the walls of a closed room. These panoramic paintings were intended to make the viewer feel present in another time and place, at a historical event. With the invention of stereoscopic images in 1838 by Charles Wheatstone, a new impulse was given to the 'immersiveness' of virtual tourism. 'Immersiveness' is a word that indicates the quality or degree of being deeply enveloped. From this discovery came the 'View-Master Stereoscope' in 1951 which is in many ways comparable to the Google Cardboard, a cardboard holder for your phone which separates the two images in a stereoscopic app and thus creates a 3D image in your brain.40

39 Pompeii's ashes pp 380-382
40 View Master | viewmaster.co.uk 2016.
In the 1930s the science fiction author Stanley G. Weinbaum wrote ‘Pygmalion’s Spectacles’, about glasses through which the wearer could experience a fictional world through holographic, smell, taste and touch.\textsuperscript{41} This immersiveness was later put to the test in the Sensorama, created by the cinematographer Morton Heilig in the mid-1950s. During this experience, the viewer sees a stereoscopic 3D video while sitting on a vibrating chair, feeling a breeze made by fans and even smelling custom-made fragrances.

Heilig’s next invention was the Telesphere Mask in 1960, which was the first example of a head-mounted device. This headset provided stereoscopic 3D video with stereo sound, but it was still non-interactive and didn’t have motion tracking. One year later, magnetic head tracking was incorporated in another head-mounted display, the Headsight. A viewer could look around in a video by moving his head. This headset was developed for immersive remote viewing of dangerous situations by the military.

The theoretical background of virtual reality started with a paper written by the American computer scientist and internet pioneer Ivan Sutherland in 1965. This paper is still referred to as the blueprint for the concepts that encompass virtual reality today. He wrote about a virtual world that could behave like a physical world, with tactile feedback and the ability to interact with the objects in a realistic way. Sutherland concludes that “a display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking

\textsuperscript{41} Weinbaum 1949.
glass into a mathematical wonderland." It would be interesting to see this author’s reaction if he saw people today, for whom displays make out a prominent part of the day.

After the name Virtual Reality was coined in 1987, a range of virtual reality head-mounted displays was put on the market. The expectations were high as virtual reality would inevitably become a billion-dollar industry. Only at that time, both the resolution of the screens and the graphic renderings were still too far behind to make virtual reality a tolerable experience. The concept stagnated and fell into what managers call the ‘Trough of Disillusionment’ of the Gartner Hype Cycle. This cycle provides a general view of how technology will evolve over time. After the peak of early success stories, interest wanes as experiments and implementations fail to deliver and thus cannot live up to the expectations that were set in the overenthusiastic first peak.

For two decades, virtual reality was shunned in the media, while graphics chips and computers were making steady progress. Experiments with the immersive video were still ongoing with projectors, big screens and eventually again with head-mounted displays. The use of screens, tablets and eventually smartphones led to an alternative interpretation of virtual reality in academic literature where interactive worlds on these devices were also counted as virtual reality. Researchers in computer-science began making the distinction between immersive and non-immersive virtual reality as early as 1993. The usability, low costs and technical possibilities were immediately selling factors, which lifted virtual reality up from the trough of disillusionment and put it on the way up the Slope of Enlightenment, where the technology becomes more widely understood.

With the launch of the Kickstarter-campaign for the Oculus Rift in 2012, a virtual reality headset was made accessible to a broad audience. Together with the headset HTC Vive, these head-mounted displays are

---

42 Sutherland 1965, p.1.
43 See also the graphic presentation of the Hype Cycle in figure 1 by Gartner inc. 2018.
44 Robertson et al. 1993, p.83.
currently the best on the market for desktop-computer driven virtual reality. The do-it-yourself cardboard virtual reality viewer by Google is being used by over 10 million people worldwide.45 This cardboard viewer is a simple holder for your smartphone, with a separator between and around your eyes. The cardboard viewer needs to be held before your eyes, as there is no strap and movement is registered solely by the sensors in the smartphone. With this mainstream adoption virtual reality and augmented reality has arrived at the Plateau of Productivity in the Hype Cycle, which introduces the stage for more profound reflection into practical possibilities, where this thesis a part of.

A bit more advanced than Google Cardboard are the Samsung Gear hand the Google Daydream, which provide consumers with the best budget mobile virtual reality experience. These viewers are devices on itself, as they have sensors that supplement the sensors in your smartphone, to create a more accurate movement of the 360 image which makes up the virtual environment. New devices that make use of holograms and projections, such as Meta and Microsoft HoloLens are not further discussed in this thesis. These technologies are still very unsophisticated, and because of their restrictions, they are not yet a part of the possibilities in the near future.46

The previous chapter discussed views on authenticity from the expert and non-expert perspective. Part of the fear of the experts in humanities comes from lack of knowledge of the steps in making a digital reconstruction. This makes them very dependent on graphic designers and programmers. There are, however, many accessible courses to be found. You can find them for example on the previously discussed Khan Academy or another great learning environment such as Coursera. These courses provide a solid basis in the process of digital reconstruction and can enhance conversations between the experts from different fields. A full discussion on 3D reconstruction lies beyond the scope of this thesis.47

45 Singh 2017.
47 For a free course on 3D modelling for virtual reality, see Coursera | Coursera.org 2018.
the 3D object is modelled, for it to become a part of augmented reality it needs to be anchored in the concrete location. This process of making sure the digital construct overlays the exact reality it is referring to, is known as ‘positioning’.

The right position can be established directly or indirectly. So-called ‘recognition’ is the most advanced technology, where iconic objects in the real environment are ‘recognised’ directly by their characteristics and used as a marker to ‘know’ where a visualisation should focus. The device ‘sees’ where you are and uses these data to edit the perspective of the virtual environment to your current viewpoint. ‘Georeferencing’, another means of positioning, uses GPS coordinates to locate the position indirectly and thus tries to present the viewer with the right image in the right location. However, the method of georeferencing is not precise enough for most reconstructions. To ensure an exact overlay, manual reference points can be set up on site which then can be used in conjunction to provide a more specific location. What option is the most cost-efficient differs per situation as the case-studies mentioned later in this chapter will illustrate. We will view the possibilities and limitations of positioning per case-study.

2.2 DEFINING AUGMENTED REALITY

If you watch a movie on your television screen, you might feel as if you were transported into another world, where the story is unfolding right in front of you, when in fact you are still acutely aware of your surroundings. The device you use influences how you experience the movie; a big cinema screen with Dolby surround sound impacts the average viewer more than watching on one’s phone. In the same way, the medium ‘written words’ can be viewed and experienced in printed newspaper form, on an e-reader and a computer screen. The term ‘medium’ is here used as a “means by which something is communicated or expressed”. The plural ‘mediums’ will be used throughout this thesis to make the distinction with the
singular ‘media’, which is normally used for the main means of mass communication, such as broadcasting, publishing, and the Internet.48

The creation of new devices and new mediums goes hand in hand; the e-book format gave way to the e-reader, although the e-books could also be read on the screens we already used, like the computer or our smartphone. The previously mentioned head-mounted devices have been specially developed to experience three-dimensional mediums, like a 3D movie or game. We can all agree that watching a 3D movie on a smartphone or other handheld device like a tablet, does not fully make use of its immersive possibilities. The device also influences the medium, although more often through limitations than creating more possibilities. For example, the poor quality of computer graphics and head-mounted device were to a large extent why virtual reality ‘flopped’ in the 90’s.

The best known ‘variety’ of a digitally made reality is the medium of virtual reality. The definition of virtual reality is “the computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.”49 virtual reality places the user in an entirely virtual world, developed or defined by the programmer, which has no relation to the actual environment of the user. In comparison, augmented reality is “a technology that superimposes a computer-generated image on a user’s view of the real world, thus providing a composite view”.50

If we look at the accepted interpretation of virtual reality, augmented reality and mixed reality as is shown in figure 2, there is a clear distinction made in the uses of the technology.51 In the same figure, Virtual Reality is shown as a non-realistic world in which you are enveloped, as it were. Augmented Reality has a very practical purpose. Researchers in computer science and educational technology have roughly defined

49 Oxford Dictionaries 2018c.
50 Oxford Dictionaries 2018a.
51 Guilherme Schmitt | Dribble.com n.d.
augmented reality by either a broad or a restricted approach. The restricted approach emphasizes the technology aspect and is defining augmented reality as “a form of virtual reality where the participant’s head-mounted display is transparent, allowing a clear view of the world”. The broad approach is more philosophical in nature and corresponds more to the definition given by the Oxford Dictionary.

The restricted approach can be seen in figure 2, which depicts augmented reality in the centre image as a real environment overlapped with information that is useful while driving. The illustrations in this figure are an artist’s rendition of virtual reality, augmented reality and mixed reality with the ‘corresponding’ device depicted on the left, through which the information is most often interacted with in that medium. The positioning might give the impression that one device can only be used with one medium and only that medium can be used to show information

---

52 Milgram 1994.
on that device. However, the use of these mediums and devices, and their terminology, overlap and are subject to constant change – which, remembering the exponential technological progress, is not surprising. It is thus essential to see figure 2 as a dated illustration, presenting the status of augmented reality mid-2016.

As for the devices in figure 2, the Google Glass - with the orange background - is portrayed as an augmented reality headset, which it is. Although, the 'VR'-headset as shown on the top of the image, is more commonly used to display augmented reality. Most often, the real world is recorded through the camera of the smartphone that is plugged into a head-mount, and the digital image is added to this live-stream of reality, thus creating an augmented reality on a screen.

From the field of education technology, Eric Klopfer and Kurt Squire indicated that the term augmented reality should not be used restrictedly but may be applied to any technology that blends real and virtual information in a meaningful way.\textsuperscript{53} In this, they follow engineer Paul Milgram’s mixed reality continuum, which is presented in figure 3.\textsuperscript{54} Milgram first presented the vague idea that augmented reality is in a no-mans land where there is a sort of interaction between something digital and the real environment.

From a philosophical perspective, Nicola Liberati compared augmented reality to earlier technology, which was created to escape the cyber vacuum of virtual reality at the end of the 80s as an auxiliary technology. This comparison led to the exciting conclusion that augmented reality is more than hanging digital labels in the world around us. She concluded that there is an added benefit: the possibility of “enhancing the subject’s skills.”\textsuperscript{55} With this, she sees augmented reality as more than only information providing technology and adds the feeling and emotional impact of this technology to Milgram’s Continuum.

\textsuperscript{53} Klopfer & Squire 2008, p.205.
\textsuperscript{54} Milgram 1994.
\textsuperscript{55} Liberati 2016, p.26.
In this thesis, the term augmented reality will be used in its broadest sense, making a clear distinction between medium and devices. Augmented reality can be used to embed our world with a new kind of interaction. It enables us to modify the world we live in and in such is not only an auxiliary technology. It could also be something that allows us to perceive completely new parts of the world.

### 2.3 AUGMENTED REALITY IN PRACTICE

All these possibilities ask for concrete examples. This section provides an overview of some key studies that will be used in chapter six to explore the possibilities of augmented reality on the Acropolis. Some examples of recent projects and research in the digital humanities, virtual archaeology, museology and heritage studies are: ‘ARCHEOGUIDE’ in Olympia, Greece, ‘Imitatio Maria’ at HumLab in Umeå, ‘Via Appia project’ at Radboud University, ‘Pompeii project’ at HumLab in Lund, ‘CHESS project’ at New Acropolis Museum, ‘MATRIX’ project at Michigan State University. These projects focus on various aspects of visualising the unseen and presenting heritage. In combining the results of these studies, we will find the key to understanding the possibilities of augmented reality at the Parthenon.

![Figure 3 Milgram's Continuum. Virtual Reality, Augmented Reality and Mixed Reality.](image)

At Palazzo Valentia, the no longer visible colours were projected onto the walls underground to visualise how it looked before. The same was done at the Ara Pacis museum, where the marble decorations of the altar were brought to life with colour via a laser show and later in an augmented reality experience using head-mounted devices. This was the ARA COM'ERA exhibition which initially led to the writing of this thesis.
ARCHEOGUIDE is one of the very first and most quoted case-studies, which presented digital content at specific points at the archaeological site of Olympia, Greece, in 1999.56 A team of computer scientists and engineers sought to bridge the gap between recreation, education and scientific research by providing a personalised electronic guide on the well-visited 'birth-place of the ancient Olympic games'. From a technical point of view, this project explored how multimedia could be made available to the public via mobile devices at specific locations of the site that were triggered via GPS. The project used state of the art head-mounted device's outside and linked it to a database with 2D & 3D reconstructions, audio and text. This study tested usability and experience on non-expert visitors and was not used to promote archaeological research or for conservation purposes.

From the field of heritage conservation, heritage visualisation specialists Westin and Almevik have recently undertaken the task to combine the physical reconstruction of the wooden church of Södra Råda with layers of digitised historical photographs from the archive.57 This building was one of the best-documented buildings in Sweden, and after the physical wooden reconstruction project was finished, the urgent need arose to keep this newly reconstructed building relevant for the non-expert public.58 In contrast to projects where technology is almost exclusively used to separate documentation from the physical site, Westin and Almevik rose to the challenge and made the extensive archive of historical photographs accessible in situ, by processing, contextualising and analysing them into a kind of digital canvasses, which were then mapped on a 3D model of the interior of the church. These differently mapped canvasses were made available to the viewer on a handheld device such as a tablet or smartphone. Because you look solely into the virtual environment, this is a perfect example of indirect augmented reality, as the

56 Vlahakis et al. 2002.
57 Westin & Almevik 2017, p.22.
58 Westin & Almevik 2017, p.25.
connection to reality is only done by recognition of markers that were set up in Vuforia and GoogleVR.

In 2005, visitors could experience an immersion in the fresco paintings at Pompeii, through the revival of their fauna and flora in a real-time storytelling scenario-based environment. The virtual Pompeii Project pioneered the use of laser-scanning to (re)create navigable virtual spaces. Visitors could rent and wear a small computer and interact with animated characters and virtual frescoes. By 2009, Pompeii further provided a ‘sensory platform’, which would allow visitors to ‘feel’ an earthquake and participate in the final moments of the destruction of the city. This created an emotional reaction in the participants. Comparable is the exposition ‘ARA COM’ERA’ at the Ara Pacis museum in 2016, where visitors could individually experience the coloured reconstruction of the altar while watching the marble reliefs through a head-mounted device, the Gear VR.

An interdisciplinary team of archaeology experts and engineers used 3D documentation for research purposes for the ‘Mapping the Via Appia’ project. They developed tailor-made 3D solutions to enhance the analysis and exploration of the Via Appia in the form of a 3D Spatial Data Infrastructure (SDI). This research clearly demonstrates the opportunities this most advanced software has to offer for archaeology and architectural history studies that aim to use 3D technologies to support the process of analysing complex sites. Visualising data for the analytical purposes of experts is, however, a totally different area than visualising the data for the non-expert tourist public visiting an archaeological site. Of course, research data should be used to base the visualisations for a broader public on. But offering a captivating presentation on site is a different ball game. This project is a clear example of the current research approach that will lead to libraries of tools. Expert users will soon be able to configure interfaces with the required functionalities for their purposes.

---

60 Costa & Melotti 2012, 55.
61 de Kleijn et al. 2016, p.23.
A good example of the use of augmented reality specifically for the non-expert public is the ‘Along the Appian Way’ project by Liestøl, a professor in the field of media and communication studies in Oslo. This project reconstructs three time periods on 1 km of the Via Appia Antica. They can be viewed via indirect augmented reality by looking through a smartphone at the virtual environment. These so-called ‘situated simulations’ (sitsims) let the visitor travel between space and time, where the transitions between the temporal phases are triggered by the user’s active repositioning on location. Figure 4 shows situated simulation on Milgram’s continuum spectrum. The project is one of the first to include research on multimodal learning and thus contributes to the discussions on experiential and emotive learning through storytelling and memory. Also interesting is the fact that the makers refer to their perspective as “positioned in and dominated by humanistic approaches to digital design and composition.” Connected research by Liestøl in this field shows his deep personal engagement related to curriculum content.

One of the companies clearly applying their archaeological expertise to the historically accurate virtual reality reconstructions, is Lithodmos VR. Their team consists of highly qualified archaeologists who craft stories and write scripts that support and enhance the virtual reality experiences in an engaging manner. They have introduced audio to

---

62 Liestøl 2014.
63 Liestøl 2011, p.310.
64 Smørdal et al. 2016.
enhance the visual journey in their Ancient Athens experience. “For this site they have recreated cultural icons including the Acropolis, Parthenon and Athenian Agora, digitally restoring them to their original splendour and glory for anyone to see with a virtual reality headset and smartphone. Add a pair of headphones, and upon entering the Acropolis, you are given a chance to interact with historical artefacts and hear their individual stories in wonderful detail.”

The team of Lithodomos VR searches the edge of where virtual reality ends and augmented reality begins. They want to create a deeper understanding of the location by the visitor, which is why the locational aspect of their VR-experiences is very important. However, the storytelling aspect also plays a big role in their experiences. For this, true virtual reality is more logical. Just like when we watch a film, Lithodomos VR wants to make us forget for a moment where we are. While the scene is already set, the storyline is ultimately defined by our own experience and interpretation. The virtual reality experience provides the entertainment value in itself. There is no need to embellish the historical facts of the past. They are astoundingly interesting.

Another company, Moptil is the first to provide an augmented reality experience at the Acropolis in which you can observe a detailed 3D reconstruction of the Acropolis of Athens during the height of antiquity approximately 2000 years ago. Their reconstruction is discussed in more detail in chapter five when examining the current presentations of the Parthenon available on site.

In 2014 the Acropolis Museum in Athens participated in CHESS, a project specialized in interactive digital storytelling. It creates customized stories that guide individuals and groups through a museum based on personal information. It makes use of the sense of discovery and wonder in the visitor experience. Curators, museum staff and scriptwriters wrote a plot around pre-selected museum themes. The main outcome of user-
centred evaluation sessions was that the presence of one or more characters telling the story was one of the highlights of the experience. The story plot acted as a ‘glue’ that connects the different parts of the presentation.

This section provided a summary of some of the relevant literature and case-studies in relation to augmented reality at heritage sites. The next chapter describes what uses the Parthenon has served throughout history and describes what societal and political impact the remains of it have today. This information forms the basis of the educational value that we could present to the contemporary non-expert public via the new medium of augmented reality. The subsequent chapters will explore the possible added value of this digital new presentation at archaeological, cultural heritage sites by linking recent research and case studies to the current presentation of the Parthenon from an interdisciplinary point of view.
“Facts can be highly entertaining and engaging, and the presentation of visual information through VR is an extremely powerful way to deliver such information.”
- Simon Young

CHAPTER 3 | THE PARTHENON

To make the proposed concepts tangible, this chapter discusses the presentation of a much-visited temple, the Parthenon on the Acropolis in Athens. It serves as a case-study. This classical monument has always had a significant historical, societal and political impact on our Western culture. We see it as the symbolic cradle of the democracy on which we base our society. It is important to keep in mind that we claim the Parthenon’s value only from a Western perspective. That value is specifically connected to certain groups of people. Not all people share these opinions. That is made painfully clear by the destruction of the ancient site of Palmyra.

We find the importance of the Parthenon in one of the earliest accounts of the temple by the ancient geographer Heraclides of Crete, who wrote in the third century BCE:

“[It possesses] an expensive temple of Athena, which stands out and is worth seeing, the so-called Parthenon, located above the theatre. It makes a big impression on those who see it.”

“Ἀθηνᾶς ἱερὸν πολυτελές, ἀπόψειον, ἔξιον θέας, ὁ καλούμενος
Παρθενών, ὑπερκείμενον τοῦ θεάτρου, μεγάλην κατάπληξιν ποιεῖ τοῖς
θεωροῦσιν.”

---

68 Heraclides Criticus, On the Cities in Greece. FGrH 369a F1.1, own translation; Pfister 1951.
Fast-forwarding to the present, the late President Barack Obama gave a speech with the Parthenon in the background during his visit in November 2016: "We’ve got the Parthenon behind us, part of the Acropolis. It is here in Athens that so many of our ideas about democracy, our notions of citizenship, our notions of the rule of law, began to develop."\(^{69}\)

Despite the obvious importance of the Parthenon to our Western society throughout the ages, one might object to using this monument as a case study for presenting digital cultural heritage. In fact, this monument does not need the extra attention for the purpose of increasing visitor number, where other sites could certainly use this help more. With over a million visitors per year, this archaeological site is a very popular tourist attraction. Also, there is rather much of the building left standing, which begs the question if an augmented reality experience is even needed, as looking up at the real Parthenon is already a truly inspiring experience for many, and the Acropolis is already an experience many people will not soon forget.

However, the Parthenon has a lot of historical value, both as an archaeological site, but also because of its association with the ideology of democracy. This monument still facilitates discussion of principles in both narrow and broad context. This thesis wants to show that also at sites which get a lot of attention and are already famous, these presentation techniques can make a difference, in addition, it may even be more important to get it right at those sites. Second, there are not many sites where virtual or augmented reality is already being employed, whereas on the Acropolis three virtual reality application are already available for the non-expert public. Altogether, this means that if there is indeed any additional value of an augmented reality experience at a cultural heritage site, the archaeological site of the Parthenon must provide ample opportunity to explore them.

This chapter shines a light on a few topics which have started some discussion in the academic environment as well as in the public space. A

\(^{69}\) Obama 2016.
lot has been written about the Parthenon already, and we are at a point that people start to research seemingly trivial topics such as “the pedimental figure, whose rising marks the dawn of the day of Athena’s birth and who is shown emerging from the sea in a rare and remarkable classical fusion of figure and nature that has not received the attention it deserves”, which might not be very interesting for the non-expert visitors. Then again scholars still disagree on important topics, such as what the original use of the Parthenon was, what scene is depicted by the sculptures on the pediments and the frieze and where in the world the Elgin marbles should be displayed.

Where the previous chapter introduced several case-studies that have been done on archaeological heritage sites around the world, this chapter discusses the case-study of this thesis, the Parthenon on the Acropolis in Athens. A brief history of the Parthenon is given, as well as some background information on the research that was done on the monument and the discussions surrounding it. So that at the end of this chapter, we have a clear understanding of what information might be valuable to a non-expert visitor to guide them on their experience of the Acropolis, and in particular the Parthenon.

3.1 HISTORICAL DEBATE ON USE

Firstly, the historical use of the Parthenon is not as clear-cut as it might seem. It might have replaced an earlier temple in the same location, called the Older or Pre-Parthenon. This earlier building would have been built before the Persian War and destroyed by the Persians in 480 BC. When work began on the Parthenon in 447 BC, the Athenian Empire was at the height of its power and the building survived for nearly one thousand years. During this time, parts were repaired after the roof was lost in a fire and Athens was sacked yet again. Whatever its use was, the Parthenon owes its survival to the continued appropriation of its vast structure. The accessible location is probably the biggest factor in the successive use of the building. It was a monumental place and could be seen from the whole city, not much unlike today.
Supposedly, the Parthenon served many purposes over the centuries and was used as a city treasury, converted into a Christian church, turned into a mosque until an explosion of stored ammunition caused its partial collapse during the Ottoman period. It is reasonable to assume that there was a period of disuse rather than direct transformation when going from temple to church.\textsuperscript{70} In the final decade of the sixth century AD, it served as Church of the Virgin Mary. The Parthenon even became the fourth most important Christian pilgrimage destination in the Eastern Roman Empire.\textsuperscript{71} After the Turkish Ottoman forces invaded Athens in 1456, the monument was turned into a mosque. During these changes, the primary structure of the Parthenon remained intact, which is evident from sketches made by the French artist Jacques Carrey in 1674, and an engineer named Plantier.\textsuperscript{72} Unfortunately, only two centuries before the first photographs were taken, the Parthenon was extensively damaged by the explosion already mentioned. After the explosion of 1687, all that had been left from the eastern, inner six-pillared prostasis of the temple was a single column and the lower two or three drums of the remaining five.\textsuperscript{73} From the 1830’s onward, the ruin turned into a symbol of democracy and Greek pride. The closer we get to the present, the less controversial the use becomes; it becomes a monument.

What the Parthenon looked like at the height of the Athenian empire can be imagined by looking at the early written accounts. In the ancient equivalent of a travel guide, written by Pausanias almost 600 years after the Parthenon was built, we find the first account of it.\textsuperscript{74} The better part of his description focuses on the colossal statue of the goddess Athena inside the building. Though his account is crucial to picturing the ancient Parthenon, he does not mention seemingly essential aspects of the architecture, the metope panels or the meticulously sculpted frieze. Perhaps this is very logical visitor behaviour, to gaze quickly at the

\textsuperscript{70} Ousterhout 2005.
\textsuperscript{71} Kaldellis 2007, p.3.
\textsuperscript{72} Carrey et al. 1971.
\textsuperscript{73} Hurwit 2005, p.321.
\textsuperscript{74} Pausanias 1.24.5-7.
pediments and then focus your whole attention on the golden eyecatcher in the cool shade of the building.

Although Pausanias calls the Parthenon a temple, which is architecturally correct, the building never hosted the cult of Athena Polias, patron of Athens.\textsuperscript{75} The cult image was located on the northern side of the Acropolis, at an older building. In contrast with what we usually view as a temple, the priestess is absent, as well as a cult name and even the most common piece of a Greek temple; an altar directly outside its front entrance.\textsuperscript{76} This supports the view that the building was a particularly grand treasury, or a commemorative monument built more than 30 years after the Persians destroyed the Acropolis. This use of the monument is further subscribed by Thucydides, who claims that the Athenian statesmen Pericles once referred to the statue as a gold reserve, perhaps sarcastically.\textsuperscript{77}

We know enough about this lost statue to be able to identify a whole variety of smaller scale versions found all over the ancient world in marble, bronze and terracotta, as well as in images on coins and gems.

At this point, a full discussion of the history of the Parthenon lies beyond the scope of this study.\textsuperscript{78} However, it is clear that the question of the Parthenon's original use is only one of the many we cannot answer with any certainty. This should not be seen as an omission; our study of the past is not focused on uncovering the absolute truth but is more generally centred on coming in contact with the so-called 'otherness' of different cultures.\textsuperscript{79} Pausanias' and Heraclides' accounts can serve as a reminder of how difficult it is to reconstruct the way in which an ancient viewer saw and interpreted the Parthenon. It is just as difficult to align modern opinions in one way.\textsuperscript{80} Renowned classicist Mary Beard acutely summarises this dilemma when she writes: “The Parthenon, in other words, offers an object lesson in those tantalising processes of

\textsuperscript{75} Deacy 2008, p.111.
\textsuperscript{76} Burkert & Raffan 1985, p.143.
\textsuperscript{77} Thucydides 2.13.5.
\textsuperscript{78} For a very readable and well researched history of the Parthenon, see Beard 2003.
\textsuperscript{79} Settis 2006, p.111.
\textsuperscript{80} McInerney 2012.
investigation, deduction, empathy, reconstruction and sheer guesswork that must be the hallmarks of any study of classics and the classical past.”

If ever there was a recommendation to use the Parthenon as a case study for digital cultural heritage, it is this citation.

3.2 DEBATE ON THE SCULPTURES

The latest use of the Parthenon is as we experience it today: an archaeological monument not to be missed when visiting Athens. The present site is the result of a campaign of clearance and excavation which took place in the nineteenth century, under the supervision of the newly formed Greek Archaeological Service. After the ‘remains of barbarity’ were stripped away following the instructions of the neoclassical architect Leo von Klenze, the Acropolis was left with a handful of isolated monuments.82

Now the visitors walk in between these monuments, experiencing the site as it was constructed by archaeologists of the nineteenth century. A leading scholar of ancient Greek art, Jeffrey M. Hurwit, discusses the physical setting of the Parthenon at the end of the fifth century and states that “the Parthenon ... stood squarely at the ideological center of a constellation of monuments that pronounced and continually reiterated both the venerability, the antiquity, of the Acropolis, and the power of Athena as goddess of victory.”83

As mentioned previously, the Parthenon owes its survival partly to its accessible location. There is no question that in antiquity, as today, the Parthenon dominated the Attic skyline. However, we should imagine the original view of the Parthenon as partly obstructed by other buildings, walls and monuments.84 The experience of visiting the monument would have been entirely different after a walk full of tantalising glimpses. The crowded surroundings of the Acropolis, which must have been full of life,
form a stark contrast with the spacious emptiness we now encounter around the monument.

The excavations of the nineteenth century were in many aspects an enormous success. After the garrison village was cleared away, it was much easier to access the vast building, and this created the opportunity to study the metopes and frieze in more detail with the help of technology. Archaeological discoveries made by the Greek Ministry of Culture’s Acropolis Restoration Service in the meticulous study of the building have revealed new information on the materials, tools, techniques and engineering employed in the Parthenon’s construction. Moreover, many sculptures were found during these excavations. They were displayed in a museum to the east of the Parthenon. Later, they were moved to the New Acropolis Museum, which opened in 2009.

The repertoire of sculpture from the Parthenon is remarkable. The west pediment on the rear shows he quarrel between Athena and Poseidon for Athens and Attica. The east pediment on the front side probably depicts the birth of Athena before the other gods together, a theme already developed in ceramics, but never yet in sculpture. Of all the decoration, the frieze is the most discussed, as it survives reasonably intact. It portrays a procession of horsemen, musicians, animals, charioteers and water-carriers. From the Westside, they progress on the two long sides towards the Eastern front side. The meaning of the sculptural decorations is extensively discussed among scholars, and again the views show a wide range of interpretations. One sees democracy in the marble figures, where the striking uniformity of the faces and expressions shows Athens democratic principles. The other connects the naked riders to the homoeroticism of classical Athenian culture. From the seventeenth century, the figures have been understood to be marching in their Panathenaic, or all-Athenian, procession, a key event within the annual festival of Athena. This presentation has been challenged in recent studies that suggest the Parthenon was adorned with a scene from the mythical

---

85 Bouras et al. 2015, p.46.
past. According to mythological sources, the child of the king had to be sacrificed for the founding of Athens.\textsuperscript{86} Remains were even discovered of a second frieze that would have run around the inner eastern porch.\textsuperscript{87} This frieze would have been easily visible to any visitor climbing the steps, and it is already an excellent source for new hypotheses and questions. As with the discussion about the original use of the Parthenon, we are also left here with tantalising questions.

Discussing the sculptures of the Parthenon always brings to light the question of the Elgin Marbles. Lord Elgin, a British ambassador to Constantinople, removed and shipped many Parthenon sculptures to England at the start of the nineteenth century. The ‘stolen’ parts of the sculpture are pristinely white in the reconstructions at the New Acropolis Museum, to highlight the problematic ownership of these sculptures by the British Museum in London. This thesis, however, does not engage in the debate on restitution but instead argues that this debate itself has become an intangible part of the heritage sites and should thus be incorporated in a presentation for the public.

3.3 DEBATE ON APPROPRIATION

Another alluring intangible part of the Parthenon’s heritage is its association with democracy. Many agree that this link stems from the Periclean aristocratic building programme during the fifth century BC when Athens was by far the wealthiest polis in the Greek world. At the height of their power, the Athenians embarked on a massive building and rebuilding program. Remarkably, temples that had lain in ruins since the Persian sack in 480 BC were now to be rebuilt under a building program with which, according to Plutarch, Pericles was closely associated.\textsuperscript{88} We have evidence to believe the final decision on whether and what to be

\textsuperscript{86} Connelly 2014.
\textsuperscript{87} Beard 2003, p.136.
\textsuperscript{88} Plutarch, Perikles 12.3-4.
rebuilt was made by the Assembly. This democratic decision made these buildings prominent signs of the power of the demos.89

Perhaps our strong association of politics with the Parthenon is not as logical as it seems. Scholarship has put so much emphasis on Athens in the fifth century BC, that it seems almost impossible not to see the building in the context of the golden age of Greece, with democracy as its shining product. Athenian culture is not as clean and simple as it is sometimes presented. Wariness is key when viewing Athenian democracy through a modern lens. In the long history of the city of Athens, democracy turned out to be relatively short-lived. The radical form of popular government that had developed in the fifth century was not the standard during most of classical antiquity. Instead, the Parthenon was a symbol of the power of the autocrats more often than not. Why then is this building still so closely associated with the ‘rule of the people’? This power of the demos is contrasted by the more familiar privately developed monuments that only spoke to the power of a monarch or tyrant. In comparison, the Parthenon - a publicly funded temple - was a visual reminder of the power of Athens, and therefore its people.

In the last few decades, there is a shift in the way ancient studies and archaeology are approached. Different research models and methods are being deployed, which contributes to a more holistic view of the monument in its time, space and, perhaps most importantly, its society. A society in which religion was embedded in virtually every aspect, albeit the practice of religion differs enormously from the contemporary religious practices. Joan Connelly describes this as: “An awareness of an ‘other Acropolis’ is emerging, one that seeks to build a multitemporal and multisensory appreciation of the site and its buildings, including the Parthenon itself”.90 How can we compare the clear political association we have now, with the political context from back when the Parthenon was constructed?

90 Connelly 2014, p.xix.
The Parthenon is now seen as a part of our collective ‘world heritage’, rather than being seen as specifically ‘Greek heritage’. This is caused by years of appropriation of the physical decorations and the ideological concepts which are associated with the monument. Since the construction of the first Parthenon, its concept/idea has crossed many borders, both in tangible and intangible form. First, the tangible form seems most comprehensible, and if we look at the original parts of the Parthenon, a good proportion of the sculpture that decorated the monument in the fifth-century BC is now scattered across the museums of Europe. The enthusiasm for the monument has inspired emulation in material from all over the world. These emulations can be seen as indirect tangible forms, a specific form of the intangible heritage of a site. They range from tiny silver jewellery to a full-scale, walk-in concrete replica in Nashville. Also, in this way, the Parthenon has earned its place in our world heritage.

Other parts of the intangible cultural heritage lack a physical equivalent. For example, the abstract concept of democracy that we clearly associate with the pristine white symbol of the Parthenon. It has even overshadowed its association of the building with the city of Athens. The building has been turned into a recognisable icon for involved citizenship with evident fame and associated glory, free for anyone to affiliate themselves with.

The stark contrast between the Parthenon as a flawless icon created in the 50’s and 60’s of the last century, and the real archaeological ruin on the Acropolis, has not gone unnoticed. The joy of experiencing the Parthenon for the first time is often accompanied by tears of grief for the tragically dismembered ruin, a tradition started by Lord Byron and enthusiastically preserved by the Greek government.91 The most famous target of many people’s ire - including Byron’s - was Lord Elgin. Although, as much as Elgin changed about the Parthenon’s look, we might say that the real damage was done in trying to get back to the Periclean Parthenon

---

91 Lord Byron makes his views very clear in many works, including his satire ‘English Bards and Scotch Reviewers’ 1809.
of the fifth century BC. Despite all the controversy about the 'stolen' sculptures of the Parthenon, there may be an uncomfortable truth in Beards conclusion: “that, if it had not been dismembered, the Parthenon would never have been half so famous.”92 She argues that many conversations, from the lauded architecture to the sublime sculptural decorations, were heightened by the emotional discussion about the dismembered sculptures and metopes, which Lord Elgin brought to England.

This chapter explored the use of the Parthenon from temple/treasury and church to an idealised archaeological site. Following the nineteenth-century urge to show the Periclean monument it was stripped of context. The monuments of fame is the result of the close and intangible association with our construct of democracy, but perhaps it has begotten most fame by 'being famous' and discussed. The more people wrote about it and published pictures of the impressive building, the more fame it begot. As the Greek government tries to present the idealised icon of democracy at the height of Athenian power, we have to use our imagination to see the monument in the context of all its history and interpretations.

Many aspects like continuance and appropriation might be relevant in educating the non-expert public about the monument. They play a role in the validation of the archaeological heritage site. Drawing on the baseline of information on the Parthenon given in this chapter, it is now possible to discuss new ways of presenting the scholarly knowledge to the public. Chapter two already provided an overview of the history, uses and impact of augmented reality. Together these two chapters form the basis of the evaluation of possibilities in chapter four. There we take a look at the information available to the non-expert public visiting Athens this day.

92 Beard 2003, p.22.
“As you make your way through the entire VR journey, you’ll learn about the very foundations of democracy by engaging with history’s greatest philosophers. You’ll visit music halls and grand temples and use the audio guide to unlock their fascinating stories of art, culture and ancient civilisation.” 93
- Simon Young

CHAPTER 4 | PRESENTING AND AUGMENTING THE PARTHENON

Standing in the heat at the foot of the Acropolis, looking up at the throngs of tourists making their way up the slippery rock, you cannot help but wonder what they are thinking about. What is certain is the allure the Parthenon has for visitors, as well in situ as digitally. Remarkably, a four-minute YouTube video, where you have a 360-degree view of walking around the Parthenon without any commentary, has been watched over 15 thousand times since last year.94 Walking around on the bare bedrock today, this outdated archaeological vision is hugely present. As a recent critic concludes “the viewer is encouraged to reflect on the passage of Time - that is, Time as an abstract concept, uncomplicated by the messiness of specific historic events.”95
This chapter will explore the possibilities of augmented reality at the site of the Parthenon. First, the information panels and current presentation

---

93 Young 2018a.
in situ is discussed, after which we will take a closer look at the augmented reality applications that are already available. Then new possibilities are explored by adjusting existing AR-applications to the content available for the Parthenon, which was discussed in the previous chapter. Together these findings form the last chapter of this thesis.

**4.1 PRESENTATION ON SITE**

Let us take a look at the state of presentation of the Parthenon on the Acropolis as it is today, in 2018. On-site, archaeological and historical information is presented on information panels, put up by the state. The texts and images on the panels focus mainly on three aspects of the site: the history, the archaeological procedures and the reconstruction works. The purpose of these information panels is to inform the visitor, by displaying the information from the Greek governments perspective. In total there are six information panels concerning the Parthenon, two about the history in general, two on the restoration work and two on specific archaeological topics. As an example, a photo of one of the general information panels about the Parthenon is shown in figure 5. The language is characterised by rather complex sentences and frequent use of specific terminology. Illustrating the information, a few images show the location on the Acropolis and a reconstructed ground plan, curvature and the sculptures.
This information panel lists briefly the history of the Parthenon, focusing on the dates and names of the people who either added or subtracted to the structure of the Parthenon. Ending with the “most severe damaged to the monument […] when the Scotch ambassador of England to Constantinople Thomas Bruce, 7th Earl of Elgin, remove the greatest part of the sculptures that also comprised structural members of the temple. By bribing the Turkish garrison of the Acropolis and employing teams of the Italian artist G.B. Lusieri, Elgin removed and transported to England 19 pedimental sculptures, 15 metopes and the reliefs of 56 sawn blocks of the frieze, today exhibited in the British Museum in London.” This text shows one perspective on the debate about the Elgin marbles, but it does nothing to arouse the visitor's curiosity. The information is presented as facts, and there is no trace to be found of the intriguing discussion on the Elgin marbles that we discussed in the previous chapter.

The same is true for the information panels on archaeology and restoration, as shown in figure 6. From the colours and fonts, we can conclude that the information panels were made at different times, but the general layout and style stayed the same. In a way, these information panels touch upon very interesting debates that are still relevant today, but they fail to engage the visitor critically.

The second topic that the information panels discuss is the restoration work that is prominent on site. The information panels are limited and only discuss how the Parthenon is begun to be 'conserved' and
slowly restored with the utmost care. The identification of the marble architectural members that lay scattered on the Acropolis Rock, their resetting in the monuments from which they come, and the correction of the faulty placing of marble members in the previous interventions led to a broader anastylosis, extended to a greater part of the monuments, thus increasing their comprehensibility and their educational value.\textsuperscript{96} The literal meaning of the word anastylosis is: recomposing the whole through the exclusive use of architectural members that are no longer in their rightful place. In anastylosis it is desirable to achieve a balance between original and new materials; also important is the imperative to maintain the ruined character of the monument, even after the new additions have been implemented. The publication shows that there were plans of presenting this process to the public, but unfortunately no trace of this presentation could be found on the Acropolis in March 2017.

For colourful reconstructions, the visitor has to go to the New Acropolis Museum that was built across from the Acropolis and opened in 2009. There, on the top floor, with a view of the Parthenon, a big part of the frieze is exhibited in the same spatial width and length although put lower to better observe the sculpture. In the scope of this thesis, the presentation of the sculpture in the New Acropolis Museum is not discussed. Museum presentations are a whole different ballgame, on which a few comments are made in the discussion section of chapter five. The focus here is on the people standing on the slippery rock in the sun looking at the continuous worksite, where the impressive monument has been enveloped in scaffolding since 1983.

4.2 PRESENTATION IN VIRTUAL REALITY

As mentioned in the previous chapter, in the last two years three virtual reality and augmented reality presentations of the Parthenon were built

\textsuperscript{96} In depth discussion of the restoration programme of the last 35 years can be found in Bouras et al. 2015, p.20.
and published. They all focus on presenting the Parthenon as it was at the height of the Athenian empire to the non-expert public.

In April 2016, the Greek company called ‘Mobile Optical Illusions’ (Moptil) published the first augmented reality experience at the Acropolis, ‘Acropolis 3D’. They aim to develop their own virtual and augmented reality 3D products for tourism and education. Acropolis 3D was created solely for the tourism sector and can only be accessed on the tablet or head-mounted device provided by Moptil at their office near the entrance of the Acropolis. The tour, consisting of the device and application, can be booked as an individual, a tour operator or as an agent. For an individual, the costs are €18 per tablet for two hours of use.

Acropolis 3D consists of full reconstructions of not only the Parthenon but also the other buildings on the Acropolis. The reconstructions can be viewed in 360 from set viewpoints which you can select from the menu. The building interiors include colourful decorations and it is possible to zoom in on the sculptures and motives. There is also a video provided which gives an overview of the Acropolis during the Christian (500-1500AD) and Ottoman (1500-1800AD) periods and shows the evolution of the Acropolis from prehistoric times through to our present day. The users can get a digital souvenir in the form of a picture of themselves or their friends next to the gold and ivory statue of Athena inside the Parthenon. Since 2017 an option is added to see an overlay with ancient Greeks walking, talking and running with horses on Acropolis hill.

---

97 Moptil | YouTube 2016.
participating in the ceremony of Great Panathenaea. In the same way, human actors can be added to the interior of the buildings, meant to reveal the use of every temple.

The purpose of the tour is to provide a window into the (reconstructed) past. Moptil explicitly invites the public to “enjoy history without any limits to your imagination!!” via a tablet or head-mounted device. However, this invitation seems somewhat paradoxical, as this reconstruction does not require the viewers to use their own imagination at all. The details are filled in, and no alternate versions are presented. Moptil’s reconstruction of the Parthenon was created by 3D graphic designers in collaboration with the classical department of the University of Athens. However, the role that the experts play in the story is vague at best, and it is obvious that this experience was made to satisfy a need of the public. At most it is a way to tickle the brain to see the way this building could have looked, might have looked, might have been used, etcetera. All in all, this is a strange authentic experience. Everything should be fun and informative, but most of all entertaining, easily accessible. In the glaring sun, tourists don’t like to read long informative panels with words they don’t understand. The archaeological maps can only be read if one has had some introduction to archaeology. They do not help very much.

In September 2016, Unimersiv, a company that creates virtual reality training and educational experiences also published a virtual reality
experience of the Acropolis. This experience is only accessible via an app which contains several learning experiences in virtual reality for the most common head-mounted devices, Google Cardboard, Google Daydream and Gear VR. The app costs €3.59 on Google Play store and €4.99 in the Oculus store and besides the Acropolis experience, it includes their other experiences: ‘Dinos’, ‘A Journey into the Human Brain’, ‘Rome’, ‘Titanic’ and the spaceship ‘ISS’. This app is not linked to an existing tour and cannot be ‘booked’ as such. An individual can take his head mounted device to the Acropolis and use the app there to create the same experience the other apps have.

In the Acropolis experience, the visitor can explore and learn about the Acropolis of Athens. Unimersiv has reconstructed the interior of the Parthenon with the Athena Parthenos as a massive gold and ivory sculpture of the Greek goddess Athena. Furthermore, the Erechtheion, the Athena Promachos and many more places on the Acropolis are represented as the makers think it was thousands of years ago. The user can take a guided tour through the different scenes and buildings or choose from the menu to which scene they want to jump. Each scene consists of a few viewpoints which act as a 360° video with an audio guide that provides basic historical, archaeological and art historical information. Strikingly, the reconstruction of the Parthenon shows no colour on the metopes and pediments, which is obviously not historically correct. The main goal of Unimersiv is to provide an educational experience of the Acropolis in virtual reality.

The third virtual reality experience of the Parthenon is the application ‘Athens in VR’, made by Lithodomos VR. Like the Acropolis experience by Unimersiv, this virtual reality environment is only accessible via an app for the most common head-mounted devices, Google Cardboard, Google Daydream and Gear VR. The app is comparable in

---

100 Unimersiv | Google Play store 2017; Unimersiv | Oculus store 2018; Unimersiv | YouTube 2016.
101 Lithodomos VR | YouTube 2018.
price to Unimersiv’s, €3.19 on Google Play store and €4.99 in the Oculus store. Compared to the previously described app, this one only includes viewpoints in Athens and no dinosaurs, titanic or spaceship. In May 2017, Scooterise and Lithodemos VR joined forces to provide customers with virtual reality tours of the Athenian Acropolis. Scooterise’s virtual reality tour makes use of a few viewpoints on the Acropolis and today the two-hour tour, which costs €69 per person, has become one of their most popular offerings.102

The Athens in VR application was made in the first place to be used as a historically accurate, educational virtual reality experience. A significant difference with Unimersiv’s approach is that Lithodemos reconstructs the archaeological heritage via a very thorough process in which professional archaeologists, PhD-students and graphic designers work together to create an accurate reconstruction of what might have been. This process ensures that the reconstructions are based on solid research and thus adhering to the ICOMOS charter that was discussed in chapter one.103 The value they place on factual accuracy is clearly visible in the quality and detail of the reconstructions and graphics, which can be seen in figure 9.104

102 Lithodemos VR | Scooterise.com 2018.
103 Lithodemos VR | lithodomosvr.com & Young 2017.
104 Lithodemos VR | lithodomosvr.com 2018.
4.3 PRESENTATION IN AUGMENTED REALITY

These three applications can be categorised as indirect augmented reality, in the sense that the virtual environment corresponds roughly to the point that the visitor is looking at but is not synchronized by any real-time tracking. The point of view is established at one time, and after that, the viewer looks at a fully virtual environment. It is what Liestol aptly named a ‘Sitsim’ (situated simulation), as discussed in the second chapter. These apps are already wonderful examples of the power of augmented reality for creating an authentic experience, from the visitor’s perspective at least. First and foremost, these indirect augmented experiences stimulate engagement and entertainment for the public. However, today it is possible to combine the positioning of the augmented reality environment with roughly corresponding locations, with real-time tracking via image-recognition. This way, walking around on the Acropolis could turn into an experience where various aspects of the Parthenon come together in the thought experiment here called ‘the Augmented Parthenon’.

Concerning the 3D visualisation of the monument, not even the best-researched reconstruction presented by Lithodomos VR presents what we call ‘a multivocal view of the past’. This is a view where there is room for uncertainty and different interpretations. A wonderful opportunity at the Acropolis is to make the extensive archive of historical drawings and photographs accessible in situ. Making these digital records available and applying them to the Parthenon is comparable to the project, mentioned in chapter two, reconstructing the historical archives of the wooden church of Södra Råda as digitized layers.\(^\text{105}\) In this study, the historical interiors of the church were made available through a handheld device, such as a tablet or smartphone. But they could just as well be accessed by using a head-mounted device for fuller immersion in the scenes.

By playing with transparency and colours, different views on the reconstructions of the Parthenon could be visualised. Using the already

\(^{105}\) Westin & Almevik 2017, p.22.
digitally available historical archives would reduce the costs of such a project considerably. In order to make this a functioning augmented reality experience, recognition of markers could be set up via Vuforia and the 3D-engine Unity, or GoogleVR, just as was done by Westin and Almevik in their church.

Another option for creating a more authentic experience is suggested by the commenter 'dmayers340' who left a review in the online Oculus Store:

“The site doesn’t looked lived in, the environment choice was a bit strange, didn’t really feel realistic (which I argue is good for historical visualisation). The first thing I noticed, and was very obvious throughout the entire experience was how bare it was, very solitary. Ancient Athens (especially on the acropolis) would have been filled with people. It would have been dirty, and used.”

This is a typical example of the way fast digital feedback can help close the gap between the expert and non-expert. The commenter makes a valid point and shows that he feels the authenticity of the historic site was not transferred as well as it could be in the presentation. Perhaps a layer showing a 'lived in' version of the Acropolis is not a bad idea. Not surprisingly the company that was always best in touch with their target audience, Moptil, has indeed added a similar feature at the touch of a button: the human figures and horses that populate the Acropolis.

To add to the educational value, Liestøl has created an experience based on the concept of storytelling, similar to the one at the Via Appia which was mentioned in chapter two. His Sitzim of the Parthenon was made to further the public’s knowledge on the Panathenaia procession, that was part of a ceremony in honour of the goddess Athena. The ceremony included a large sacrifice at the altar of Athena on the Acropolis hill, and next to the Parthenon, where the inner Ionic frieze also depicts scenes from the procession. As depicted on the frieze the simulation added

---

106 Lithodomos VR | Oculus store 2018.
many oxen and sheep that were led to the altar, women carrying incense burners and wine jars, and men playing on string instruments and flutes.

Liestol recreated this procession in a virtual environment and created a Sitsim with clickable positioned hypertext links, floating above the characters walking in the procession.\(^{107}\) Upon touching a link, the information on the related topic or character would show. Unfortunately, his discussion on this simulation ends with the comment that there is also controversy related to the interpretation of the Panathenaic procession. Reason to move on to the discussion of the next Sitsim where they “have tested the same functionality in a more recent historical event, and one that is much better documented.”\(^{108}\) Especially in augmented reality, there is not much reason to shy away from presenting a multivocal view, as there is enough digital space to go around, although creating different versions of the 3D environment is not feasible budget-wise, linking to different interpretations already available in 2D can certainly be considered a close second option.

Jonathan Westin does not shy away from visualising the uncertainty and shows that it is indeed possible and necessary to incorporate the uncertainties that are now only visible to the experts, also to the non-expert public. He argues that “By shedding the representation of uncertainty or dressing the uncertain in symbols lent from convention, Ancient Rome remains a city of stone since any proof of wooden structures, metal works, and ornaments is missing. The walls stand uncovered by paint or hanging fabrics since there remains no evidence thereof to base a “certain” visual representation on.”\(^{109}\) The same is true for the Parthenon. The visual representation that we present to the public, without the ‘uncertain’ factors, could easily be interpreted as complete. Therefore, it is time to seriously consider Westin’s conclusion that it is better to fill the lacuna with educated guesses. Not to dare speculate about the unknown or what was lost is less preferable, he says.

\(^{107}\) Liestøl 2017, p.1.
\(^{108}\) Liestøl 2017, p.4.
To improve upon the educational value of the Augmented Parthenon, connections to existing learning materials could be gathered in the corresponding thematical spots of the Augmented Parthenon. For example, the most engaging educational introduction movie about the Parthenon made by Smarthistory could be presented as someone enters the site. In order to avoid an overload of information for the visitor, one might use the personalisation presented by the CHESS project.

By taking a short CHESS questionnaire, the visitor gets a tailored tour of the museum, which corresponded to his interests. Recent developments even include the use of social media profiles in personalisation processes to create and evaluate personalised cultural heritage content. Personalisation is based on the assumption that the application can understand the user’s needs and that it can connect to past experiences to provide the most relevant and interesting personal context. For example, depending on which Facebook pages the visitor likes, he could be presented with a video by a philosopher, politician or historian, explaining their view on democracy. Tangible heritage should not be in the way of intangible heritage, and the rock of the Acropolis can be a great place to challenge groups to interesting dialogues on their views on democracy and freedom.

Besides the one-sided reconstructions and limited audio guides, the three existing and described digital presentations on the Parthenon do not make use of the connective aspect of augmented reality. Augmented reality can augment more than just visual information; it can also connect ideas, disciplines and people. The three apps mentioned are very solitary in their use, while we have seen that this does not have to be the case. Therefore, the Augmented Parthenon could be connected to a social platform, enabling visitors to add their own associated media to a digital layer. Especially a spoken medium like podcasts, which has become very popular over the last few years, can be combined well with viewing an augmented environment.

---

110 Antoniou et al. 2016.
To facilitate sustainable conservation of cultural heritage, an emotional connection should be built with the public. This emotional engagement is closely related to the social interactions that form the personal learning experience in connection with a site. This emotional response might be one of the hardest things to induce. In what ways could the visitor be invited to think about the Parthenon and its societal impact? In this regard, again the CHESS study shows the possibilities of augmented reality on emotive responses. Here the human component plays a big role, and this shows a possibility that has until now never been explored for the Parthenon. We could rouse the emotions of the visitors by playing music or showing a heartfelt speech by former actress and minister of culture Melina Mercouri on the Elgin marbles. As a contrast, there could be the argument made by the British Museum to keep the sculptures accessible to the broad and diverse public that visits the freely accessible British Museum in London.

We do not have to look far to find emotional responses to debates surrounding the Parthenon’s sculptures. There is a heated debate on returning the sculptures in the comment section. You can see these comments underneath a YouTube video featuring an animated 3D reconstruction of the Parthenon starting with the frieze in the British Museum.\textsuperscript{111} The emotions run high for a Brit and a Greek in these comments, which is the reason for other people to chime in and express their opinions. These people are learning through experience and facilitating better understanding through their emotional connection to the topic.

Obviously, a more curated approach to the educational content is advisable. this was shown for instance in the Via Appia project, where the information was presented as a mnemonic learning tool. There the conventional quiz was used to test the awareness and learning output of the multimodal educational experience that Liestøl designed. Such a debate is more structured and thus better applicable. The virtual debate

\textsuperscript{111} BUCCAPHELUS | YouTube 2008.
only came up in the last decade, in which the internet is freely available as a platform for anyone who would like to share his or her opinion.

Lastly, we could argue that at this moment in time there is already a very augmented atmosphere at most cultural heritage sites. Everyone can now search for information of personal interest on the internet. In that way, one can create one’s own learning experience and instantly find the information that one is interested in. However, it needs no explanation that this information is in no way curated and the option of a curated augmented experience is favourable. This way archaeological heritage sites can raise curiosity instead of boredom, and we might fulfil the objectives of the ICOMOS charter with flying colours.

I would like to show that we can look further than just visualising the past and creating digital reconstructions. The focus should be on the experience of the visitor and creating an experience that adapts to the learning curve of a visitor, by stimulating connections and individual interpretation, as well as interactivity.
CHAPTER 5 | CONCLUSIONS AND RECOMMENDATIONS

The purpose of this thesis was to determine if there is added value of using augmented reality at the archaeological site of the Parthenon. In addition, the study set out to test the value of a digital presentation and interpretation of an important cultural heritage site.

Chapter one described the recent transition of our society into the digital era due to technological innovations. This lead to further research in the field of digital cultural heritage. The implication for education was that the ‘expert-only’ presentation is making room for an emphasis on process and collaboration. This change was started bottom-up, by the non-expert, who is looking for an authentic experience at a cultural heritage site. Experts should overcome the fear of losing authenticity and look further than the confines of their research. The guidelines described in the ICOMOS charter and Impact Playbook play a valuable and reassuring role. From these two documents the key values at a digital cultural heritage site were put together: the learning experience, meaningful authentic communication and sustainable conservation.

Chapter two discussed the history and developments of virtual and augmented reality with a focus on practice. We have seen that virtual and augmented reality have gone through the stages of the Hype Cycle and have now reached the stage of adoption by the wider public. Augmented reality was defined in its broadest sense, but with a clear distinction
between medium and devices. The examples of adoption of the new medium and its current devices in case-studies is widespread, which creates many different points of reference to explore new possible augmented experiences.

In chapter three on the Parthenon, we have seen why this specific cultural heritage site, despite its limitations, is a valuable case-study: because of its relevance and connection to society, as well as the fact that there are existing virtual reality experiences available of this monument. Furthermore, we saw a debate about the different historical uses of the building throughout history. The debate on authenticity from chapter one returns, when discussing the arthistorical meaning of the sculptures. From the socio-political side, the debate on the Elgin marbles was presented. These discussions show how the debates on tangible and intangible subjects join together in relation to the Parthenon. Where the columns are clearly tangible, the related columns in Nashville can be seen as indirect tangible forms. Intangibly, the concept of democracy is closely connected to the Parthenon in contemporary society. In these examples, just a few debates are highlighted of the many with which the non-expert public could connect to the Parthenon.

Chapter four showed that the presentation on site is outdated and the information panels still rely on outdated communication strategies, where the expert gave a monologue to the public. The three existing virtual reality presentations by Moptil, Unimersiv and Lithodamos VR, have been discussed in regard to their setup. In comparison, the colourless reconstructions of Unimersiv’s experience lack authenticity, where Lithodamos VR wins with flying colours. The thought experiment ‘Augmented Parthenon’ showed how the possibility of layers and visual signifiers could provide new possibilities for the presentation of the debate on the historical use of the building. Furthermore, it was shown how Augmented Parthenon could provide a personalised experience for the public if connected to a social media account, which would then stimulate the emotional connection to the site. A social media layer in the Augmented Parthenon experience could feature the option of additions by
the visitors themselves, for example in the form of podcasts which could be listened to while strolling in the shade of the Parthenon.

This study has shown that there is the added value in using augmented reality at the archaeological site of the Parthenon. With augmented reality, we have the possibility to add features to the site that enhance each of the three key principles of value at a digital cultural heritage site. The learning experience can be enhanced by connecting directly to the personal interests of the visitor, which also creates a means of authentic communication and on the long-term might even add to sustainable conservation by establishing an important emotional connection with the public. Authentic communication is further enhanced by providing a layered reconstruction, in which uncertain aspects have their rightful place. The accessibility of these digital reconstructions and the digitised historical archives on themselves is an example of sustainable conservation. Together these possibilities create an awareness of the worth of the site, and thus they transfer to younger generations this implicit idea that this cultural heritage site should be safely kept for the future.

The research has also shown, in general, that this method could be used to test the value of a digital presentation and interpretation of another cultural heritage site. The findings will be of interest to all cultural heritage professionals, but especially in the field of archaeology. The insights gained from this study may be of assistance to professors looking to introduce case-studies of digital cultural heritage into their lectures. Hopefully, these new understandings will help to improve predictions of the impact of further technological developments in the field.

The field of digital cultural heritage will be a fruitful area for further work. Future research can focus on how to make the augmented reality spectrum broader more varied and more interconnected. Different disciplines could work together more intensely to construct new digital presentations. Furthermore, integration of this medium in university and even secondary school and higher education curricula would be advisable.
WORKS CITED


UK; Cambridge University Press, p. 430.


Lithodomos VR | lithodomosvr.com & Young, S., 2018. Listen… can you hear the virtual reality? Available at: https://lithodomosvr.com/listen-can-hear-virtual-reality/ [Accessed April 7, 2018].


Mkono, M., 2012. A netnographic examination of constructive
authenticity in Victoria Falls tourist (restaurant) experiences. 

*Electronics*, 2437(May), pp.1–8.

Moptil | Moptil.com, 2016. Acropolis site - Moptil. Available at: 

Moptil | YouTube, 2016. ACROPOLIS 3D with Augmented Reality. 
Available at: https://www.youtube.com/watch?v=8KA0C26Vz8 
[Accessed June 17, 2018].

UK: Cambridge University Press.

Obama, B., 2016. President Obama in Athens, Greece. Available at: 
https://www.youtube.com/watch?time_continue=31&v=ct_54shfku 


Oxford Dictionaries, 2018a. “augmented reality.” *Oxford University Press* 
Available at: 
https://en.oxforddictionaries.com/definition/augmented_reality 
[Accessed February 15, 2018].

Available at: https://en.oxforddictionaries.com/definition/medium 
[Accessed February 14, 2018].

Oxford Dictionaries, 2018c. “virtual reality.” *Oxford University Press* 
Available at: 
https://en.oxforddictionaries.com/definition/virtual_reality 
[Accessed February 14, 2018].

Papagiannakis, G. et al., 2005. Mixing virtual and real scenes in the site of 
anient Pompeii. *Computer Animation and Virtual Worlds*, 16(1), 
pp.11–24.


Unimersiv | YouTube, 2016. Explore the Acropolis of Athens in Virtual Reality. Available at:
https://www.youtube.com/watch?v=y9zWmURQyc [Accessed June 17, 2018].

Universiv | Universiv.com, 2016. We just released the Acropolis experience on the Unimersiv app. Available at:


View Master | viewmaster.co.uk, 2016. View-Master Model E. Available at:http://www.viewmaster.co.uk/htm/e.asp [Accessed June 17, 2018].


VR World 360 | YouTube, 2017. 360 VR Tour | Athens | Parthenon | Parthenónas | Παρθενώνας | Acropolis | VR Walk | No comments tour. Available at:
https://www.youtube.com/watch?v=xB_yLnCK6a8 [Accessed June 19, 2018].


Young, S., 2018a. Is VR the future of storytelling? Available at:
https://lithodomosvr.com/vr-future-storytelling/ [Accessed April 7,
2018).

Young, S., 2018b. Lithodamos VR. Available at: https://lithodomosvr.com/listen-can-hear-virtual-reality/ [Accessed April 7, 2018].