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Reconstructing Pozzuoli:
Textual and visual reconstructions of a Roman port town

by

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ABSTRACT

FACULTY OF ARTS

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VISUALISING POZZUOLI: TEXTUAL AND VISUAL RECONSTRUCTIONS OF A ROMAN PORT TOWN

Elizabeth De Gaetano

With its long tradition of trade contacts with the eastern Mediterranean, coupled with the productivity of Campania, Pozzuoli rapidly became a centre for technical and commercial expertise. It soon became the principal port of the Capital in the late 3rd and 2nd Centuries BC and maintained its function as a port of Rome at least till the 3rd Century AD. Pozzuoli was also a ‘packet port’ for travellers to the east and the principal place of arrivals and departures for officials, embassies and ordinary travellers making the port very cosmopolitan in nature. Its richness in archaeological remains coupled with its unique geological setting has resulted in plenty of scholarly research, particularly on the individual public monuments of the port. There has however been little attempt to understand the urban development of the port and when compared to other Campanian towns such as Pompeii and Herculaneum, thematic research in the area is still in its infancy.

The context within which the study will take place is the idea of knowledge representation and the use of visualisation as a tool for understanding complex datasets. Pozzuoli has been represented in many ways through various periods in time and a digital visualisation, together with the process with which the vast documentation is selected, gathered, transformed and ultimately displayed aims to provide a legitimate synthesis of all the complex information that has accumulated over time. The methodology adopted will be that which adheres to the principles of the London Charter with a particular focus on the documentation of process known as ‘Paradata’ and attempts to provide a new critical example of its implementation.

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DECLARATION OF AUTHORSHIP

I, Elizabeth De Gaetano

declare that the thesis entitled:

Reconstructing Pozzuoli: Textual and visual reconstructions of a Roman port town

and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

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Any mistakes and inaccuracies that may remain in this work are entirely my own.

1 Introduction

Following the Hannibalic wars, in an attempt made by the Roman senate to strengthen the coast of Campania against possible renewed hostilities with Carthage and in 194 BC, a *colonia* of 300 settlers was sent to the Greek city of *Dichaearchia*. With its defensible hill, sheltered harbour and good communications with the hinterland, *Dichaearchia* had already proved its importance both as a military depot and strongpoint. In just over 200 years the *colonia Puteoli* was one of the largest and greatest ports in the Mediterranean. Those two centuries also saw the unrivalled expansion of the city of Rome and its increasing demands for food and products of all kinds not to mention the political subjugation of the entire Mediterranean coastline by Rome. A remarkable increase in the volume of seaborne trade in Italian waters was subsequently instigated (Frederiksen 1984: 319). It thus becomes clear to us that it was as Rome's principal port that *Puteoli* grew so significantly.

Pozzuoli's success, which lasted well into the 3rd C AD, owes as much to its political foundations as it does to its geography. There are very few natural harbours on the Tyrrhenian coast south of Luna with only the Bay of Naples offering deep-water shelter next to a dry and productive coastline. However, even there, the coast was more open to wind than is desirable and realistically, Pozzuoli's natural setting was no better than that of Naples as either port would have offered the nautical advantages that are needed to create a suitable *entrepôt* (Frederiksen 1984: 325).

1.1 Aims and Objectives of the Project

The project aims to explore how aspects of Pozzuoli can be reconstructed both textually and through the use of digital visualisations in order to synthesise and represent current scholarship on selected elements of the port town's geography and archaeology.

The project's method for digital visualizations will allow for flexibility through the proposal of different interpretations and consequently enable the thinking of alternative ways in which the archaeology of Pozzuoli can be explored. It will explore and engage with the current available digital tools for the analysis and interpretation of ancient architectural data in a way that is self critical and transparent.

The textual reconstructions will also be used where appropriate given that in some contexts, particularly when there are gaps in the data, a textual reconstruction offers an easier and more appropriate means of representing these said 'gaps'. In some instances, the textual reconstructions were found to offer a better means of reconstructing historical narratives than visualisations.

The project's methodology aims to document in as much detail as possible every aspect and stage of the project in such a way as to allow the easy and seamless retrieval of data for any potential future research.

The project hopes that these two forms of reconstruction – textual and visual – can work together to give a more holistic representation than either form would on its own. As a result of this, it hopes to set the basis for a study that can progress beyond this project and allow for a model that can be augmented in the future, thus allowing access to future researchers of the area, encouraging new forms of interpretation and providing an alternative and adaptable resource to the researchers of Pozzuoli's rich archaeology. Very few cities allow for a detailed study with places like Pompeii, Herculaneum and Ostia being the exception rather than the rule. Pozzuoli, with its richness in archaeological remains coupled and its unique geological setting, is therefore an ideal case study for implementing and analysing three-dimensional reconstructions.

1.2 Literature Review

The geography and the geological phenomena of Campania caught the attention of travellers, scholars and geographers just as much as the archaeological remains did. The most comprehensive description of the geography of Campania within an archaeological context is that by Martin Frederiksen, who sadly did not live to see his work completed and it was Nicholas Purcell who put together the remaining chapters using Frederiksen's notes to complete the book. The first chapter in his book *Campania* is perhaps the most appropriate starting point for anyone wishing to know more about the region, thanks to a combination of descriptions of the viewed physical landscape as well as those of the various volcanic events, that formed the region as we know it today. Frederiksen (1984: 3) rightly points out that if we are to recover the ancient features of Campania, its geological history is essential. Moreover, these descriptions are set against a backdrop of ancient texts, thus giving us perhaps one of the clearest pictures of Campania's geography and geological history. Like most descriptions related to the geography of the Campanian region and more specifically to those of the Phlegraean Fields and to that of Pozzuoli, the focus inevitably shifts towards the volcanic phenomenon of "Bradyseism".

This rapid rising and sinking of the coastline has been a subject of considerable debate during the last two centuries. As Mohrange (2006) accurately points out, the peculiar perforations by marine shells visible on the columns of the *Macellum* (mistakenly labelled *Serapeo*), attracted and puzzled both geologists and archaeologists for many years. Parascandola was the first to carry out the first modern synthesis in 1947, following which, further research followed, with authors like Dvorak and Mastralorenzo (1991) who collected historical documentation with the results of oceanographic surveys, geology studies and geodetic surveys in order to determine the history and identify the likely causes of the movements (Dvorak and Mastralorenzo:

1991). In Orsi (1998) the work highlights the reasons why the Phlegraean Fields is not a volcanic region (In this case understood by the presence of volcanic eruptions and flowing magma) while highlighting in great detail the uplift and sinking of the land. It was not till 2006 that Christoph Mohrange and Nick Mariner were, for the first time, able to radiocarbon date the biological indicators and establish a total rise of sea level of 17m since Roman times (Mohrange and Marriner 2006:95).

The one element that is missing from Frederiksen's chapter is a description of the flora and fauna of Campania. There are a few underlying references to these elements but they are mostly related to the description of the rivers and marshes in the area (Frederiksen 1984: 17-20). The reason for this absence is perhaps no fault of Frederiksen. Fausto Zevi highlighted the lack of research on the flora and fauna in the Campanian region in 1987 (Zevi 1987). Today, scientific techniques are beginning to remedy this. Key researchers in this field, Wilhelmina Jashemski and Frederick Meyer have a chapter dedicated to the environment around Lake Avernus in their book on the natural history of Pompeii. Similarly a study by *Centre Jean Bérard de Naples* in 2002 outline and re-evaluate the current methods and knowledge base used for the study of environmental data of the Campanian region (Guarino and Sciarillo 2002).

With its striking archaeological remains enveloped within such a unique environment, it is no wonder that aside from the classical texts, some of the earliest descriptions of Pozzuoli, came in the form of paintings and sketches by the numerous travellers that visited the area in the 16th and 17th Centuries (Horn-Oncken 1982). The earliest written synthesis describing the numerous aspects of Pozzuoli is found in Charles Dubois' 1907 volume *Pozzuoles Antique (Histoire e Topographie).* The work is a careful treatment of different forms of evidence, literary, epigraphic and archaeological and art-historical and is divided into two main sections: Pozzuoli's history and Pozzuoli's topography. Dubois is perhaps one of the first scholars, to explore Pozzuoli's topography based on ancient representations, the most notable of which are those found on the glass flasks and the painting known as the Bellori drawing. It was perhaps a work well ahead of its time as it highlighted the need for further synoptic studies of the area for more than half a century. Apart from Maiuri's monograph on the Pozzuoli's amphitheatre (1955) and articles by the same author in *Encyclopedia dell'Arte*, little attention was paid to the town after Dubois. Works by Frederiksen and J'D'Arms contributed significantly in the following years, but they dealt with different aspects of Pozzuoli, primarily its commercial and political fabric. Since Dubois, the evidence for these representations increased to the point where a re-evaluation of Pozzuoli's was long overdue and took the form of a thesis by S. E. Ostrow (1977).

1977 also saw the first publication of the *Puteoli* periodical that continued to be published only until 1989. It would be unfair to pinpoint any one article as being more important than any other, but with relevance to Pozzuoli's archaeological remains, in this case it is perhaps appropriate to highlight Sommella's second volume in the *Puteoli* series. The work, similar in form to a gazetteer, is the second most thorough synthesis. All of the archaeological remains described, are accompanied by photographic and architectural documentation. These descriptions are further accompanied by an analytical discussion that addresses the development and the more functional aspects of the city's topography. Unfortunately the fragmentary nature of Pozzuoli's archaeological record only allows for a range of approximate dates, making analysis occasionally rather speculative. That being said, Sommella had reached, at that time, some interesting conclusions, such as the possible layout and subsequent expansion of the town (85-91). Sommella was perhaps also the first author to publish scientific details of lesser-known monuments such as the baths (*Tempio di Nettuno*), of which we still know very little, even today. It is not till 1993 that we then see an updated version of both Dubois and Sommella's work in the vestiges of

'*Puteoli*' edited by Fausto Zevi. As the editor of this work Zevi's approach was somewhat different. The book tackles the various elements that made up Pozzuoli. Each chapter is dedicated to a different study: from Pozzuoli's Greek origins, to its relationship with the east, its trade and production, the towns' topography and finally, its archaeological remains, including those underwater. The literature aside, Zevi's work is essential for another reason: in a separate folder published and updated by Costanza Gialanella and acting as an appendix, are a series of map tiles upon which we find numbered remains, each with a description, an approximate date and an associated bibliography. It is perhaps the first publication that gives us a more informed idea about the wealth and extent of Pozzuoli's archaeology.

Research on Pozzuoli is far from over with excavations still taking place in many areas around the town. In 2003, Costanza Gialanella published a volume dedicated to a series of excavations that took place on the promontory of Rione Terra. Following a description of the towns' history, the authors proceed to discuss and illustrate the excavations that further revealed, much to their delight, perfectly preserved roads that extended well beyond what they previously imagined (Gialanella 2003). Furthermore, the 2003 publication is of particular relevance as it supplies the reader with a series of plans upon which are highlighted and annotated the various remains that were excavated. In addition to this, Costanza Gialanella's (pers. Comm. 2009) most recent contribution towards the study of Pozzuoli's town plan is now also available and it is now possible to better understand Pozzuoli's layout, and as she concludes appears to be considerably different to the "typical" plan of the *Coloniae Maritimae* originally proposed by Sommella.

As with much of the areas in archaeology, Pozzuoli's underwater remains too have only recently been explored. The 2001 proceedings of the international forum of underwater archaeology are testimony to this.

Of particular interest in this case are the articles by Ceraudo et al. entitled *Tra terra e mare: nuove ricerche lungo la ripa puteolana* and Camodeca's *Ricerche sul vicus Lartidianus di Puteoli*. In recent years interest in Pozzuoli had lead to many more publications, since Dubois' contribution, many taking the form of articles, museum catalogues and book chapters, such as the chapter published in 2005 by Costanza Gialanella in *Noctes Campanae* (2005) (a publication in memory of Martin W. Frederiksen) which is a further update on the research that took place in the area.

The publications on Pozzuoli's archaeology as many as varied as they are, still leave us with some unanswered questions. Whilst all the archaeological literature provides ample descriptions and dating for the various monuments, none of the authors appears to try and explain the choices that were made with regards to the location and position of the monuments. None of them appear to consider the possible significance of these monuments within their landscape and the impact these monuments would have had on the people who inhabited, worked and visited the town. Even Ostrow, in his thesis about the problems on the topography of Pozzuoli, whilst offering an extremely constructive analysis of the glass flasks together with a hypothesis that the views on the flasks would have represented and where the artist would have been standing to see these views, falls short of explaining the potential implications of these positions (Ostrow 1977).

In the years following Dubois' contribution, the various publications that followed in their various forms, confirm that over time scholars recognised Pozzuoli's vital importance as a port of Rome (D'Arms 2000, Frederiksen 1984), not simply in terms of its archaeological remains but also culturally and politically. In J. D'Arms' work originally published in 1970 and reissued with additions in 2003 entitled *Romans on the Bay of Naples and other Essays on Roman Campania*, the focus is aimed towards the regions' more social aspects, using textual rather than archaeological evidence. D'Arms starts by describing the first villas belonging to famous Romans during the republic such as Scipio Africanus and proceeds to explore aspects of the culture of the region during the empire. The visits of the various emperors are discussed and more importantly, he includes an essay on *Puteoli* in the 2nd century AD (pgs 283-316). While the 2nd C AD is perhaps a little later in the time-frame chosen for the current research, the article is particularly relevant because it suggests that the impact of the construction of Portus had on *Puteoli* appears to have been minimal, thus raising an important question about how we assess the wealth of a port city and consequently how this is reflected in its architecture. The chapters following the natural setting in Frederiksen's *Campania* unfold in a similar vein with the regions' narrative also taking a more socio-political form, including the section on *Puteoli*.

With a list of the archaeological remains and with a better understanding of the political setup of Pozzuoli, we can begin to further investigate the overall ideology that was transforming and dictating the architectural styles and decisions in the last years of the Republic and the beginning of the Empire under Augustus. In the fourth chapter, the research tries to better understand the location and the extent of the impact Pozzuoli's monuments, by looking at the more theoretical contributions about Roman political ideology as reflected by the choice of public monuments and overall urban planning, not simply in Rome (since Rome's urbanism was a unique development) but also in the various colonies in Italy and around the Mediterranean.

MacDonald (1986) describes the monuments not as isolated individual buildings but considers them in terms of the space they occupy and the vistas to which they contribute. In his *Architecture of the Roman Empire* we find chapters dedicated to "urban armatures" (the city's core, made up of the main road and all the buildings that flanked it), "passage architecture" (arches, arch façades, way stations), connective architecture (thoroughfares, plazas, stairs) and a chapter dedicated to public buildings marked by an extensive typology. Mac Donald's approach is that of asking the reader to view the city from a users point of view. In his essay entitled "*The city as symbol"* (1998), Paul Zanker seeks to complement MacDonald's treatment of the Roman City. By investigating the external characteristics that mark the "typical" Roman town and corroborating this with ancient texts such as that by Aulus Gelius, who writes that he is not interested in the concrete physical appearance but rather in the aesthetic affect and the quality of life that these monuments offered their people, Zanker outlines what he believes to be the realization of certain abstract ideals in the built environment and although he is very specific with regards his focus, which is primarily on newly founded cities and on public rather than private monuments, this essay proves invaluable to anyone trying to understand the significance of Roman architecture.

Taking MacDonald's idea a step further is Diane Favrò (1996) whose work, *The Urban Image of Augustan Rome,* involves presenting the reader with a series of descriptions involving an individual moving from one vantage point to another. The two key chapters in Favrò's work are detailed descriptive walks through Rome, one taking place in Republican Rome in 52 BC, and the other in Augustan Rome in 14 AD. The chapters in between proceed to explain the transition from the two apparently different ideologies that dictated Roman urban planning, with a perhaps overly negative summary of the state of Republican architecture. Favrò's book is very similar in some respects to Paul Zanker's highly acclaimed *The Power of Images in the Age of Augustus*, who does not so much to provide a simple description of Augustan art and its monuments, but rather an analysis of the development of the imagery that was chosen to convey the cultural renewal and imperial mythology of Augustus' New Rome as well as to investigate the 'creation of a whole new method of visual communication' (Zanker 1988). Favrò's main difference in this case, is that she places less emphasis on the ideological significance of the monuments and more about the rather complex relationship between the urban layout and the individual's experience (Favro 1996) while Zanker is concerned with Augustus' motives.

A third approach that fits almost effortlessly within the debate on Roman monumental architecture is that by Edmund Thomas in his recently published *Monumentality and the Roman Empire: Architecture in the Antonine Age* (2007). As with similarly quoted literature in this overview, Thomas deals with a period that is later than that proposed in this study but certain ideas can nonetheless be applied to Pozzuoli. In his introduction Thomas describes how in Roman times the word "monumental" assumed different qualities from what we understand (Thomas 2007:1-14). In the fourth part of the book entitled "Responses to Monuments" Thomas further illustrates the subjective and visual approach Romans had towards architecture. Of particular interest in this case is the author's mention of how movement required different viewing positions on the outside or the interior of a building and that such views would have evoked strong feelings such as wonder awe and perhaps even shock (Thomas 2007).

In the introduction to his book *Roman Architecture and Society*, James Anderson states that his approach is but a synthesis of the current state of knowledge of the interaction between Roman architecture and the society that produced it (Anderson 1997). He further details the aspects of architectural reconstructions that interest him, with questions such as: who built it? Who financed it and how did it affect the daily life of the people who used it? Anderson's synthesis, which is based on ample archaeological evidence, begins with the use of building materials and personnel and moves towards a vision of spatial organisation based on the similar principles Favrò uses. In the second part of his work entitled "How the Romans organised space", the fifth chapter of the book is of particular interest because it deals specifically with "Public Architecture and Shared Space" giving descriptions of a variety of public and private buildings/spaces and more importantly describes the role that these spaces (such as markets, theatres, amphitheatres and baths) played in the visual organisation of the city (241- 287).

Similarly, John Patterson also dedicates a chapter in his book entitled *Landscapes and Cities* to the changes that took place during the early empire. Whilst the first part of this second chapter deals with the author's exploration of the complex factors that caused cities during the later Republic and early empire to either flourish or 'decline', the second part of the chapter focuses on the changing nature of public buildings. Each building type is dealt with individually and while with the new priorities under Augustus, we find an increase in theatres, amphitheatres and large infrastructural projects in the second century we find an increase in the construction of baths, basilicas and *macella*. By exploring these shifting priorities, Patterson also highlights the social roles these buildings and their patrons played in the early Roman Empire (Patterson 2006).

Each described approach is somewhat related and relevant, particularly when we bear in mind Pozzuoli and its monuments. How are we to draw these seemingly different strands together? MacDonalds' work and his formal approach to the idea of Roman architecture are the ideal starting point for this research. Zanker's book mainly addresses the deliberate tailoring and extension of Augustus' public image on the physical city but is fundamental to our understanding of what in many other texts on Roman architecture is simply referred to as the "Augustan building programme". Favrò's work in the meantime has been heavily criticised on numerous accounts with Authors such as Stephen Dyson and Eleanor Leach being particularly damning in their review of her work (perhaps rather unfairly), whilst Thomas focuses on the monuments on Asia Minor omitting almost entirely those of Rome. Anderson and Patterson use a more descriptive approach based on the synthesis of archaeological and survey evidence. Nonetheless they are each in their own right, a reminder to us that as we are trying to understand Pozzuoli's urban layout together with the social commercial and political circumstances that dictated the overall development of the town, its location and the visibility of the monuments therein, we should remember to ask ourselves questions related to the reactions these monuments might have evoked in the individual and perhaps try and understand to what extent they were consciously designed to achieve this effect, particularly in a bustling port town.

While Pozzuoli was to become the first port of Rome, it was certainly not the only one and neither did it develop in isolation. It is unfortunately all too easy to get lost amidst the finer points of a single area but we must bear in mind that as Rome's political and economic power flourished, so did her preoccupation with grain supplies and the sheer increase in maritime trade inevitably led to the establishment of ports that not only dotted the Italian peninsula but the entire Mediterranean coast. All were subject to interaction with one another or linked by a series of the political circumstances.

The most recent addition to the above literature review is perhaps the most crucial to the project's success. The most recent because the work has only just been published (2012) and crucial because at the core of this study's methodology is the collection and description of 'paradata' an element which has always been important but was yet to be described in more concrete terms. The use and presentation of paradata in visualisation projects and research is relatively recent, despite the many scholars having long clamoured for transparency in scholarly digital reconstructions (Ryan 1996). This publication entitled *Paradata and Transparency in Vitual Heritage* edited by Anna Bentkowska-Kafel and Hugh Denard is the result of a series of international collaborative efforts that sought to establish the London Charter (a series guidelines for computer based visualization of cultural heritage). The volume presents a series of considerations on paradata[1] followed by a collection of projects that applied the principle of paradata, many of which were originally presented at an expert seminar[2] (Bentkowska-Kafel, Denard et al. 2012: 2), the major outcome of which was the creation of an initial draft proposal for the 'International Standard for Documentation of 3D Visualization-Based Cultural Heritage Projects' which then became known as 'The London Charter'[3]. The texts in this volume complement the work that was presented in the 2006 meeting "Paradata and Transparency in Virtual Heritage edited by Anna Bentkowska-Kafel, Drew Barker and Hugh Denard" (Bentkowska-Kafel, Denard et al. 2012: 2).

Each author, through the various considerations and challenges encountered, contributed immensely not only to a more robust understanding of the nature of paradata but provided a number of elements upon which this project's methodology could identify with and compare. The various relevant chapters of the above-mentioned publication will be considered in more detail in different parts of the ensuing chapters.

1.3 Theoretical considerations

In line with the aforementioned archaeological questions, the project will take place within the following theoretical frameworks. Starting at the very basis of our theoretical context are the considerations of

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

[2] Making 3D Visual Research Outcomes Transparent, co-sponsored by the AHRC ICT Methods Network; European Commission Research Network of Excellence in Open Cultural Heritage (EPOCH); Il Pin Scrl – Polo Universitario (PIN) Prato, Italy and King's Visualisation Lab, King's College, London, held at the British Academy on the 23 – 25 February 2006.

[3] http://methodsnetwork.ac.uk/activities/act1.html

Roman architecture and Monumentality. The survival of Roman monuments in and outside of Rome have provided ample testimony for many an archaeologist and art historian to explore a variety of topics related to Roman architectural history, ranging from the ingenious techniques used by Roman architects to the transformation and development from Etruscan and Greek styles as well as form and decoration.

Coupled with the theory of Roman architecture is the exploration of public buildings and the creation of an urban image. The Romans were quick to use the founding of towns as a means to spread their power and influence. Towards the end of the Republic and with the establishment of Augustus as Emperor, lavish and competitive public buildings began and extended well beyond Rome throughout many towns in Italy and across the empire. This depended on a variety of factors such as the length of tradition of urbanization, the date in which the citizens were annexed to Rome and the potential wealth of the territory amongst others. Many veteran colonies, including *Puteoli* received buildings as gifts by Augustus as well as by individual benefactions at the hands of local elites, eager to adhere to the new ideals whilst outdoing neighbouring cities.

Over the years, research has identified significant patterns for different types of monuments. In the first century, expenditure was mainly directed towards temples, theatres, amphitheatres and large-scale infrastructural projects such as aqueducts, all inevitably linked to the new social priorities of Augustus. In the second century the focus seems to shift towards building baths, *curiae* and markets (*Macellum*). Paul Zanker further observed that many of these public buildings had no fixed space within what seemed to be a highly ordered town plan, perhaps because these buildings did not exist when the basic city plan for the early colonies was being developed in Rome (Zanker 1998: 28). Consequently, these buildings redefined and legitimized their own space. The very height of these public monuments, whether located outside the city or on a main thoroughfare was indeed staggering, and purposely so. Each building was stamped as ‘Roman’ in terms of ideology and function. This meant that they defined a space that corresponded to the social and political needs of late Republican and early imperial Rome. By the 1st century, it seemed the Romans were less interested in the concrete physical appearance of the cities than to possess all the necessary public buildings and that these were able to reflect the ‘greatness’ of the Roman people (Zanker 1998: 32). With Pozzuoli so visible from the sea and yet so inevitably functional, these arguments are particularly interesting. Archaeologically however, these ideas are not easy to evaluate. For the most part, remains of public buildings are scattered and engulfed within the modern cities allowing at best, the evaluation of a single structure at a time.

And what of the visual impact these monuments had on their ancient viewer? It is undeniable that the modern viewer has grown up with a very different set of visual stimuli. The exploration of these theoretical aspects will come to the fore, later on in the project when carrying out the formal analysis of the generated views of Pozzuoli and even here we must not forget the phenomenological framework within which the exploration of these representations will take place. Therefore of paramount importance are the theoretical considerations of visualisation, which will be addressed to include the description of Colin Ware’s work entitled Information Visualization: Perceptions for Design as well as Sien et al.’s work, entitled *Visualization ability as a predictor of user learning success* that addresses cognition and visualisation. Each scientific work will be presented within the context of archaeological reconstructions and an example from this project will be given to each of the scientific observations presented above. These will be linked with the works of classicists such as John Clarke (2003) who have argued for the role of visualisation in order to understand the more complex visual representations in the lives of Romans and includes digital reconstructions to highlight aspects of the visual impact the location and decoration of monuments would have had on the viewer. More importantly, this study's theorization will also seek to address the impact that visualisation has on the researcher and the resulting consequences of decisions brought about by the use of visualisation.

1.4 Proposed methodology

The core of the methodological process is the collection, organization and documentation of every stage of the reconstruction. This will be achieved by making use of the best practice guidelines as set out by the ADS, the terminology as employed by the digital humanities website and the standards as outlined by the London Charter. To help with the reconstruction and interpretation of the digital reconstructions as many available resources will be used, such as modern photos and antiquarian engravings. What will *not* be used as part of dataset are inscriptions or detailed ancient literary sources. This deliberate decision was made because the amount of data available could easily be the subject of a separate project altogether. That being said, the use of epigraphy should certainly be considered in any future work related to the port of Pozzuoli as this could open up additional avenues of inquiry that together with a digital visualisation would further enhance the synthesis and bridging of archaeological, epigraphic and historical data.

The first element that had to be addressed while reconstructing the landscape was data acquisition. A large portion of the project was heavily dependant on particular data sets that could only be obtained at the discretion of the *Soprintendenza Speciale per i Beni archeologici di Napoli e Caserta* (SANC). Despite the best efforts to organise the procurement of the data, the time frame required steadily increased, dependant as it was on the availability of the individuals concerned.

Initially, contact was made the archaeologist in charge of the Pozzuoli area: Dr Costanza Gialanella. A series of meetings where held, where there was the opportunity to explain the rationale of the research project as well as to seek expert advice and view the most recent research in the area. Consequently, in order to access the archives, a letter of request was needed that was sent to the Superintendent (based at the main offices in Naples). Upon the receipt of this letter and once it had been approved, signed and distributed to all the various offices concerned, it was then possible to access the archives.

The archives in Naples are divided into various departments, including the photographic archive, the drawing archive and the written archives. Access was obtained primarily for the drawing archives. Unfortunately, only a fraction of the drawing archives is in digital format. With the exception of a few external surveys carried out by private companies, the majority of the maps, plans and sections are still very much in hard copy, each with their own inventory number that was obtained from a call card. Each card was checked, the inventory numbers where then noted and the drawings consequently located. Once the drawings were found, these were scanned and saved on disc. Despite the prolonged process, the data was successfully obtained with some of the more significant data also in digital format. It was now possible to reconstruct the landscape using a digital base map of the Pozzuoli region along with various bathymetry datasets that were also obtained (both digitally and in hard-copy). To complement any missing data from the digital maps, a series of scanned contour maps were also acquired. The data also includes details for the various monuments around the port. A selection of this data includes plans of the underwater remains of the *Portus Iulius*, plans and sections for the Temple of Augustus, a section through the promontory of Rione Terra, plans for the baths, the stadium as well as the original archaeological map that was used in the 1993 *Puteoli* volume by Zevi.

Following the collection of the raw data, it was possible to work on the reconstruction of the landscape. Geo-archaeological data now allows us to accurately map the bradyseismic events that occurred in the Phlegraean Fields, at least for the last 2000 years. Christoph Mohrange and Nick Marriner (2006) collected fossilised marine organism samples, which were then radiocarbon dated. Various episodes of sea-level changes in Pozzuoli were then identified amounting to a total rise of sea level of 17m since Roman times and whilst it was originally thought possible to recreate this, there was however a restriction: Ultimately, the effects of the subterranean gases are irregular and unpredictable and to recreate these accurately would require work that was beyond the scope of this study. This fact fundamentally compromised the original aim of the project, which was to recreate and analyse the ancient views of the port from the sea. In light of this discovery, the central aims of the project were revisited. While the digital visualisation may have at this point already been unsuitable for a recreation of the original landscape and subsequent views, it was still possible to use this method to explore other aspects of the port's dataset such as its main monuments, for which detailed data exists.

The research will therefore use the current contour data for Pozzuoli and proceed to place all the archaeological structures (on land and underwater) on the modern digital elevation model and past relative elevations will in turn be inferred from the archaeology where possible.

Upon recreating the landscape context the project sought to build the individual monuments: Throughout scholarship, reconstructions of ancient sites have taken many forms such as maps, plans, drawings and scale models. All these approaches survived into the 20th century but while they allowed the visualization of Roman monuments, they were perhaps altogether too dry or lacking context for a public that demanded an easier means of understanding an ancient city. Even when this demand led to the creation of scale models within museums, these were often limited by the way in which they were displayed. The relationships of buildings to one another and to the different levels of the site could be better understood, only if the observer was prepared to move around the model, if this was at all possible, and even then without being able to look into or around the buildings. The potential of the current technology allows us to investigate what are now limitless options.

The digital models of the Imperial monuments at Pozzuoli seek to address the long sought-after goals within the study of ancient architecture: to give professional scholars, students and public a clear idea of designs, complexity, visual effect and more importantly, meaning of Roman architecture. In Pozzuoli, even where there is enough extant archaeology to understand the building, the visual reconstruction will supplement the existing materials. Where less data is available, there is the possibility to experiment with alternative theories, materials and singular elements, such as lighting and time of day.

Despite the richness of its remains, the extant archaeology is but a small fraction of what originally existed and as a result somewhat glaring shortcoming emerges. This is the inevitable ‘gap’ in our knowledge of the site and how this is consequently addressed. The work carried out by Fausto Zevi in 1993 recorded over 300 architectural remains around Pozzuoli; these varied from entire monumental complexes such as the Amphitheatre, Rione Terra and the *Macellum*, to simple foundation walls belonging to unknown structures. On estimate, even if we are to include the port facilities of Portus Iulius and the main public monuments, only about 40 per cent of the port is known.

Then what to do with the remaining 60 per cent? If for the purposes of this project we are to try and understand what was “seen” upon entering the port, then it must be accepted that a large part of the port will be conjectural since leaving large blanks within the landscape would significantly limit any form of interpretation.

These questions will be approached using the following methods; To begin with, as far as it is possible the conjectural reconstructions will be based on the ongoing research in the area as well as on the interpretations put forward by the researchers of the port of Pozzuoli.

As a result, despite the conjectural nature of a large portion of Pozzuoli, various interpretations and reconstructions will be put forward and interpreted. Questions about commercial need versus imperial patronage will be answered by analysing if it was commercial buildings or imperial monuments that first came into view when entering the port, whether public monuments covered or were covered by commercial buildings, which edifices were most prominent/impressive, which architectural elements were observable only from a particular angle and which buildings could only be encountered when on land? Did the Caligulan mole obscure everything behind it?

1.5 Thesis Structure

The following thesis is divided into nine chapters which are described as follows: This introductory chapter, which gives a brief overview of the project, its rationale, its aims and objectives, the theoretical framework and methodology as well as a description of the potential implications of the research, which will be described as a conclusion herewith. Chapter two of this thesis aims to provide an overview of the geographical setting of Pozzuoli. If one is to recover any features of Pozzuoli's development or the significance of her major monuments, these must be placed within the wider geographical context, even more so given that the Campanian region is characterized by unique volcanic phenomena, for which it is so renowned. This chapter will start with an introduction to the Italian peninsula, followed by the description of the wider Campanian region and by a more localised portrayal of the *Campi Flegrei*, of which Pozzuoli and its harbour belong to. This chapter will also take a brief look at views of the Italian landscape as seen from the sea and will conclude on this note with a description of modern photographs of Pozzuoli and parts of the Bay of Naples as seen by modern photographers from the water. This will illuminate the regions' diversity both formatively and geologically and will consequently inevitably impinge on the decisions and choices that are made during the data processes and the visualisations selected.

Following on from chapter two, the next chapter (Chapter three) will take a brief look at the landscape as captured by the antiquarians and travellers of the 16th and 17th Centuries and the implications of these representations on the contemporary understanding of the landscape and how these in turn influence our understanding of Pozzuoli's archaeological landscape. Of the many facets of Pozzuoli's history is that which its visitors make up. Whilst we have very few representations of Pozzuoli's harbour from antiquity, a plethora of historical representations are available to us. This chapter will look at the 19th and 20th antiquarian paintings of Pozzuoli's landscape, carefully noting and describing relevant aspects of the representations particularly the artist's choices of representation such as what has been represented and how. Looking at these valuable resources will be able to tell us plenty about the visual impact the port and its landscape had on its visitors, with some surprising results.

Chapter four of this thesis moves onto what is a detailed description of everything that has to do with ancient Pozzuoli from ancient representations of Pozzuoli to ancient way-finding but most importantly the chapter is dedicated to becoming familiar with the site's history and archaeology, which is a key element in order to create an accurate virtual reconstruction. The following description will not limit itself to the main monuments but will also address some of the functional port buildings. However before justifying this chapter simply for the use of the visual reconstruction, it is perhaps more important that this chapter's role be understood as the groundwork necessary to simply understand the archaeology of Pozzuoli. Familiarity with the historical development of the town and with its main archaeological remains are steps that are essential when studying any site regardless of the focus of the study and the consequent methodology that will be applied. The conclusion will summarise how much is known about the town, the problems with the levels of documentation of various archaeological remains and how understanding the development of Pozzuoli and its monuments impacts on the proposed methodology. This impact ranges from simply identifying where the main monuments need to be located to the more complex and uncertain elements such as the forum. The literature tells us that it was located behind the promontory of the Rione Terra and that fragmentary archaeological evidence to corroborate this was discovered; yet no traces of it remain today. As a result this impacts on whether to include this in the reconstruction or not and if included to what degree. Each question requires a decision, each decision requires a justification, every justification requires documentation and everything documented needs to be understood in its wider context: the historical development and the archaeology of Pozzuoli.

Chapter 5 takes a detailed look at the theoretical considerations already mentioned namely: Roman architecture, public monuments and monumentality and the ancient viewer, as well as the theoretical considerations on the principal nature of this project, that is visualization, a cognitive role that we take for granted but also visualisation techniques in archaeology. These have long been studied and discussed, particularly in more recent years with an increasing corpus of literature dealing with a multitude of aspects in the field such as the transparent methodologies for presenting the past, the impact these methodologies have had on the interpretive process and the dangers of computing techniques potentially dictating archaeological methods. The chapter will also briefly touch upon the theoretical considerations of the similar port towns as well as the virtual phenomenology of landscape. There is no denying that this is an awful lot of theory to be coming to terms with but without the considerations of even one of these elements, the already fragmentary understanding of an archaeological site would be even more problematic

Having outlined the theoretical framework of the project the logical progression would be to outline the core methodology that is at the heart of this research and that is being employed to answer the research’s main questions: How much of Pozzuoli’s architecture was a result of the commercial needs and how much of it by the desire to assert imperial influence in the area? On the other hand from a methodological point of view, can the model's objectification and extraction from its landscape really help us in answering these questions? How? Chapter six will therefore also look at why this particular method was chosen over others, how it is going to be employed and why it has proven successful. It will proceed to outline the process employed for the reconstructions and the process that was implemented in order to carry out the analysis of the model. In keeping with the rationale of the methodology but with some subtle differences comes chapter seven. The aim of chapter seven entitled "The Biography of a monument" is to describe in detail the rationale and the sources that were used for the reconstructions of the main monuments. These include, the Amphitheatre, the *Macellum*, the Stadium, the Temple of Augustus, the harbour Mole and the Warehouses. The degree of information and documentation varied considerably between monuments. Where less documentation and interpretation was available the project sought to draw parallels from alternative sources including monuments of similar date found in other parts of Italy and interpretive sketches and reconstructions put forward by leading scholars in the field. As it was only possible to reconstruct with reasonable certainty what turned out to be a handful of monuments at *Puteoli*, the second part of the chapter will be dedicated to describing the gap-filling practical and theoretical process that was used throughout the project.

This will also include a description of the available technologies currently being developed and discussed and their subsequent implementation on various archaeological case studies.

The penultimate chapter, chapter eight is dedicated to describing the analytical process employed in the final stages of the project. The analysis of the Pozzuoli reconstruction takes place in several stages based on a series of aspects related to the monuments' visibility from static points on the water. In his thesis on the topography of Pozzuoli as depicted by the glass flasks, Ostrow makes a series of interesting observations, particularly one that describes where the observer might have been situated in order to be able to see the various buildings that are represented on the flask. These and other elements of this study such as the comparisons of modern views with those created digitally, will provide vital clues in the setting up of the analytical framework and it is at this crucial point, with all the data that this project has amassed, that it may possible to answer the questions set out at the start of this research.

The concluding chapter, chapter nine has the sole aim of bringing the strands unravelled during the exploration of Pozzuoli to a close. The aim of this chapter is to highlight the salient points of the research and draw upon these to describe the relevant concluding remarks.

1.6 Potential Implications of the Research

The potential implications of the current research on the study of Pozzuoli could be that: It takes a novel approach at the site that was perhaps not considered before. It does make an attempt to look as many aspects of the town as possible but with the knowledge that this is most certainly not an exhaustive view. More importantly the project has created a usable and accessible data set that can be the basis for future studies of the site.

1.6.1 On Roman port studies

A Roman port study is most certainly outside the researcher's remit and in no way is this a maritime archaeological project. It is not. The focus is the methodological process in relation to monumental architecture. This architecture happens to be within the context of a very famous ancient Roman port. However as a result of the approaches adopted, some useful elements can be gleaned that may have positive implications on Roman port structures. The first is the usefulness of 3d modeling techniques to address interesting aspects of a port, such as the impact of buildings when viewed from the sea. This is by no means a new idea, however it can be further explored with the help of visualization techniques.

1.6.2 On Computer modeling in Cultural Heritage

This is an attempt to put into practice as much of the core standards set out in the London Charter as possible but each with varying degrees of success. This project also gets to grips with a relatively new aspect in digital modeling and that is putting into practice what is currently being emphasised about paradata and uncertainty. This study is also taking a rather self aware analysis at how the user was able to interact with the various available datasets and how they impacted the user’s knowledge, decision making and reconstruction process. The outcome of this critical approach may prove helpful in the ever-evolving computing debate.

2 *Campania Felix:* The Natural Setting

2.1 Introduction

If one is to recover any features of Pozzuoli's development or the significance of her major monuments, these must be placed within their wider geographical setting, even more so with the Campanian region being characterised by the unique volcanic phenomena, for which it is most famed. Whilst it is understood that this project is not equipped with the tools to carry out the above surveys, it is still possible to glean ample information about the environment of Pozzuoli using the available literature and datasets. The studies that relate to the regions' volcanic activity need to be understood in order to recreate even the simplest of surroundings needed for this project. During the course of the research it becomes clear that to recreate the landscape as it was in Roman times using bathymetry data, is far too complex an exercise in this instance but it is still possible to re-create useful elements such as the original size of the lake Avernus or some of the types of trees that populated the region.

The following chapter aims to provide an overview of the geographical setting of Pozzuoli, starting with an introduction to the Italian peninsula, followed by the description of the wider Campanian region and by a more localised portrayal of the *Campi Flegrei*, of which Pozzuoli and its harbour belong to. The subsequent sections shall attempt to outline the various geological processes, which are typical of the region and not without their complexity. The last part of the chapter looks briefly at the more unusual (at least to the more land bound types) description of the coast as seen from the sea and concludes with a textual reconstruction of the ancient landscape of Pozzuoli and what its implications may be.

2.2 Broad Structural Outlines

The very nature of the Italian peninsula means that it projects into the Mediterranean Sea thus placing it in a central strategic position within the Mediterranean. The eastern side of the peninsula is covered by the Adriatic, whose access is potentially blocked by the control of the narrows from Capo d'Otranto across the Balkan Peninsula (Figure 1). The western Tyrrhenian flank is more accessible. The straits of Messina, between Calabria and Sicily form one point of control, but the whole Tyrrhenian seaboard can also be approached from the west (Stoddart 2010: 102). It is in these western approaches that the Bay of Naples and the delta of the Tiber came to form two important nodal zones of communication from the sea and into the hinterland through major rivers. The first was the northern-most point on the peninsula where the Greeks established their colonies. The second was the core area of the indigenous state formation. In the area north of the Tiber, the Etruscans first developed the most powerful states in the course of the first millennium. In the area immediately south of the Tiber and beyond, the Latins replaced them by the Republican period as the leading force. (Stoddart 2010: 102).

The key structural feature of peninsular Italy is the presence of the Apennines that run from continental Italy for a length of about 1,000 km and covering a breath of approximately 50–100 km across, down to Sicily. The peninsula as a consequence is disproportionately mountainous, with less than 20% being lowland and where substantial changes in altitude can be encountered over short horizontal distances (Stoddart 2010: 103). This mountain chain has had a profound effect on the communications within the country, defining the major routes of access between regions and splitting the peninsula in two sides and as a result provided a long term setting for human activity (Stoddart 2010: 103). This mountain chain forms a continuous and prominent relief from the North to the South but is however formed from blocks with different characteristics that have, in turn, produced a series of weathered products, further emphasising the regionality of the peninsula (Figure 2). Furthermore, the area is also very active geologically with a number of phenomena that range from the more dramatic processes of earthquakes and vulcanism to the more long term processes of erosion and alluviation, equally dramatic to the residing populations (Bintliff 1992: 126). The relative youth of this mountainous range has led to considerable verticality in the landscape and transitions from valleys to mountain summits (between 500-1500m) take place over short horizontal distances often reaching substantial heights of 1000-2000m. It has also led to steeper gradients and a more limited width of the valleys (Brown 1997:242).

The climate of Republican Italy appears to have been very much the Mediterranean climate we experience today: that of a wet winter and an extremely dry summer, although some authors (Burroughs 2001: 225-226) suggest that the climate was potentially warmer and drier consequently affecting both agriculture and health. Sea levels, in the areas not prone to tectonic instability also appear to have been relatively stable and has not altered by more than half a *metre* in the last 2000 years (Stoddart 2010: 103). Even though the focus of this project is mainly with Imperial monuments, there is no reason to believe that much would have changed in the landscape between the Republican and Imperial periods.

2.2.1 The Pre-Appenines of Latium and Campania

The Latium and Campanian regions, contained by the Appenines, one finds a diverse zone of geology, dominated by volcanic activity and lower limestone relief (Figure 3). The most prominent of this limestone relief, which is formed by the Lepini, Aurunci and Ausoni mountains, separates a northern (Latium) from a southern (Campanian) province of volcanic activity. The northern volcanic province of Latium has generally an older history, which began in the Pliocene times, as in the case of the Tolfa Mountains, and stopped its activity in the Pleistocene (Stoddart 2010: 106). Some of the recent dates for this activity range from 95,000 to 90,000 years ago. By the Republican period volcanic activity would have been long distant and it would have been its distinctive by-products that would now be of importance, such as the metal ores that were quarried from the Tolfa Mountains and deep lakes (Bolsena, Bracciano and Vico) that were originally calderas (Stoddart 2010: 106).

The southern volcanic province of Campania on the other hand has remained active into very recent times, the most notorious date of which is AD 79. The morphology is very similar to that of the northern Latium province but in an earlier stage of evolution, given its continuing activity. It is for this reason that Vesuvius is today the highest peak reaching 1,277m and has a better-defined cone shape. Other areas such as the Phlegraean fields, retain a diversity of cones and craters and the plains north of Naples contain extensive flat areas of tuff (DeNatale, C.Troise et al. 2006: 25).

2.2.2 The Campanian plain

The Italian peninsula dominated as it is by upland regions, leaves very little areas of flat ground. The most prominent wider areas within the area of Republican Italy were the plains of the Tavoliere and Campania. Alluvial plains occurred more frequently on the Tyrrhenian coast but are usually surrounded by hills and mountains. Most plains are simple coastal strips, bordered by a beach of about 20-25m. The Tyrrhenian coast is generally characterised by alternating headlands, smaller or larger embayment and prominent lagoon-shaped formations (Spivey and Stoddart 1990: 24).The Campanian plain is set within the characteristic "great limestone framework" that we find elsewhere in peninsular Italy. The peculiarity of this region lies in the contents, which are frequently derived from volcanic action; a substantial part of the plain is based on volcanic ash; the *Campi Flegrei* is composed of small hills and craters, the product of volcanic activity close to the surface; the *Baiae* coastline has a lunar aspect; and the whole is of course, dominated by the deep seated Vesuvius itself (d'Argenio, Pescatore et al. 2003:106).

The Republican populations would have lived some 1,600 years after an eruption of similar scale (technically defined as as "Plinian" after Pliny the Younger who described the eruption) to the one that later engulfed Pompeii in AD 79. This major explosion, 1,600 years before AD 79 was probably from a different summit (*Somma antico*), which is of recent formation. There were however at least nine eruptions in the years to follow, three of which would have been of considerable proportions, described by volcanologists as sub-Plinian, and as a result the resident populations should have been very aware of the presence, and to some extent, the dangers of volcanic action. The last sub-Plinian explosion is dated to about 1000 BC and was followed by four smaller events, which laid down thin, dark layers of ash, lapilli, a type of ash particle ranging from 2mm to 64m in diameter, and fine scoria, also called **cinders** and are particles less inflated than pumice. They readily sink in water. They are generally composed of **tachylite**, that is, glass rendered nearly opaque by microcrystalline iron/titanium oxides . Studies of the erosion of these deposits suggest that as much as 700 years may have elapsed since the last threatening volcanic activity by the time of AD 79 and thus the Republican era lay in a period of stability, allowing considerable re-growth of the vegetation (Sigurdsson 2002: 31). The *Campi Flegrei* and the associated promontory (Misenum) and islands (Procida, Ischia and Vivara) represented a more unstable landscape of changing land and sea levels, fumaroles and springs that were associated with classical mythology (Stoddart 2010: 111).

2.3 Campania

> *'Next comes that lucky land Campania. Beyond this bay rise the vine-covered hill whose liquid produce is famous in every land and ennobles tipsiness-the land in the old phrase, of ardent competition between the divine patrons of wine and corn. Passing on from the lands of Setia and of Caecubum we come to the* ager Falernus *and the territory of Cales; around the rise of the mountains- Massicus, Gaurus, and the range of the peninsula of Sorrento. Here is the wide expanse of the* campi Leborini *whose harvest of* alica *is the delight of the gastronome. These shores run with water of hot springs and surpass all other coastal regions in the reputation of their shellfish and other high quality seafood. Nowhere produces richer olive oil, that other substance whose varieties vie to give pleasure to humanity. Its rulers have been the Oscans, the Greeks, the Umbrians, the Etruscans and the Campanians'.*

(Pliny's Natural History III, 60)

This is perhaps one of the fullest ancient descriptions of Campania, from Pliny who perceived the region as a clearly definable entity. However, as his remarks further acknowledge, politically the name 'Campania' has had various meanings throughout the ages (Thomsen 1947: 55). Fortunately, in the geographic terms relevant to this study, the area is easily and clearly defined. It comprises the stretch of Italian coastline between Mons Massicus to the north and the Sorrentine peninsula to the south, the volcanic areas to the west of Naples and Mount Vesuvius to the east as well as the flat plain that lies behind them up to the first outer ridges of the Appenines (Frederiksen 1984:1-2). This was the Campania as understood and described by Polybius and Ptolemy. It also included the territories of Capua, then independent, the *ager Campanus* and beyond the river Volturnus, the *ager Falernus;* the Greek cities of the coast, which for a long time remained politically and culturally distinct from the rest of the peninsula (Frederiksen 1984: 1). Both ancient and modern geographers define the region by its natural frontiers; that is the area lying between Sinuessa and Cales in the north and Nola and Nuceria in the south (Frederiksen 1984:2).

Geographically, the ancient Campanian plains are held together by limestone framework. At its northwestern point the Mons Massicus rises at Sinuessa, near modern Mondragone. Clockwise from this point, is a small pass that separates the Massicus range from the spreading conical mass of the old Monte Roccamonfina volcano (Walker 1958; Paget 1968: 155; Frederiksen 1984: 2). On the north and east the boundary is made up of the first outer ridges of the Appennine chain. The sheer slopes of Monte Maggiore overshadow Cales and extends in a ridge as far as the river Volturnus (Unger 1953: 507; Walker 1958: 184) which pours through a narrow valley, only to lose its impetus in the flat plain before reaching the sea. The limestone ranges are further cut by smaller streams as they flow out to sea (Unger 1953: 508). Moving further east, the viewers' eye is caught by the hill of Cancello and its imposing medieval castle, always having been a strategic point (Frederiksen 1984: 2). Moving south, two more ridges are encountered Monte Sant'Angelo and Monte Visciano, the valley exits of which are blocked by the city of Nola. Lastly, is the chain of Monti Lattari with an imposing height of 1,444m and extending westwards as the Sorrentine peninsula and beyond the end of which is Capri, the broken seaward extension of the mountains (Frederiksen 1984 :2) (Figure 4).

This is the basic limestone framework that encompasses the ancient plains of Campania. Within these plains are further hills but they consist of rounded profiles and soft volcanic soils making them appear less dominant. Up the main river valleys lie smaller areas of alluvial plains and terraces cut in volcanic deposits (Unger 1953: 507). Time has helped make the landscape more, rather than less picturesque; weathering of the topsoil has made the limestone ranges appear harsher, whilst smoothing and rounding the profiles of the volcanic coastal hills, presenting the viewer with striking contrasts (Unger 1953: 506; Frederiksen 1984: 3) (Figure 5).

The basic Apennine chain is the youngest of all the European mountain systems, the present structure having been formed in the Tertiary era, with some tectonic activity still taking place in the present day (Frederiksen 1984: 3). The raised beaches of the Sorrentine peninsula attest to the fact that recent uplift may have occurred. During these vertical adjustments, the limestone masses would have also contained their original sand and clay covers supporting the subsequent vegetation (Walker 1958: 184). As well as an abundance of sedimentary rock, the Apennines also possess small lakes and caverns, underground streams and rivers that disappear or change their course. There are numerous mineral springs, saline, aerated or volcanic and sulphuric. The natural chemistry of the whole area is still very active as is evidenced by the regular scientific publications of the *Osservatorio Vesuviano.* For a complete list see Elena Cubellis, 2010, *Istituto Nazionale di Geofisica e Vulcanologia, Sezione Napoli – Osservatorio Vesuviano, Elenco delle pubblicazioni*

2.3.1 The Vesuvius, The *ager Falernus* and *ager Campanus*

The volcanoes of the Campanian region are an equally predominant factor in the areas' instability. To the west of Naples lie the small hills and craters which make up the area known as the *Campi Flegrei*, and to the east the large, isolated cone of Mount Vesuvius (Walker 1958; Frederiksen 1984). In this respect Mount Vesuvius and the *Campi Flegrei* need no introduction. Mount Vesuvius is perhaps the most famous volcano in the world, in part due to its imposing appearance. It is surrounded by plains on three sides and by the sea on the fourth side, the conical sides rising even more steeply to the crater; standing in what appears to be proud isolation, the mountain seems higher than it really is (1277m) and dominates the whole bay of Campania. Its fame is also partly due to the calamities it has caused. As a result it has been under constant observation allowing us to understand it further.

The present cone of the Mount Vesuvius lies within the remnants of an earlier structure, from which a large caldera rim called Monte Somma is still partly preserved on the northern and western sides of the mountain. The original eruption probably took place beneath the sea, before the gradual uplift, which raised the whole Apennine area and which is responsible for the raised beaches of the Sorrentine peninsula (Frederiksen 1984: 6). An enormous eruption in prehistoric times caused the collapse of the upper part of the cone, leaving a caldera, a wide crater of enormous depth, which is where the traceable history of the volcano begins – a long period of more or less continual eruptions followed by a pause and the beginning of a second period of activity (Figure 6). These two periods, known amongst volcanologists as *Somma Antico* and *Somma Recente*, appear to have come to an end some time before recorded history (Frederiksen 1984: 6). The cone of Mount Vesuvius proper was a later development and in recorded historical times was the only active crater and its lavas according to experts are mineralogically distinct from *Monte Somma* (Frederiksen 1984: 7). The explanation given by geologists is that the original outlet of *Monte Somma* became blocked and this led to a long period of relative calm, but that under the accumulated pressure a new vent formed in a fresh spot and in the view of the majority can be associated with the great eruption of AD 79 described by Pliny. Whatever the truth about the date of the appearance of the Vesuvius' present cone, the evidence is still unclear. (Frederiksen 1984: 8- 12), we know that it was definitely the product of a large eruption at some time, followed by several successive smaller ones, wholly altering the appearance of the mountain and making the rather large flattened cone of *Monte Somma* almost unrecognizable (Frederiksen 1984: 7).

To the north of Campania lies the large volcano of Monte Roccamonfina (1005m) whose ancient name we are still ignorant of as literary sources make no mention of it, despite it being an imposing and sprawling mountain occupying an area of some 250sq km. Its primary cone is composed of layers of *tufa* and lava (as are most Italian volcanoes) and its shape is most clearly visible from the western side, where its steep slopes would have offered good protection from tribes who ruled over the country to the north. The last important activity of the volcano seems to have been to send out a vast ash flow to its south and east so that this side of the mountain is broken up into a series of terraces and tongues of land (Frederiksen 1984: 12).

When we turn to the geology of the *ager Falernus* immediately to the south we are likely to be dealing with a distinct and more recent creation. The soils of this basin look different from the Roccamonfina *tufa*s and their origins must have been different. Falernian *tufa* is grey in colour and takes many forms verging from loose soil through *tufa* proper (*tufa pipernoide)* to the relatively hard grey flecked stone called *piperino* that has been much used in buildings. Originally geologists believed that some huge explosion in the *Campi Flegrei* or even from the Vesuvius itself and which then became more compacted had deposited this *tufa* aerially. However, its forms and chemical compositions rule these possibilities out (Frederiksen 1984: 13) and more recently geologists have pointed out a curious series of lakes and round depressions that stretch from the neighbourhood of Mondragone and Falciano as far as Variano (See note 63 in Frederiksen 1984) . These craters may well be the answer: They are small and without crests, yet well preserved as would be recent creations. There was probably a volcanic fissure running northeast from about Mondragone, parallel with Mons Massicus and in a relatively recent era had expelled a lot of volcanic matter, some by eruption and some by perhaps mud-flows and as a result supplied the fertile covers, slopes and alluvial flats of the *ager Falernus* (Frederiksen 1984: 13).

Over the remainder of the north Campanian plain and around ancient Capua the formation is not very different. One finds deep layers of similar grey *tufa*s, varying from the very soft to the very hard *piperino*. Meanwhile on the edges on the volcanic areas there are occasional outliers of the Apennine limestone and its associated *terra rossa*. Once again, the depth of the volcanic soils excludes them having been settled from eruptions elsewhere and are most probably material of local origin. They were most likely deposited in the form of mudflows and have left no traces of the craters and depressions that appear in other places (Frederiksen 1984: 13). This material is the principal ingredient of the famous soil of the *ager Campanus*, of which ancient writers had many a praise to sing (Frederiksen 1984 note 66: 14) (Figure 7). Opinions vary about the time of deposition, originally believed to be created by the first great explosion of the *Campi Flegrei* but the local eruptions that have now been identified suggest a much later date (Frederiksen 1984 note 67: 14.). In appearance, the Campanian *tufa*s are very like those of the *ager Falernus* and are likely to be related to them. They are even more recent than the Roccamonfina *tufa*s, which can be seen to underlie them quite clearly in various places (note 68 in Frederiksen 1984: 14). This collection of evidence highlights the fact that the thick volcanic soils of the Campanian plains must be considered a very recent formation in geological terms (Frederiksen 1984: 14).

The above-mentioned volcanic activity is as vast as it is intriguing but it is still only one aspect of the geology of the Campanian region. The Phlegraean Fields, which are described below (and whose volcanic nature is considerably different to what has just been discussed) also form a considerable part of Campania. This region’s geology and its related volcanic activity deserve particular attention given the far-reaching effects they have had on the area.

2.3.2 The Phlegraean Fields (I *Campi Flegrei*) and the phenomenon of bradyseism

The Phlegraean Fields were as famous in antiquity, described in great detail in Petronius's *Satyricon*, as they are today, for their frequent and impressive geothermic phenomena, associated with volcanic activity, the word "Flegrei" having its origins in Greek meaning "burning". These phenomena are still found in the form of thermal springs and fumaroles, the most famous of which is the small semi-active crater of *La Solfatara* (Frederiksen 1984: 4). The surface area measures 150km^2. It is a caldera complex created by volcanic collapse and a third of this area is presently underwater forming the Pozzuoli Bay (Mohrange, Bourcier et al. 1999: 349; d'Argenio, Pescatore et al. 2003: 106).

Mount Vesuvius and the *Campi Flegrei* (Figure 7) are two very different volcanoes, despite being relatively close to one another. The molten lava of the Vesuvius comes from a magma chamber deep within the Appenine chain (Scherillo 1977: 85) whilst the *Campi Flegrei* constitutes an expansive area of relatively small scale and superficial volcanic activity likely representing the remains of a larger volcano, most of which has been eroded away (DeNatale, C.Troise et al. 2006). The pressures of steam and gas have lead to further formations of lesser craters and short-lived eruptions. The two zones therefore are different in age and depth of volcanic activity and they are best defined by the centre of modern Naples that lies roughly on the boundary of the two (Frederiksen 1984: 4).

The *Campi Flegrei* is formed largely by soft volcanic ash and *tufa* that has been deposited over a long period of time, possibly at the beginning of the Quaternary period. Giuseppe De Lorenzo divided the chronology of the formation process pertaining to the geology of Campi events into three stages (Scherillo 1977: 5; Orsi, Vita et al. 1998: 17-18; Christoph Mohrange 2002).

To begin with, there appears to have been a volcanic eruption, comparable to the one that gave birth to Mount Vesuvius. It expelled an ash that is trachytic[4], sandy relatively light and poor in limestone and basalt fragments, at least when compared to the Vesuvius. The first eruption was characterised by a pale grey tufa[5] with black pumice inclusions and is known as the *tufo campano*. This is the oldest ash in the district covering the current area of the *Campi Flegrei* and reaching as far as the gulf of Pozzuoli and is 40,000 years old (Squitieri 1937: 22; Scherillo 1977: 6; Frederiksen 1984; Christoph Mohrange 2002).

As time progressed, pressures of steam and gas accumulated and brought about another period of eruptions that produced smaller craters and whose eruptive material was nearer the surface, this gave rise to the configuration of the area as we know it today. The *tufa* expelled on this occasion was yellow in colour and crystalline in texture. De Lorenzo calls this period the period of the "*tufo giallo napoletano*"(Scherillo 1977: 89), not to be confused with the earlier rock formations (such as the tufo of Torre franco) or the more recent ones (such as the tufo of Nsidia).This type of rock formation is of particular importance in the geology of the *Campi Flegrei* because it is where the oldest settlements were founded including Cuma, the Rione Terra of Pozzuoli, Naples and Bacoli. All these were founded directly on the *tufo giallo*. The *tufo giallo* layer can easily be reached through excavation and subsequently extracted and worked making it ideal for construction material even in Roman antiquity (Scherillo 1977: 90). As a result of these eruptions, the land level sank again, leaving a series of raised

[4] Relating to or denoting a rock texture (characteristic of trachyte) in which crystals show parallel alignment due to liquid flow (Oxford English Dictionary)
[5] The correct English geological name is *tuff* but the Italian more popular *tufa* shall be used here.

beaches and fossils, all belonging to the quaternary period and from which it is clear that the sea had penetrated at least as far as *Pian di Quarto* and the present hills would have once formed a semicircle of islands (Squitieri 1937; Frederiksen 1984: 4). Date of the *tufo giallo napoletano* is 12,000 years old (Christoph Mohrange 2002: 367) .

The third period of the Phlegraean Fields is characterised, according to DeLorenzo by a more recent group of Volcanoes (i.e those less than 11,000 year old) and whose eruption was marked by mixed discharges of ash with stone fragments. This was later to become the famous *Pozzolana* (Squerillo 1977: 94-5). These discharges produced a number of small craters, (Figure 8) some of which are still very active. The *Fondo di Baia* is one of them, still emitting hot gases and spring water; the Solfatara and its spectacular fumaroles is another and the sizeable crater of Agnano is the largest of them (Frederiksen 1984: 4). In one crater, that of Astroni, pottery belonging to the early bronze age was discovered beneath a layer of eruptive material and so dates the explosion to around 1500 B.C. The recorded eruptions of historic times are simply a continuation of the same process and there is no reason to suppose has finished in the present days.

The large eruption of AD 1538 is historical fact and had been preceded for several years by a series of tremors and earth movements, which increased as the eruption drew nearer. The sea was seen to have retreated from the land leaving large stretches of uplift which were impressive enough to be recorded in the royal scripts in 1503 and 1511 (Frederiksen 1984: 5; Mohrange and Marriner 2006: 96). The shocks grew alarmingly in 1537-38 and on the 29th September 1538, an eruption took place that buried over half of the former Lucrine Lake, a hill, a valley and a medieval village called Tripergola. The expelled material formed an ash cone approximately 140m wide and 3 miles round, now known as Monte Nouvo (Figure 9). Eye witness accounts describe the associated tremors as having caused much damage to

Pozzuoli and to the nearby towns and that at one point the shore at Baiae was high and dry (Frederiksen 1984: 5). Since the eruption had long been expected, eyewitness accounts were clear and accurate and there is little reason to doubt their reliability. It was an important event for the *Campi Flegrei* but was nowhere near the as serious or as devastating as the eruptions of AD 79, for which Mount Vesuvius is famous for, nor was there any lava, another characteristic of the Phlegraean Fields. The frequent discharges of the *Campi Flegrei* expelled friable and light matter, mostly ash and pumice (Castagnoli 1976; Frederiksen 1984: 5; Orsi, Vita et al. 1998; Galasso 2009).

There is another vulcanological phenomenon which has had far reaching consequences on the geography and history of Campania and which is indeed almost unique to the region. This is the vertical coastal movement which in this context is known as “Bradyseism” (Scherillo 1977). Bradyseism involves the relatively rapid rising and sinking of the coastline caused by the pressures of subterranean gas and steam. The intervals between oscillations amount to centuries and the amplitudes as much as several *metre*s (Paget 1968). Although this activity has been detected elsewhere, it is clearest and most studied in the *Campi Flegrei* (Frederiksen 1984: 5-6).

Historically, secular subsidence has been interpreted by rapid crustal uplifts, the relative sea-movements of which are particularly intense around the area of Pozzuoli (Mohrange and Marriner 2006: 93). Two days before the 1538 eruption, uplift had culminated in a +7m ground movement relative to the sea level and is attested by a gravure (a type of printing method) executed by Delli Falconi in 1539 (Mohrange and Marriner 2006: 93). Even more recently, two further major events between 1969 -1972 and 1982-1984 resulted in a total uplift of ~3.5m with an evacuation of the town of the town of Pozzuoli in 1984. Despite these concerns for renewed volcanic activity, no eruptions ensued and a slow subsidence started instead in 1985 and continues to the present day (Mohrange and Marriner 2006: 94) broken only by three minor uplift episodes in 1989, 1994, and 2000 (Gaeta, S. et al. 2003: 1).

The clearest example of bradyseismic activity is found at Pozzuoli at the *Serapeo*, in fact a market building (*Macellum*) of Domitianic date with Severan additions (Squitieri 1937; Scherillo 1977; Frederiksen 1984) (Figure 10). Within the building's main courtyard, there are the remains of a pillared rotunda and in the *cella* on the north side are three columns of Carystian marble (*cipollino*). It has been observed that these said columns suffered partial immersion since antiquity. As a consequence, the columns have been eroded and pitted by a type of sea mollusc at 5.7 metres from their base (Squitieri 1937; Frederiksen 1984). The molluscs are referred to in Italian as *Datteri di Mare,* literally meaning date mussel. It burrows deep into the marble, preferring to live just below the surface of the water. It is generally agreed that the coastline achieved its lowest level sometime in the Middle Ages (attested by the highest ring of erosion on the three columns. A period of rapid rise followed, associated with the pressures that created by Monte Nouvo in 1538 but since then the coastline has been in slow decline. In areas such as Misenum and Nisida, the effects were far less marked (Scherillo 1977; Frederiksen 1984).

There is no clear sign at Pozzuoli that the coastline began to subside in antiquity, although the discovery of an earlier pavement in the *macellum* could be interpreted as that. It is also known that the harbour works twice needed repairing, however the only recorded cause for these repairs appears to have been the force of the sea (Frederiksen 1984). It is however clear that the shoreline was then about two or three metres above its current level. More recent studies have shown that the coastal subsidence was more dramatic in the area near *Baiae* and the Lake Lucrine, where the curve of the coastline might conceal a volcanic trench. Roman buildings near the shore now lie some 4m beneath the surface and 800m further out the remains of Baiae are reported to be some 18m below the surface. Much of the elegant foreshore of ancient *Baiae*, the Via Herculanea and the harbour works that fronted Lake Lucrine lie underwater (Lamboglia 1971; Frederiksen 1984) but there is still no certain indication that the phenomenon was present in antiquity (Frederiksen 1984).

The market was perhaps Pozzuoli's most observed monument for its archaeological and geological interest. With it being so close to the shoreline, it became a precious source of information for the study of the crustal deformations in the area (bradyseism). Already in the 1500s the partially drowned columns attracted the attention of the artist painting the vignette (Giaminelli 1996). It was after excavations undertaken in 1750 that visitors noticed the holes on the columns evidencing the fact that in the past the monument lay underwater (Christoph Mohrange 2002: 370).

The question about the rising and sinking of the land quickly ensued amongst 19th Century with scholars such as Goethe and Faivre participating actively in the debate. Goethe himself visited the market and came to the conclusion that its three main columns showed signs of erosion that were a result of marine molluscs. He further hypothesises that a lagoon had formed inside in the courtyard of the market following the eruption of the 1538 eruption and the consequent flooding of the monument (Christoph Mohrange 2002: 370). This hypothesis was very much supported thanks to the fame of its advocate but also caused much confusion.

The various travellers to Italy at the start of the 19th century also contributed greatly to the documentation and understanding of Pozzuoli's antiquities. The Neapolitan scholar Andrea de Jorio in 1817 described in a small guidebook various monuments pertaining to the Phlegraean Fields. He then looked at the *Macellum* in more detail in 1820 (DeJorio 1820) using four elements to outline the land movement that had taken place including the sedimentary stratigraphy produced by the shell perforations, 15th and 16th Century topographic maps as well as written eye-witness accounts. De Jorio concludes that the land rose between 1441 and 1524 indicating the bradyseismic movement prior to the eruption of Monte Nuovo (Christoph Mohrange 2002: 370).

In 1829 the British scholar Forbes in disagreement with De Jorio published a very well documented article on the subject of bradyseism in Pozzuoli, which he believed indicated “a long continued immersion in sea-water” (DeJorio 1820). In his work he also highlights that other marine organisms were also present and that other buildings were also submerged. He describes the various explanations that were put forward at the time: that what one saw was the effect of the absolute movement of sea level at the time (Niccolini’s theory). That this was a result of movement related to volcanic activity, which is his preferred theory. That this was a result of the lagoon waters present on the inside of the monument (Goethe’s theory) (Christoph Mohrange 2002: 370-1).

It was however after the work by Charles Lyell in 1830 (Lyell 1830) that the market of Pozzuoli became an icon representing the study of geology (Figure 11). Using the image for the cover of his book, the building was forever quoted in many publications. Lyell believed that the longest period of submersion was at the beginning of the 15th C before the eruption of Monte Nuovo in 1538. After visiting the site, collecting the data of his colleagues such as Forbes, Niccolini and Babbage he proposes the following solution saying that he will prove that the controversy surrounding the phenomenon of the gulf of Pozzuoli is a result of the repugnance that one has in admitting that land is more susceptible than the sea to the phenomena of rising and sinking (Christoph Mohrange 2002: 371).

The Neapolitan architect Niccolini in 1839 and 1846 “revolutionised” research by regularly measuring the level of the surface of the water within the monument from 1822 to 1838. Using these bathymetric measurements he was able to prove that the land movements persisted in the present age. Babbage visited Pozzuoli in 1828 and publishes in 1847 an incorrect stratigraphy of part of the Roman market, particularly, the columns were not found in a vertical position during excavation as is shown by numerous drawings from the second half of the 18th century that show them scattered on the ground (Christoph Mohrange 2002: 371).

Gunther in 1903 was the first person to undertake an archaeological study of underwater remains but his work concentrated mostly on the coast of *Pausilypo* northwest of Naples. It was the archaeologist Charles Dubois in 1907 that summarises these results and describes the various archaeological remains found in Pozzuoli with particular reference to the submerged mole and the indication of potential harbour structures underneath *Rione Terra.*

The problem with most of these publications is that that paleo-bathymetric data is sourced from a variety of different geological contexts producing complicated graphs without any real meaning (Christoph Mohrange 2002: 373). Of the most recent research on bradyseismic activity was that undertaken by Mohrange et al. in 2006. This involved carbon dating fossil marine organisms located at three different sites in Pozzuoli: The columns of the *Macellum*, (Figure 12) the nearby volcanic cliffs of *Rione Terra* and an excavated Roman cave in the same area (Mohrange and Marriner 2006: 94). This work was an elaboration of the studies of the marine molluscs in 1999 (Mohrange, Bourcier et al. 1999: 349-350) undertaken in order to provide an independent yet complementary approach to the already varying scenarios put forward to explain the ground deformations from post-Roman times (Mohrange, Bourcier et al. 1999: 350).

The various shells that were collected combined with the stratigraphy from within which the molluscs were found led the researches to conclude that the submersion since Roman times was not a unique event but comprised at least three peaks of more or less the same amplitude between the 5th and the 15th centuries AD (Mohrange, Bourcier et al. 1999: 353; Mohrange and Marriner 2006: 95). In sum, the data analysed not only confirmed the frequency of the land oscillations but also the relative levels. It is now understood that the sea level did not remain stable at ~+7m. *Portus Iulius*, just offshore from the *Macellum* is currently drowned at -10m below sea level thus giving us a 17m envelope of crustal mobility since antiquity summarised in three main phases. The first phase, marine transgression of the of the market ended circa A.D. 400-530, after its last restoration in A.D. 394 and no eruptive activity appears to have followed this initial phase (Parascandola 1947; Mohrange and Marriner 2006). In the early middle-ages a second oscillation seems to have taken place between ca. A.D. 700-900 and in a third phase, a late Middle ages submersion took place, followed by the well documented period of land uplift that culminated in the eruption of Monte Nuovo in 1538 (Mohrange and Marriner 2006).

Given the various studies carried out, one can now say with a fair degree of certainty that the bradyseism of the Phlegraean coast is a post-classical phenomenon and it was not so gradual or so continuous as the more traditional views would have us believe. Moreover, it seems likely that there has been a general rise in sea level worldwide of about 1 and a half to 2m (see note 89: 17). The relationship of specific points on the coast to differing sea levels is always difficult to determine because it is affected by too many factors (Frederiksen 1984: 17). These include rates of erosion inland and deposition by rivers at their mouths, strength of currents and direction of coastwise movement of sediment and the incidence of stormy periods as well as vertical movement caused, in this case, by volcanic activity. This is certainly the case with the effect of rivers and watercourses in general on the Campanian landscape, which shall be further discussed below.

2.3.3 Rivers and Watercourses of Campania

It is initially surprising to see that for may ancient authors, one of Italy's advantages were the many navigable rivers which today can be said to not exist at all. Moreover, the problem of marshes, drainage and reclamation have always been persistent in Italy and when looking at the hydrographic conditions within ancient Campania, there are many surprising aspects for which Frederiksen encourages us to put excessive scepticism aside (Fredriksen 1984: 17).

The Volturnus is the largest river in southern Italy. It rises in the complex Appenines chains and because it is fed by permanent springs at higher altitudes, it never dries completely and rarely floods. It runs deep and fast as it emerges from the mountains near Capua after which it quickly loses speed when it reaches the coastal plain. The river Volturnus has always been an obstacle. Its lowest bridgeable crossing point was for a long time at Casilinum after which the river followed a slow, meandering course where the land on either side tended to be swampy and subject to seasonal flooding (Frederiksen 1984: 18). This would explain why throughout most of history, the traffic between Rome and the south has found it impossible to follow the coast and had to make inland detours; between the Apennine chain and the sea, Casilinum being the only feasible crossing point (Frederiksen 1984:18).

The short river of Savo is about 50km long and rises on the slopes of Roccamonfina where it's fast flowing up to Ponte dei Cervi, after which it loses its strength and winds a slow path through the *ager Falernus*. In antiquity, the river's mouth lay some five Roman miles north of the River Volturnus and therefore must have partly contributed to the coastal marshes (Frederkisen 1984: 18). This must have required the building of a bridge on the Via Domitiana as it already had one on the Via Appia (*pons Campanus)* lying eight Roman miles from Sinuessa, where Horace, Virgil and Maecenas once had a picnic lunch (Frederiksen 1984:18).

A small but important river was the Clanius that rose in a series of springs close to ancient Suelessa and meandered in a generally western direction that then emerged on the coast by the ancient Liternum (Frederiksen 1984: 18). This river is rather lethargic and is formed by a series of muddy pools and areas of reeds, forming a wide band of marshes that ultimately divided the Campanian plain into two. Looking at a modern map, one can see a stretch of land running from east to west, with no ancient remains, no Roman centuriation, no towns of ancient or Medieval date (Frederiksen 1984: 18). The Roman road between Capua and *Puteoli*, the Via Campania crossed the stream on a substantial bridge, and both were crucial for communication in antiquity and centuries afterwards (note 101:18). Nowadays the stream is completely subdued and a driver from Caserta to Naples is likely to be completely unaware of its presence even while crossing over it (Frederiksen 1984: 19).

The other major watercourse in Campania was the river Sarno (Sarnus) that rises in perennial springs in the Appenines, between the modern towns of Sarno and Nocera (Frederiksen 1984: 19). Its ancient size was certainly greater as until recently it was fed by other springs in the plain of San Valentino, San Marzano and Nocera Inferiore, that have since been diverted elsewhere (Frederiksen 1984: 19). Its length and volume nowadays can be misleading: the mouth at least was navigable in antiquity and formed the port of Pompeii, which prospered on the export of the produce of the rich agricultural valley flats (Frederiksen 1984:19). The river has changed a lot since antiquity. The Vesuvian eruptions both lessened its flow and by raising the local ground level forced it to cut a deep and impenetrable channel with precipitous sides (Frederiksen 1984: 19) and land improvement schemes have further confinded its flow together with the heavy irrigation schemes that draw upon it: the whole area now known for its tomatoes (Frederiksen 1984: 19).

The Campanian rivers today have a rather innocuous look; they have all shrunk, two of which are no longer navigable and two that are no longer recognizable as rivers at all. It is therefore understandable that we cannot imagine what kind of problems they would have posed to communities in antiquity. The Greeks appeared to have made a start: Livy mentions a canal near Cumae that may have been part of a scheme to drain marshal coastal areas where the river Clanius used to stagnate (note 112: 20). If the Greeks had started reclaiming land, then to what extent was the impetus to be kept up? The coastline nowadays consists of a long stretch of sand that separates the open sea from a series of lagoons running from the south of Cumae (Lago di Fusaro)[6] (Paget 1968: 155) to the north (Lago di Licola, now drained and Lago di Patria near Liternum) (Frederiksen 1984: 20). North of the Volturnus there were probably more lagoons that extended further inland or at least, this is the picture depicted to us by the ancient authors that describe the Volturnus as swampy (vadosus). In his praise for the Via Domitiana, the poet Statius predictably suggests that the Romans reclaimed more land than the Greeks (Frederiksen 1984: 20). However behind his picturesque prose there is indeed some technical reality (note 116: 20). Domitian's road building must have required some measures of land reclamation and drainage (Frederiksen 1984: 20).

Even after having described the hydrography of Campania in order to understand her coastline, one must still accept the fact that the alternation of the coastline in antiquity is not easy to demonstrate. The Volturnus brings down a large quantities of silt, as was known to the

[6] Lake Fusaro is not a sea made lagoon but a true geological lake made resulting from residual tectonic pressures and movements connected with the formation of the Mediterranean basin in Tertiary geological times (Paget 1968: 155).

ancient communities and this problem is still very pertinent today. Figures from filtration tests highlight that the stream deposits approximately half a million cubic metres of soil every year with 10,000 more added by the river Savo and yet no large delta has ever formed at the rivermouth. A lot of material is carried even further: the silt from the north Campanian rivers is carried first out to sea and then far to the south has blocked the ancient harbour of Cumae (Frederiksen 1984: 21). Other material does not even make it to the sea and is either deposited in the flood plains or on the riverbed. This process continually raises the riverbanks and still causes severe problems to engineers trying to reclaim land. We can therefore assume that time has not altered the coastline greatly and might imagine the same dunes and wind blown scrub that can still be seen in the unimproved areas of the shore nowadays. The real changes would have taken place inland (Frederkisen 1984: 21).

2.3.4 A brief note on the climate of Campania

The climate of ancient Italy as well as that of Campania appears to have been very much the Mediterranean climate we experience today; that of a wet winter and an extremely dry summer and although it has varied our time, there is little reason that it was considerably different than it is today. In the Naples area the average high temperature in July is 29^0 and 12^0 in January. The majority of the rainfall, which is approximately 70% takes place between the months of September and March and the region has endured many summers with almost no rain at all (Taylor 2010: 6). Some authors (Burroughs 2001) have however suggested that the climate was potentially warmer and drier consequently affecting both agriculture and health. Sea levels, in the areas not prone to tectonic instability also appears to have been relatively stable and has not altered by more than half a *metre* in the last 2000 years (Stoddart 2010: 103).

2.3.5 Modern Pozzuoli

Located at the latitude of 40° 49' 18, 20 and the longitude 14° 7' 24, 9, the modern town of Pozzuoli has a surface of 43,21km^2 and is presently located 28m above sea level. With a population of about 83,400 inhabitants is has a density of approximately 1,900 inhabitants per square kilometre[7]. Pozzuoli's current occupants, who have an ageing index that is inferior to the Italian average[8] are for the large part, concentrated around the Communal Capital and to a lesser extent around the localities of *Grotta del Sole*, *Lido di Licola, Montagna Spaccata* and *Monteruscello* (www.Italiapedia.it). However as a result of the housing expansion, these areas merged and are sometimes confused with the territories of *Bacoli, Giuliano* in Campania, *Napoli* and *Quarto*. Small urban centres and a number of individual houses radiate from the town's centre and extend on the *tufa* hills that slope towards the sea (Taylor 2010: 6).

Pozzuoli is well particularly well connected by road and sea routes. It is serviced by the Naples ring road (*tangenziale*) that connects it to the North of Naples and consequently to the A1 motorway (known as the *autostrada del sole*) that travels from Milan-Rome-Naples. Furthermore the town is only 11km away from the commercial port of Naples but has its own port and docking facilities, which are used primarily by fishing boats. The town is the heart of the Neapolitan fishing market. The port of Pozzuoli is also the point of departure for ferries heading to the islands of Ischia and Procida (Heikell 2011: 201).

In antiquity, the whole region of Campania was renowned for its agricultural wealth, with its most famous farmland lying in the area of

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[7] Current statistical data from 2010 provided by the Italian National Institure of Statistics (ISTAT).
[8]http://www.istat.it/en/campania/data?q=gettable&dataset=DCIS_INDDEMOG1&dim=98,0,0&lang=1&tr=0&te=1 This data can be easily compared with the ageing index from other Italian regions on the website.

the Voltunus valley. The Ager Falernus on the other hand produced according to Strabo some of the finest vintages in Italy (Strabo 5.3.6, 5.4.3) (Taylor 2010: 6). Moreover, in antiquity the towns clustered around the western caldera – *Puteoli*, Baia, Misenum – survived on service economies rather than agriculture, the most famous farmed commodity was shellfish, especially oysters (Strabo 5.4.6).

It therefore comes as no surprise that Pozzuoli's economy today is a mixture of tradition and innovation. A combination of lush vineyards, fertile arable land and coniferous forests that characterize the territory surrounding the town of Pozzuoli, allows for a wide range of work for its current inhabitants (Taylor 2010: 7-8). The fertile sloping hills favor an agriculture that produces grapes and numerous other fruits in general. This represents a fundamental economic resource together with fishing and forestry. Pozzuoli is also equipped with a rich industrial apparatus composed of metallurgic, chemical, chemical and ship building industries. The tourist industry is also becoming increasingly profitable with an increase in restaurants and hotels in the area. This is not solely due to Pozzuoli's thermal complexes but also thanks to an ever-increasing awareness of the town's archaeological and historical richness (ISTAT: http://www.istat.it/en/campania/data).

2.3.6 Mediterranean winds and currents

During the summer months, the winds that prevail over the Italian archipelago come from the NW and W, even though in some areas, such as the western coast, there is a constant presence of land and sea breezes. Moreover, the complexity of the Italian land formations described above, significantly alters the winds in the proximity of the coast, so much so that the wind in one particular area may be considerably different from the wind blowing 20 miles further south along the coast or in the open sea (Heikel 2011: 28).

There are a number of winds (Figure 13a) that blow over the Italian peninsula, each with its own character and strength. The *Maestrale,* the name is a corruption of the word *Magistralis* meaning authoritative, are the strong winds that blow from the N-NW of the Mediterranean. However, the name is now more commonly used to describe the direction of the wind rather than its strength (Heikel 2011: 29). This is not be confused with the *Mistral* wind that descends from the Rodano Valley and blows westwards over the coast of Corsica and Sardegna. The *Libreccio* is a wind that blows in a southwesterly direction in the area of Corsica, the Ligurian coast and the northern Tyrrhenian, often with a force of 5-8 knots that can last for up to four days. The *Ponente* is the westerly wind, whereas the *Tramontana* is wind that blows in autumn and winter along the western coast of Italy, principally towards the north usually lasting no more than a couple of days. It can however reach gale forces with violent gusts of wind that drop suddenly. This wind is associated with the depression, an area of low pressure (generally bad weather), in the Ardiatic (Heikel 2011: 29).

The *Gregale* is a strong wind from the NE that sweeps through the Adriatic until it reaches Malta, where it becomes particularly dangerous as it produces a strong backwash. Early warning signs of this approaching wind are large waves coupled with low clouds and rain. This wind often reached gale forces and can last from two to five days (Heikel 2011: 30). On the other hand the *Scirocco* is a warm and humid wind, often found in the southern Mediterranean that blows from the south as originates in the Sahara. Low clouds and scarce visibility often accompany this wind that usually lasts no more than 3 days and the particles of sand cause what is known as “red rain” (*pioggia rossa*) (Heikel 2011: 30). The *Bora* is another strong wind that blows from the north but travels over the Adriatic rather than the Tyrrhenian, manifesting itself in all its force during the winter months but can also blow throughout many other times during the year. This wind too is also capable of reaching gale forces and can last from two to twelve days (Heikel 2011: 30).

In the summer, gentle breezes characterize the Tyrrhenian coast both on land and at sea and are often easily predicted. One can usually observe a SW-SE wind with the strength of 2- 5 knots in the afternoon that then dies down at sunset (Heikel 2011: 162). During the night and at the early hours of the morning, a light E-NE breeze can be felt that rarely blows beyond a force 2. The calm days with no wind are also rather frequent, especially in the gulf of Salerno and the Gulf of Policastro (Heikel 2011: 162). In some areas of the Tyrrhenian however, the wind tends to come from the west. Towards the Straits of Messina, a NE or SW wind dominates the area that can blow both up and down the Strait. At Reggio Calabria, winds from the NE constitute almost half of all the winds that blow during the months of July and August. During the spring and autumn months however, short but frequent storms begin to manifest themselves close to coast and in winter, strong winds come from the NW and the S. Strong winds can also be observed close to the coast in areas near Ponza, the Gulf of Salerno, the coast between Capo Palinuro and Reggio Calabria and also along the coast of the Straits of Messina (Heikel 2011: 162).

The currents around Italy flow E-SE, with the exception of a slight opposing current that travels along the Tyrrhenian coast in a N-NW direction and along the southern coast of Italy in a S-SW direction. With the exception of waters between Sicily and Tunisia, the strength of the Mediterranean currents is rather modest but often exacerbated by the winds (Heikel 2011: 3) (Figure 13b).

2.3.7 Approaching Campania’s coast

With modern roads forming part of our mindset, it is easy to take a landlocked attitude towards the Italian Peninsula. On the other hand it is important to include a brief survey of the maritime views of the landscape. To the Romans, the sea was not only vital for communication but an important resource, supplies of which included fish and salt (Stoddart 2010: 114).

Starting from the central stretch of coastline at Santa Severa, not far from the archaic sanctuary port of Pyrgi has yielded at least one shipwreck of Republican date, with finds that point to an important route down towards Campania (Stoddart 2010: 115). To the south, the delta of the Tiber has extended quite considerably seaward from Ostia since Roman Times and the volcanic *tufa* behind have become more eroded. The Capo di Anzio and Monte Circeo sitting on top of the pontine plains are more stable landmarks for those at sea (Stoddart 2010:116, Heikel 2011: 176).

The next stretch of coast, some 270km in length, runs from the promontory and port of Gaeta, through its spectacular gulf and through the gulfs of Naples and Salerno dominated by the Vesuvius volcano. The rugged and often cliffed peninsulas that are headed by the distinctive islands of Ponza and Ventotene delimit wide and fertile plains (Stoddart 2010: 116). The islands of Ponza and Ventotene along with the *Secca dei Mattoni* reef between the Ponza and Palmarola islands caused the shipwreck of several Republican ships. Another reef, *Le Grotticelle* between the small islands of Ventocene and Santo Stefano (in the Pontine islands) also destroyed many a Republican ship (Delgado et al 1997: 315-6). The promontory of Gaeta that protects two natural ports is approached from the north of Terracina along a steep and rocky coast that rises quickly to the limestone mountains beyond. The Fondi basin forms a small interruption in this harsh looking landscape, filled as it is by marshland and lagoons. After another promontory, a sandy beach backed by wide-ranging dunes and marshland, runs along for about 60 km towards Cumae, only to be broken by the mouths of the Gargliano and Volturno, two of the largest rivers in Italy (Stoddart 2010: 116, Paget 1968: 153). At Cape Misenum, the coast transforms into the spectacular Bay of Naples (Heikel 2011: 198). Every place-name one reaches whilst travelling round the bay draws its significance from classical history such as the secure port of Misenum, Baia, Pozzuoli and Naples itself (Stoddart 2010: 116). Beaches and rocky coastline alternate in front of the *Campi Flegrei* all visibly modelled by the constant volcanic action as well as by the sea. From Naples, the bay runs underneath the Vesuvius, now remodelled by post Roman activity, before widening into the Sarno plain. The Sorrentine peninsula, which is made of limestone and volcanic tuff displays the effects of faulting and can be seen projecting beyond, with Capri seaward (Stoddard 2010: 116). Punta Licosa on the other hand has proven to be dangerous (Heikel 2011: 229). This is a coastline of imposing rocky cliffs until just beyond Salerno, where there is once again, a sizeable plain which opens some 10km, in the area of ancient Paestum and provides drainage for the Sele river that drops from the higher reliefs of the Eboli, that itself backs into the higher Appenines behind. Lastly before entering Northern Calabria, major mountain blocks project into the sea with Monte Stella (Punto Licosa) to the northeast and Monte Bulgheria (Torre Iscolelli) to the southeast (Stoddart 2010: 116).

2.4 A boat with a view: An image search of modern day Pozzuoli based on views from the sea

Reading the picturesque descriptions as described above by Stoddart already fuel one's imagination in trying to visualise what could be seen on approaching the Campanian coastline from the water. To get a further sense of colour, shape and overall viewscape, an image search was carried out looking specifically at photographs taken from the water looking inland.

The search terms used were narrowed down to: "Pozzuoli" and "Rione Terra". The Search terms "Bay of Naples", "Gulf of Pozzuoli" "Port of

Pozzuoli" yielded too big a search field in Panoramio[9]© and it was not able to provide a specific location for these images. All the images are on a public domain and while they belong to their owners, they have been made available to Panoramio. Another website, Flickr was also also searched but due to various degrees of copyright permissions, many of the images had to be discarded. Of the following photos none belong to the author of this thesis, with the sole exception of one image that is described quite separately.

All the images found in the search results were viewed, lokoing out for as many photos of Rione Terra and the Gulf of Pozzuoli in as many atmospheric conditions as possible; daylight, nighttime and from many angles as possible (always at sea). Any photos which despite including the sea, were taken from a seemingly land based position were also discarded. A focus was maintained on those photos that appear to have been taken from a boat (there is a chance that I may be wrong about the position but this is part of my own perceptual process).

The photos were then grouped depending on how closely the photographic angles were to one another and the distances at which these photos were taken such as in group one and three and what features were visible in the photos such as the mole in group two. Finally those photos, which were thought to be relevant but could not be put in any of these groups, were put in one final group four as they are worthy of descriptions anyway.

One important element of this exercise is that one has to bear in mind that the following descriptions are made solely using the photos selected and that I myself have not experienced these or any other views from a boat. The views I have seen of Pozzuoli have been solely land-

[9] A geolocation-oriented photo sharing website used with Google Maps© and Google Earth©.

based. These images are also static so I am making the assumption that the interpretation of these images is actually easier than if I were trying to make them on a moving vessel. Another consideration that I have to point out now before I proceed with the descriptions is that I have deliberately chosen to discount the cranes. They are in almost every image and they are very prominent and I felt they were rather distracting to the eye. They are also temporary elements that may have also been moved from time to time even if they seem to have been present in the Rione Terra for years. So in order to focus on the landscape, they have not been included in any of the subsequent descriptions.

Another element, which will become noticeable during the descriptions of the various images of Pozzuoli and Rione Terra is the lack of the Vesuvius. From these angles at least, the dominant promontories are Monte Nuovo, Monte Gauro and the Island of Nisida. The Vesuvius is clearly more dominant when facing directly the port of Naples and if heading in the direction of Pozzuoli, one would still have to go round Posilipo and the island of Nisida, both of which are also rather imposing hills so that by the time one can see Pozzuoli lost the view of the Vesuvius has been lost.

2.4.1 Observation 1 (Plates 1 and 2)

The likely view of both photos is from the South side (therefore photographer is looking north). One photo is taken during the day, the other at night. Consequently, the landscape in the background that cradles Pozzuoli can be seen clearly during the day but not at night.

The noticeable features: Big white *Palazzo* on the far right of the photo. Can be easily identified in both lighting conditions. As can the shape of the small church immediately to the *palazzo's* left. Another noticeable building is the yellow and red small building standing alone further left of the church. Its particular colour scheme makes it identifiable during the day but it is its distance from neighbouring buildings that help identify it at night. The *Palazzo vescovile* can be seen in the daylight because it is painted a cream colour but at night it is best identified by its series of windows.

The white building that appears to be residential and which is close to sea level and right of the crane is clearly visible and contrasts quite nicely with its surroundings. It is however completely obscured in the night photo. The position of the lighting sources is very important in this case. The opposite observation related to artificial light can be said for the concentration of night-lights highlighting the road just left of the centre of the image. The road is clearly identifiable in the dark but merges completely with the scenery in the daylight photo. The Rocky outpost on the far left of the image is also clearly visible and in both images.

2.4.2 Observation 2 (Plates 3, 4, 5, 6, 7)

The likely position of both photos (Plates 3 and 4) is south-west (therefore photographer is looking NE) both are taken just off the modern harbour mole.

This skyline is considerably different from the previous comparison because a lot less can be identified and the viewscape itself is more limited. The building that catches the eye first and foremost is the white structure on the left hand side of the image behind which one can see two cupolas, also clearly identifiable. Just below these white structures on the left one can easily make out walls and to the left of these walls is what appears to be the façade of a building with twenty individual balconies. It should be noted here that these buildings appear uninhabited or rather, undergoing restoration works (as is it known that a large restoration project was undertaken in the area of Rione Terra) as is evidenced by the towering cranes on various parts of the promontory.

Plate 5 of this set is taken from more or less the same position but at a further distance and immediately the difference is noticeable and this is not only because more structures attract the viewers' eye. Even at this distance the white structures and the cupolas are still the most distinct elements as are the large retaining walls of the town. In this image another dominant feature is the modern harbour mole in the foreground. Another two smaller features catch the eye. These are the buildings painted red, both towards the left of the building. At the very back one can see peeking out from the building further to the right, a promontory and just above the cluster of modern buildings on the left-hand side of the image is a slither of landscape.

Plate 6 of this group of photos is taken directly in front of the seaward tip of the harbour mole. In this view the landscape is considerably more conspicuous both immediately left of the Rione Terra and to the right of Rione Terra the promontory of Coroglio and in front of which is the very distinct island of Nisida. Of the buildings from Rione Terra the ones that stand out the most (at least to my eye) will remain the white buildings with the Cupola and the building with the twenty individual balconies.

Plate 7 of this series is particularly interesting. It appears to be taken, in my view, from the right-hand side again at the extremity of the modern mole. In this image we can see the considerable extension of the town of Pozzuoli sprawling to the left of the promontory of the Rione Terra. In this view it is very difficult to identify any one particular building, perhaps because of the variety of colours that have been used indiscriminately. Having said that, the whole Rione Terra complex remains rather distinguishable from the modern town. This viewpoint also brings into further perspective the landscape that can now be seen in its entirety rising up just behind the modern town. The town now appears be sandwiched between the blackened harbour mole in the foreground and the gentle slopes (dotted with houses) of the background.

Plate 8 is a close up of the Rione Terra taken southwest (left of) the harbour mole. The highlighting of the buildings by the sun creates an interesting effect on the old buildings, creating shadows and at the same time clearly defining the angular blocks of the houses undergoing renovation. In this image even the white building with cupola only just manages to distinguish itself from the remainder of the built cluster.

2.4.3 Observation 3 (Plates 9 and 10)

These two images were put together because they present the town of Pozzuoli from a more distant viewpoint. The first image (plate 9) seems to have been taken just in front of the bay of Pozzuoli. Here we can identify a mixture if modern buildings and in what appears to be commonplace in Italian modern architecture, all in a variety of colours. The one building my eye falls on again is the white church with its silver dome and bell tower. These cluttered buildings are then topped once again by the rugged hills that lie just behind the port. Of particular interest if the promontory sticking out right in the middle of the image and is perhaps the images' highest point.

The second image (plate 10) is of singular use primarily because it depicts a considerable portion (but not all) of the town and gulf of Pozzuoli. Observing the wake in the centre of the picture, it seems safe to assume that this picture is taken from a boat, perhaps one heading to the Island of Procida. With Rione Terra now clearly identifiable to the left and the modern city taking up the rest of the photo. The most eye-catching elements of the modern buildings are those painted red and those painted white. No other colour (to me at least) draws my attention as much. Rione Terra's white building with cupola, standing out from the old buildings awaiting repair creates a stark contrast. On the horizon we again see a slither of landscape, greener towards the centre of the photo that on the right as the buildings seem to be encroaching inland. On the water to the right we have the small breakwater carefully concealing the sailing boats of which we can see only the masts. On the opposite side we have the imposing mole. Again, furthermost right is the promontory of Nisida rising from behind the harbour mole even if in reality it is quite a distance away.

2.4.4 Observation 4 (Plate 11 and 12)

These two images, despite being taken by different photographers, are similar in distance and we can see that they have been taken from either side of the Rione Terra. The first image (plate 11) is taken from the SE (photographer looking NW) of Rione Terra. Here we can almost make out the progress of the restoration project, with the right half of the old town's building cleaned and painted with earth colours and to the left side of the promontory, its grey structures, retaining walls and scaffolding jarring in between the promontory's rocks. The difference between old and new is quite striking. At the very end of the photo to the left one can make out the landscape that forms part of the Gulf of Pozzuoli. The green-topped hills sloping down towards the sea can easily be made out.

The second image in this group (plate 12) is taken from more or less the same distance (if perhaps a little further away) but SW of Rione Terra (photographer looking NE). Here, it is clear that this is the part of Rione Terra awaiting restoration. There are no colored buildings with the exception of a white building with a domed structure. The hollow windows and/or doorways suggest that these buildings are so far uninhabited. What is different in this case is the landscape. Here it is not merely seen as peeping out from one side of the Rione Terra but it acts as a well and true backdrop. These rugged edged slopes at least on this part of the bay are interspersed with modern buildings but these buildings do not detract from the imposing hinterland.

2.4.5 Observation 5 (Plate 13a and 13b)

The first image (plate 13a) of this miscellaneous set is labelled by the photographer Gulf of Pozzuoli but the point where it was taken from is a little ambiguous as is the height of the image. This looks like it is a photo of Monte Nuovo which dominates the coastline at this angle as is evidenced by how dwarfed the buildings seem in comparison.

In the second image this set (plate 13b) we have to first bear in mind that this image has been digitally enhanced in order to create the current effect. However it works well if we are trying to focus on the skyline of the Rione terra and part of Pozzuoli. This image is taken from a SW (photographer looking NE) direction left of the harbour mole. What I believe is highlighted here is the Rione terra, the silhouette of which is much more defined and compact than the modern buildings to its left. It therefore makes it more distinguishable despite the lack of colour and detail. Interestingly in this picture we can also clearly make out the landscape (seen in this picture in a lighter shade of blue-grey) just above the modern town that sits left of Rione Terra. Another detail that can be pinpointed (but has to be stressed that it was noticed only after looking at the image for a while) is the silhouettes of church domes, located more or less at the centre of the image. Three can easily be spotted here.

2.4.6 From observation to comparison (Plate 14)

This is an exercise that was undertaken quite by chance during the search of suitable images of the gulf of Pozzuoli. Whilst trying to identify a particular location on Google Earth© I decided to place the camera view in a location I was certain I had been. This was the Castello di Baia, where I had taken a series of photos, which were then stitched together at a later stage. As I was looking at both the computer image and the photo I had taken I began to realize that I was able to recognize certain features, particularly in the shapes of the peaks of Monte Nuovo and behind it the much larger Monte Gauro. In the photo one can also see further back the island of Nisida to the far left.

This comparative exercise (plate 14) is interesting because despite the obvious difference in colour, textures and overall feel of the landscape, I don't believe that the decrease in "reality" of the Google Earth© image affects the importance and impact of the key landscape features. Bearing in mind however that there is no three-dimensionality in the buildings of the Goggle Earth© image, which does make for a rather strange effect and it is harder in this case to understand the relationship between the built environment and the overall surrounding landscape, the latter of which is safe to say, is very dominant in the Gulf of Pozzuoli.

2.4.7 A textual reconstruction of the ancient landscape

If we had to try and imagine what this landscape may have looked like using the above data, we can imagine that the whole Campanian area must have appeared to be as vast as it was fertile. Morphologically, it was different to the landscape of today. We know that before the eruption of the Vesuvius there was another volcano in the same area and there was most certainly Mount Roccamorfina, for which no ancient name appears to exist. The Fumaroles of the Phlegraean fields and their related thermal activity were already very popular amongst the ancient Romans and they are likely to have also witnessed and observed some small scale volcanic explosions (Plinian and Sub Plinian) too. Monte Nuovo did not exist at the time and this means that Lake Lucrinus was much larger than it is today. It is also likely that there were more watercourses present and as already mentioned the Sarno River was also navigable (Veal 2009).

We also know that it was unlikely that the land began to subside in antiquity and if it did, it was too gradual to have any immediate or damaging effects. The coastline however was further out and was two to three metres above its current level. The sea level itself has remained relatively stable, as has the climate, which appears to have been very similar to todays, with wet winters and dry summers. Also relatively unchanged is the morphology and physiology of the plants. Robyn Veal presents a very interesting discussion about this in her thesis (Veal 2009) where it is safe to assume that apart from settlement development over the years and the geological events that took place, the actual environmental requirements of the flora of the area not much change would have taken place, especially when one considers that the climate itself did not undergo any drastic changes (See Veal 2009- Chapter two). An example of this are the trees that were cut down to make way for the *Portus Iulius* surrounded Lake Avernus (Gruger, Thulin et al. 2002). It was a human development that caused the short-term changes in the landscape rather than any environmental ones.

Lastly, Campania was famous for its agricultural land, its most famous farmland lying in the area of the volturnus valley as well as for of its vineyards, described by Pliny the Elder himself (*Naturalis Historiae*:14). Veal also highlights the discovery of centuriation lines (agricultural divisions) which suggests that a lot of the surrounding landscape was cultivated (See Veal 2009- Chapter two)) and classical sources tell us that one of the most thriving businesses in the area was the farming of oysters (mentioned by Horace *Sat.2.4.33* and Pliny the Elder *N.H. 32.60, 62*). The towns on the coast on the western caldera on the other hand survived on service economies rather than agriculture.

Going back to the imagined ancient landscape, we can visualize that it must have been in one way or another rather imposing, whether it was due to its volcanic phenomena or simply due to its fertile soils (a lot of which is still farmed today). It is possible to imagine the bustling port town by the coast cradled within a green cultivated hinterland and formed partly of agricultural land and vineyards, with the large lakes to the west of the town and with oyster cultivation sites not too far from them. The most interesting aspect of this textual reconstruction is that if one had to look back at the modern description of Pozzuoli's economies, one will find that apart from the modernization of building development, very little might have actually changed.

2.5 Conclusion, The implications of geography and history

2.5.1 To the study of Pozzuoli

These diverse geological features are what shaped the economic and political development of peninsular Italy, this much we know. However, what are the implications of this diversity, particularly to the development of the port of Pozzuoli? Whilst developing their empire, it would soon become clear that the Romans had to develop a flexible strategy that was capable of dealing with both the political and geographical configuration of the peninsula, this meant that there was no singular demographic pattern, no one agriculture or industry and no singular port infrastructure but a mosaic of patterns (Stoddart 2010: 118). This point, as highlighted by Stoddart will come to the fore in one of the later chapters of this project, when looking, albeit briefly, at how the Romans tried and tested their town planning (see chapter 5). The implications of this chapter on the study of Pozzuoli are such that they highlight how vital this knowledge is to our understanding of any singular aspect we wish to explore about the area, ranging from its geological phenomena, the position of its ancient remains or its modern population demographic as well as the presumed choices of modern day photographers on a chance trip along the Campanian coast. Everything is better understood within the context of the region's landscape.

2.5.2 To Roman port studies

This is most certainly not the first work related to port studies that takes into consideration the landscape surrounding a Roman port (see publications such on the ports of Portus and Alexandria for example). The implication of this chapter on Roman port studies simply reiterates the importance of this chapter (and so many others like it) to the understanding of the harbour structure itself and allows us a but a mere glimpse into elements that may have impacted on the decision of the port's location, its day-to-day functions and more importantly on those who made use of it.

2.5.3 To computer modelling in cultural heritage

The wider political and urban implications aside, looking at both the general and specific geography of Italy, the Bay of Naples, the Phlegraean Fields and Pozzuoli has more immediate implications on every stage of the project. One of the first lessons thought to the unsuspecting archaeology student is that in order to understand an ancient monument, one needs to understand the context within which this is found and that in order to understand the immediate environment, one must look at the wider landscape context, more so when the visual representation of a monument is being considered. The decision-making process that will be further described in chapter 7 and when addressing the landscape; every relevant geological and geographical point will be briefly revisited. It will come as no surprise that the awareness of the regions' diversity both formatively and geologically will inevitably impinge on the decisions and choices that are made during the data that is processed and the visualizations selected. Even the simple exercise of comparing images had the inevitable consequence that once I had identified the most prominent buildings on the Rione Terra promontory, my eye was now automatically biased towards certain buildings. How pertinent therefore is this consequence to the reliability of the photographic data collected?

Lastly, the image comparisons were also not without scope within this section. The exercise of observing these photographs has an important role, that of observing the modern landscape while thinking about the old. Which aspects of it have changed and which have stayed the same? Does the question of visual prominence in the modern photos bear any meaning when compared to what we perceive when thinking about the ancient landscape? Would the landscape features considered prominent today have also been prominent in the past? Would any buildings located on the Rione Terra promontory have the same impact as the modern day buildings with their lively colours?

3 Historical Paintings and Engravings of Pozzuoli

3.1 Introduction

The fascination with the Phlegraean fields was not only because it was surrounded by myth and mystery. The staggering beauty of its landscape and its rich therapeutic properties attracted both academic interest and made it a favourite spot for the social elite both during the Republic and the Empire. The remains that we have become familiar with are a result of the observations made by modern historians, geographers and archaeologists and the visual documentation that accompanies these studies is of a very particular format, which we have learnt to interpret and understand.

However of the many facets of Pozzuoli's history, one of them is that which its visitors make up. While we have very few representations of Pozzuoli's harbour from antiquity, a plethora of historical representations is available to us. The last part of this chapter will look at some of the 19th and 20th antiquarian paintings of Pozzuoli's landscape, carefully noting and describing relevant aspects of the representations particularly the artist's choices of representation such as what has been represented and how. These valuable resources will be able to tell us plenty about the visual impact the port and its landscape had on its visitors.

Despite the infinite possibilities of modern technology, the 16th and 17th century engravings and topographic maps are very precious to us, particularly with regards to the transformations that took place in the landscape of the Phlegraean fields. They are even more relevant to this project because they bring to our attention those parts of the landscape that must have caught the artists' eye and the consequent choices the artist made in his depiction of the site or individual monument. Bearing this idea in mind, the following section briefly describes a selection of topographic maps and panoramic views of the Phlegraean Fields with a focus on Pozzuoli.

3.1.2 Travelling to the Phlegraean Fields

According to a long-standing tradition that remained unchanged in the 16th and 18th Centuries, in order to visit the Phlegraean Fields one left from Naples, usually dedicating an entire day or more. Travellers either proceeded on horseback, with a carriage or sometimes even rented a boat, not to mention the inevitable long trail that had to be undertaken on foot (Horn-Oncken 1982: 68). It was possible to arrive to Baia by boat so that one could visit its ruins. Misenum was a little bit out of the way and was then followed by Cuma. Pozzuoli was usually visited in a second instance. Sometimes Pozzuoli was visited immediately after Baia and sometimes these routes were inverted, one went to Pozzuoli on horseback and then got the boat to Baia. All this was done with an expert guide of the area, often found in Hotels, by the cave of Posilipo or at Pozzuoli. (Horn-Oncken 1982: 68).

It was traditional of the *Grand Tour* to include a series of obligatory stops in Italy. After Rome, Naples and the Phlegraean fields were the travellers' favourite destinations. And following the eruption of Monte Nuovo in 1538, the Phlegraean fields aroused even more interest. Another element that attracted a lot of interest in this area was that landscape that acted as backdrop to ancient Roman life and the various important historical events. Here a learned person could see for himself the many places that he had become so familiar with at school and which he learnt about through the works of ancient Latin authors and poets (Horn-Oncken 1982: 71).

Of the many publications that were produced between the 17th and 18th century, we find that there are two principal categories; on the one hand we find the descriptions in general works about history, geography and the beauty of Italy and in particular Campania. In this group we can also include a series of manuals and local guidebooks (Horn-Oncken 1982: 75). This led to a series of literature and illustrations highlighting the principal sites for travellers to the area (Miniero 1995: 11). It was this enthusiasm that sparked an interest in cartography. From about the 1500s to the mid-1700s these initially consisted of perspective projections of places and monuments followed by panoramic views. The latter were usually recorded from high a vantage point and sought to include as much of the view as possible often by depicting the landscape in a bird's eye view (DeCaro 2002: 51). The most popular locations in the Phlegraean Fields for capturing the best views were Mount Posilipo, the Camaldoli hills, the hill of San Gennaro in Pozzuoli, Monte Guaro, Monte Nuovo and Rocca di Cuma (Plate 15) (Miniero 1995: 11).

On the other hand we have (in larger numbers) personal diaries and memoirs, which describe more accurately, the experiences and the personal attitudes of the author. Added to this literary material we can also add the body of illustrations, which represents a very large volume of work. It is amazing to see how many people have written about Campania (Horn Oncken 1982: 76). On of the first monographs we find is called "*Antichita di Pozzuoli*" by Ferrante Loffredo that was published in 1570. This was one of the first examples of a description that started from Pozzuoli stopped briefly at Solfatara, Lake Avernus and *Grotta della Sibilla* and the ruins of Misenum and Cumae. Following the work of Loffredo, are the works called "*Ager Naepoletanus*" by Turler who outlines a full itinerary of curiosities to see. Following these authors are various others, such as the book named "*Sito*" by Mazzella and "*Puteolana Historia*" by Capaccio who also produced a book called "*Antichita di Pozzuoli*". It was around this time that the era of great travels started in Campania (Horn-Onken 1982: 78-9).

Despite this wealth of literature, one must be aware that it is hard to find original texts because given the volume of these texts, it seems that these included a lot of re-prints, translations, re-writing and sometimes just the use of same text with a new name. All this seems to have been generated in order to supply what was becoming an insatiable demand for this kind of literature (Horn-Oncken 1982: 81-2).

3.1.3 Overview of the Artists

Another source that is essential for us to understand the attitude of the antiquarian traveller/tourist at the time, is the illustrative material that heavily influenced the travelling tradition. To begin with, we have the maps. These were essentially numbered catalogues and were perhaps one of the principal sources of information and the level of which can be identified simply by the skill in execution and accuracy of the data they represented. A series of conventional symbols were used throughout these maps and plans, such as domed structures to represent thermal complexes and rectangular buildings that denoted ancient villas. Added to these maps and plans are the panoramic views of the Gulf of Naples usually painted, as we have seen, from a high vantage point.

One of the oldest examples of these landscapes is a view that depicts the eruption of Monte Nuovo in 1538. This is perhaps one of the first etchings that start at the end of the 16th C that accompanied many of the Italian monographs. The things to visit were often indicated using symbols that were as simple and as they were imaginary. Even the ample panoramic views, which were drawn using an as the crow flies view and acted as a backdrop to many monuments; they too are not easily distinguished from the cartographic representations.

The work by Brain and Hogenberg, is a classic in this field that attests the areas' rising interest in foreign countries. To the wealth of illustrations in this work, the artist Hoefnagel contributed greatly. He stayed in Naples in 1578 (Horn-Oncken 1982: 85). 30 years after the works of Braun Hogenberg we find the incisions of Edigius Sadler, an album with seven tablets, each with a short text in which we find the most famous monuments of the areas as well as evocative images of ruins which are drawn in close ups and which are surrounded by landscape, sprinkled with groups of tourists on horseback and boats berthed on the shore (Horn-Oncken 1982: 88). These kinds of paintings are then superseded, perhaps only in monumentality rather than originality, by the views of Jan Blaeu. At the same time there are a series of works put together by Paolo Piertirnin at the beginning of the 17th C. that are merely copies of Sadler's engravings, changing them only slightly by altering the clothing of the figures in the picture so as to match the fashion of the time. Any traveller of the 1700s that needed to refresh his memory, simply turned back to the painting of the 1600s or earlier that he was able to identify with and simply added contemporary details as those mentioned above (Horn-Oncken 1982: 97).

We must therefore return to the views that were depicted by Braun Hogenberg. It is these that remain the principal source of illustrations that many guide books used for their texts. What in fact happened was that a lot of works were actually copied, the best works were copied with simple additions of people or animals or changing the clothes to match the current fashion in an attempt to make the painting authentic and modern but which in reality was not. The subjects depicted remain essentially the same. They are the Pozzuoli, Baia, Lake Avernus, the promontory of Misenum, Cuma and the volcanic phenomena of Solfatara. The remains were the temple of Venus in Baia, and others chosen based on their state of conservation and on how impressive they were believed to be and on the historical interest at the time such as Virgil's tomb. In fact the viewer is less concerned with reality than with the presence of a number of elements which they felt had a strong evocative force. This is very relevant point for here we can plainly see the deliberate choices being made by these artists of elements they believed at the time to be evocative and relevant to the contemporary viewer of the painting. In all of this material it is very rare to find material that is a proper documentation that reproduces a monument faithfully in its actual location. It is also rare to find works of high artistic competence (Horn-Oncken 1982: 99).

One would expect that as a result of the role played by foreign artists and designers that stayed in Italy, there would be many traces of their presence. However, up until the beginning of the 18th C. we find very few names especially when compared to contemporary paintings of Rome. A large part of the Campanian landscape depictions are mostly panoramic views with monuments seen in background.

The first foreign artists of which we know of is the Portuguese Francisco de Hollanda who arrived in Naples in 1540 and who drew the entrance of the *Crypta Neapolitana*, the panorama of the gulf of Pozzuoli and the crater of Monte Nuovo, which he painted as evidence of the eruption that had taken place just two years before, (Horn-Oncken 1982: 103). We also know of Pieter Brugel who drew a panoramic view of Naples while travelling in 1552 throughout all of Italian peninsula and down to Sicily. We also know of two sketches in 1550's executed by Hendrik Van Cleve, one representing the gulf as seen from *Monte Nuovo* and the other the *Thermae* of Pozzuoli and to so-called *Tempio di Nettuno*. It seems that after Hoefnagel in the 1580s, the artist Paul Bril stayed in the Phlegraean fields to finish his drawings and at the same time a young man from Antwerp named Wnzel Coberger was also carrying out his own work(Horn-Oncken 1982: 103-105). In 1590 we know of a certain Jan Breuger the elder, who eventually provided Sadeler with the models for his Campanian series.

What this brief overview highlights is what an attraction this area was to the Flemish artists in the years just before and immediately after the 1600s. Another element to consider is the seemingly insatiable need for visitors to have illustrations of the region even if the artists themselves eventually lost interest in the area. More importantly is the consideration of the influence that the works of some of these Flemish artists had on the image that was projected (at least in Northern Europe) of Phlegraean fields; an image that remained unchanged up until the 1700s. Again, we see once more that many of these drawings, simply underwent certain transformations. Some were either retouched in a second instance or other artists executed the copies that were needed. These works were sometimes also used to train young artists and were therefore utilized in many ways. So unfortunately, the result of all this was that in some cases we are presented with imaginary landscapes were the temple of Baia had been moved to Rome or the temple of Apollo instead of being on Lake Avernus was transplanted in a Northern forest. Many other characteristics, most notably early errors, remained unchanged and continued to be re-printed in many publications for centuries (Horn-Oncken 1982: 107).

3.1.4 Overview of the Authors

So who were these travellers up until the 18th century? Aside from the artists mentioned in the previous pages, another source of valuable information accessible to us are the authors of the diaries. These were written based on notes taken during their travels and were an essential item for every traveller worth his salt. These descriptions have helped researchers come into contact with a number of historical personalities. The authors of these diaries rarely travelled alone and one often found that they travelled with friends or family or that they meet people from their country or their peers along the way, it is not uncommon that in Campania there was a whole bevy of people that travellers got to know during their journey. Of course all these acquaintances were members of the more privileged classes but that is not to say that they were in any way homogenous (Horn-Oncken 1982: 113). Some of the more popular works that have come to us owe their notoriety to the scientific interest of their authors and were originally not meant for publication at all, they were simply personal memoirs. Some of the travel notes that distinguish themselves from the masses of literature are those by Thomas Hoby and John Evelyn who describe their travels in Campania within the context of their autobiographies, as did Montesquie, De Brosses and Johann Caspar Goethe. All these works were published many years following the death of their authors (Horn-Oncken 1982: 113). One can only imagine how many more travel journals lie unexplored in today's archives and personal libraries.

Let us take a closer look at some of these foreign visitors who studied the areas of Baia and Pozzuoli with such keen interest. The first person we meet is the German Dietrich von Niem, who describes with great vivacity his visit in 1404 that was part of a thermal cure for a high-ranking cleric. Following this, in the 16th C. we find Johann Fichard of Frankfurt, a commander of the imperial army based in the north of Italy who takes advantage of his assignment to undertake a long study journey that started in Campania in 1536. He leaves us with a wonderful diary full of enthusiastic descriptions of the many ancient ruins he encountered. Half a generation later, we find a young Englishman Tomas Hoby, a translator, who after visiting Campania travelled by himself on horseback all the way down to Calabria and Sicily. The antiquarian Stefanus Vinandus Phigius also stayed in Naples during this time (Horn-Omcken 1982:114).

Next come the French, with authors such as Jaques de Villamont and his detailed description of Campania, which is often cited by visitors who followed in his footsteps in subsequent years. He stops in the Phlegraean area on his way to the Holy Land. The same situation occurs 20 years later where we find Nicolas Bernard who on his way back from the east decided to stop in Naples and whose opinion on the area was very much inspired by Villamont. In the 1600s Italy sees numerous travellers, such as the Duke of Rohan, Jean Antione Rigaud, even the Bourbon Prince Henri de Conde (Horn-Oncken 1982:115). In the second half of the 16th century, we find people like Grangier de Liverdis and the Marquis of Seignelay, son of Colbert. In 1707, we find a certain De Blainville, a diplomat at the service of Holland and England and who in his diary gives us ample insight of the state of knowledge of his time. More concise in their writings are the travellers such as Mottraye and the very humorous Pierre Labat. These authors bring us to the 18th C, where we also see writings by Guyot de Merville and Montesqiue.

The English also contributed greatly to the historical tradition of travel writing. Before the 1600s we find Fynes Moryson of Cambridge who having finished his studies, undertook a journey of about 10 years that took him all the way to Palestine. In the course of his journey he touched upon Campania with the idea to visit the Phlegraean Fields and after proceeded to Naples (Horn-Oncken 1982: 116). A little later another Englishman who stops in Naples on this way to the orient is the poet Geogre Sandys. We also find travellers such as John Ray, who completed his travel descriptions with a plant catalogue (Horn-Oncken 1982: 116). In the 1620 we see another two English authors on Campanian soil. A certain Wright who walks around carrying a copy of Virgil in his pockets and Breval who gives us a short list of noteworthy things to see coupled with a detailed annotation (Horn-Oncken 1982: 117).

From a contextual point of view and with some exceptions notably due to level of details as well as gaps in the knowledge, most of the descriptions by these travellers are rather uniform in style and systematic in their approach. This should not come as a complete surprise when we bear in mind that the itinerary they followed was subjected to very little variation over time due to the institutionalization of the so called "Ciceros" (local guides) and the indications by the guide books.

What is however curious at this point is the lack of originality in the way the Campanian descriptions were penned. This is peculiar because the authors were supposed to be authentic eyewitnesses (something that some artists were not, as we have seen above) so one would not expect to find the same systematic descriptions that we find in structured literature. This is also strange because it appears that all the travellers followed the same travel itinerary. There appears to have been no questioning whether this suited their interests or otherwise. Furthermore, when looking at the descriptions we see that the volcanic phenomena, the study of ancient ruins and the copying of inscriptions can be found in every text; every diary recalls events that happened many years before. Many also hint at various famous literary figures, they quote verses by poets and of course they never tire of repeating anecdotes and ancient myths, even though the authors themselves are very well aware that they themselves no longer believe in them (Horn-Oncken 1982: 122).

Undoubtedly, some authors wrote better than others. Others were willing to put forward their opinions while some simply enjoyed collecting large volumes cultural information and attitudes, some of them transcribed what their guides or previous travellers said, especially if they spoke the same language. Some authors however wrote because they were struck by the volcanic phenomena, some were in awe of the ancient ruins and more importantly some of them wrote because they were interested in the human experience (Horn-Oncken 1982: 123).

So to sum up, at the beginning of the era of travelling, what originally fascinated the visitors were the strange volcanic phenomena and thermal springs. Little by little we begin to see the legends and the landscape and historical context and finally, in the travel diaries and guidebooks we begin to see the inclusion of literary sources and facts that start to be cross-referenced. In the last years if the 17th C. some new characteristics emerge. Authors begin to use scientific criteria and there are new interests in geology and archaeology, which we can see seeping into their writing. Their notes become more concise and this denotes a change of ideas on how a place should be visited, studied and experienced and how to describe the relevant itineraries. This idea the travellers once had of the landscape being imbued with symbolic significance and full of tradition disappears and the value of symbols and old tales now gives way to a new type of consciousness, a new reality- one which we can see with our own eyes. Of course we lose one dimension but this the start of the first scientific debates and we see an increasing tendency towards critical judgments following the observation of the object. This lead to a new type of literature (Horn-Oncken 1982: 124).

3.2 The Paintings

The first topographic maps of the Phlegraean fields date back to the 16th century and were the works of Flemish engravers. There were mainly two formats; the first are the type of engravings such as those by the artist G Hoefnagel (Cologne 1572-1598) for the *Civitates Orbis Terrarum* by G. Braun. These consisted of painting the landscape with very little information about any specific sites (Plate 16). The second format is that by the Dutchman N. Van Aelst (1527-1612) and is a true topographic map despite its figurative nature (Plate 17). His work was emulated by many of his successors such as Mario Cartaro for his work *Ager Puteolanus* (Rome 1584) (DeCaro 2002: 51; Valeri 2005: 34) (Plate 18). This type of cartographic representation made use of a set of drawing conventions that were used for the representation of some of the monuments. Thermal complexes were drawn as domed or gabled structures and Roman villas were depicted as rectangular spaces symbolising the peristyles with a monumental entrance. An example of this is the depiction of Cicero's villa in the work of Francesco Villamena's *Ager Puteolanus* (Plate 19) (Miniero 1995: 12).

This type of documentation continued to be used up until the second half of the 18th century, whereupon a new scientific interest was being developed towards the Phlegraean Fields, particularly geology and volcanology. As a result the cartography became less figurative and more technical, an example of which is the *Agro Neapoletano* published in 1793 (Plate 20). In the centuries that followed these regional maps evolved into a collection of regional atlases, all drawn geometrically and to scale. The first coloured maps then followed. This change in interest aims and scope of cartographers has not stopped, bringing us up to the aerial photogrammetry and satellite photography that we have become so accustomed to (Miniero 1995: 12).

3.2.1 Flemish Artists

> *Nullus in orbe locus praelucet amoenis Baiis*
> G. Hoefnagel (engraving) – (Plate 21).

Dating to 1580 this is perhaps the oldest artistic view of the entire gulf of Pozzuoli despite the artists' interests lying with Baiae. Pozzuoli is represented as a fortified city dominated at its peak by the *Capitolium* (now part of the 10th C. church), which is portrayed at an angle in order to highlight the original Roman columns (Miniero 1995: 21-22).

> *Explicatio aliquot locorum quae Puteolis spectantur*
> N. Van Aelst (Plate 22).

This engraving was executed in 1580 and is considered to be the first topographic map of the Phlegraean territory as its depiction spans from the *Promontorium Pausilipi* to the *Promontorium Miseni* and the *Palus Partiae*. It uses a mixture of topographic views and perspective projection when depicting the buildings and the promontories. This engraving is of particular archaeological significance because despite the small size of the engraving (38cm x 51cm), the artist was able to correctly identify and position accurately the ancient monuments. Pozzuoli is in fact depicted with its main monuments and road networks (Miniero 1995: 13).

At the centre of the engraving we can see the *Templum Iovis* (the *Capitolium* or so called Temple of Augustus) on top of the Rione Terra and from which we can see a road, the path of which snakes under a door or a monumental arch. This suggests that there may have been connection between the acropolis and its hinterland already in the 2nd C. B.C. This road then forks into two directions; towards the east, that just past the *Coliseum* (also noted in the engraving) corresponds to the *Via Puteus* (the *Via Pueteolis-Neapolim*), which is the modern day via Vigne. The second road travels westwards and is eventually joined to the *Via Capuana* (the *Via Consularis Puteolis-Capuam*), which is the modern day Via Celle (Miniero 1995: 13). Van Aelst's topographic map became the model for all subsequent topographic maps in the following century as evidenced by the work of Jacobo Lauro *Topographia Puteolorum* (1626), which is practically identical (Plate 23).

3.2.3 French Academy Artists

> *Carte du Golf de Pouzzoles avec une partie des Champs Plégréens dans la Terre de Labour*
> F.e Pietro de la Vega (drawing) Perrier e Drouet (engraving) – (Plate 24).

This map is included in the *Voyages Pittoresque ou description des Royaumes de Naples et de Sicile* by J.C. Richard abbè of Saint-Non and dates to 1782. The artists were military engineers belonging to the Bourbon crown, one of which was Pietro La Vega who signed off many plans of the archaeological excavations that took place in Stabiae in the years between 1749 and 1782 (Miniero 1995: 16; Pagano 1997). It highlights in some great detail the watercourses of the territory using stippling and *chiaroscuro* technique. It also highlights the thermal spring and the archaeological remains. More importantly, is the correct location of the *Portus Iulius* since previous maps would mistakenly place the remains on the Misenum shoreline (Miniero 1995: 16).

Amphithèatre de Pozzuol
Des Moulin (engraving), Varin (drawing) (etching) – (Plate 25).

This painting was also published in the *Voyages Pittoresque…* of 1782. It illustrates part of the exterior of the amphitheatre using a rather classical style that was typical of the artists from the French Academy that often depicted the monuments with a scene from everyday life, such as that which we see unfolding in between the arches of the amphitheatre. All three tiers of the amphitheatre are depicted together with part of the external portico, part of which is covered by vegetation (Miniero 1995: 23).

3.2.4 HAMILTON'S *CAMPI PHLEGRAEI*

Sir William Hamilton was the British envoy to the Bourbon court at the capital of the Kingdom of the two Sicilies for more than three decades. Given his official status and well versed in the culture of the Grand tour, he went on to become one of the principal promoters of Campania's many natural and archaeological treasures (DeCaro 2002: 39). He played a major role in the formation of British neoclassical tastes and the dissemination of knowledge of antiquities not only because of the active role he exercised in the formation of British collections but also because of his lavish publications of his own collection of Greek vases (Nolta 1997: 108).

The publication of *Campi Phlegraei: Observations on the Volcanos of the two Sicilies* was a collection of his scientific observations on the nature of volcanoes. Undoubtedly, the gulf of Naples and the Sicilian coast offered an abundance of examples. This magnificent volume was printed in Naples, and its hand painted engravings were executed by Pietro Fabris, who was not particularly famous but was nonetheless commissioned by Hamilton because he was an accurate landscape artist (DeCaro 2002: 39).

Vesuvius is the main protagonist, in the majority of the representations, however many of the paintings are dedicated to different areas of the Phlegraean Fields and its ancient monuments such as the Posilipo Grotto, the Solfatara crater and the Avernus lake. The images of Pozzuoli will be described in further detail below.

Veduta di Pozzuoli da oriente
P. Fabris (copper outline and watercolour) – (Plate 26).

This view represents plate xxiv of the *Campi Phlegraei* by Sir William Hamilton, which dates to 1776. It is drawn from above Bagnoli and depicts Hamilton himself as he indicates the various points of interest to his travelling companion. Each of these points is illustrated and numbered in every image of Hamilton's work. Pozzuoli, with its ever-present Rione Terra promontory can be seen in the distance, whilst the foreground consists of the coastal strip and village of Bagnolli (Miniero 1995:22)

Veduta presa da sopra Pozzuoli
P. Fabris (copper outline and watercolour) – (Plate 27).

This view is plate xxvi of Hamilton's work and it is taken from the height of the Cigliano crater, with a view on the gulf of Pozzuoli that makes up the focus of the image. Just left of the observer's view we can see the *Macellum* with its characteristic three columns and in a secondary view is the Rione Terra with the remains of the Roman mole. These monuments are set on a background with Monte Nuovo and a series of other hills behind it (Miniero 1995: 22).

3.2.5 Morghen's "*raccolta*"

Veduta degli avanzi di tredici pile dell'antico porto di Pozzuoli
Ph. Morghen (engraving) – (Plate 28).

This image forms part of a collection called *"raccolta"* by Filippo Morghen dating to 1769. It depicts a close up view of the port with great attention paid to the architectural detail of the Roman *pilae*. In the background we can see the entire profile of the coast up until Misenum (Miniero 1995: 22).

Veduta dell' Antico Tempio Pseudoperittero che è in Pozzuoli
Ph. Morghen (engraving) – (Plate 29).

This engraving, which dates back to 1766, is perhaps the best reconstruction of the temple at the time. While we are now well aware of the temple's fate, this image is of particular interest because it highlights Morghen's scientific rigour whereby he lists in the legend all the historical and archaeological references related to the monument (Miniero 1995: 23).

Veduta a Ponente degli avanzi di un insigne edificio in Pozzuoli da molti creduto il Tempio di Serapide…
F. Morghen (engraving) – (Plate 30).

This view, dating to 1797 is the perfect example of how, by the end of the 18th century artists were able to blend the study of an archaeological monument, seen here represented in an axonometric view (with all its elements recorded in the legend below) with a hint of realistic scenery. In this image the floor of the monument is not yet covered with water as is seen in the paintings dating to the 1800s and neither is the apsidal exedra on the eastern end of the building depicted as it was still interred (Miniero 1995: 24).

3.2.6 OTHER PAINTINGS OF NOTE

Veduta di Pozzuoli presa dal monte nuovo
Ph. Hackert, W.F. Gmelin (engraving) – (Plate 31).

In this painting dating to about 1787, Hackert with great artistic skill balances the two aspects of the Phlegraean landscape; its hillsides, where we see shepherds herding their flocks and its coastline, represented by the gulf of Pozzuoli with the unmistakable *pilae* of the Roman mole (Miniero 1995: 24)

Leafing through these beautiful and highly skilled representations it is easy to understand why so many scholars and artists were fascinated by the landscape of the Phlegraean Fields. Its geological and archaeological diversity was such that it was reproduced in meticulous detail. The first thing these paintings and engravings do, thanks to their depictions of lush green areas and arable land, is remind us that we have become all too familiar with the crowded and far less glamorous built up areas of Pozzuoli. These images provide valuable information about the landscape changes that have occurred over various periods of time.

Looking again at the selection of cartographic maps and landscape views, some aspects of Pozzuoli are clearly ubiquitous. That is the Rione Terra promontory, the *Capitolium* (despite being in Church form) and the monumental mole. There is no denying that every artist has taken a great deal of care in depicting, labelling and describing it in their legends. If one had to deduce what the most memorable elements of the port of Pozzuoli were, it would be these three. One might argue that the early cartographers simply followed or copied their predecessors. This may well be the case but even looking at this small sample that spans so many years, we still find the Rione Terra promontory, *Capitolium* and mole present executed by different artists at different points in time and from different vantage points. They cannot all have copied.

Perhaps it is therefore not surprising that we see very little of the other archaeological monuments that we know are scattered around Pozzuoli. Van Aelst's and Lauro's cartographic maps draw and label the amphitheatre (*coliseum*) and Fabris in one of his views includes the *Macellum* within the landscape painting. Most other artists tended to depict the known monuments individually, most likely to dedicate the appropriate amount of detail and attention needed to such treasures and because they may have not been as visible within the overall landscape. It would be interesting to find out whether the inclusion of the amphitheatre in the cartographic maps was the result of the cartographer's overall view of the landscape or of his implicit knowledge of it.

3.3 Conclusion: The implications of these representations

3.3.1 To the study of Pozzuoli

This overview merely scratches the surface of what could potentially be a separate project altogether and in no way is it meant to be an exhaustive study on the historical representations of the area however they do help with the scope of anyone aiming at a reconstruction (be it visual or otherwise) of the place in question. The implication of this chapter however is to highlight that there is indeed a whole other dimension to the study of the monuments of Pozzuoli: that from a historical artist’s view. A view, which as we have seen and which Horn-Onken has pointed out to us has, many more layers or ‘traps’ than originally assumed. The authors referenced in this chapter have addressed these representations from two different angles. Miniero does so in the context of the development of cartography and map making. Horn-Onken gives an interesting overview of the main works of the various travellers and more importantly makes some interesting observations about the nature of their works whether literary or artistic.

3.3.2 To Roman port studies

As with the work undertaken in Chapter two, this is most certainly not the first study of a port that draws upon the work of historical artists and travellers in order to understand things such as the position of the certain monuments, the interpretation of remains or the surrounding landscape. This section further strengthens the argument that this type of data is important to the overall understanding of the area one wishes to explore even with all the inaccuracies. Without these, questions would be harder to ask and discoveries harder to be made. See in the above text the example of the authors who followed the same itinerary for decades without question.

3.3.3 To Computer modelling in Cultural Heritage

The implications are not so much for computer modelling but rather for an understanding of the importance of visual representation and how these affect the viewer. These points all impinge on the person undertaking the modelling, just as we have seen how the replicating of certain images affected not only the artists but also the tourists' itineraries. Moreover, what was the effect of a misrepresented or misplaced monument? Did this affect the collective image? Did this affect the quality work of the artists as implied by Horn Onken?

With regards to the projects' modelling and decision-making process this chapter helps in two ways. First it highlights what parts of Pozzuoli were considered visually prominent (despite the copies) and secondly, it acts as a cautionary note about the accuracy of what is being represented and the quality of the work being used. It even presents the researcher with important choices about whether there is any tangible benefit or otherwise in using these representations as part of the reconstructions. It is however well within the remit of the person carrying out the reconstruction to propose or implement the appropriate criteria for assessing accuracy issues.

In fact, this chapter proved to be particularly interesting not only to the abovementioned point but also in light of the source assessment exercise as described by Pletinckx in his chapter entitled *How to make sustainable visualizations of the past* in Bentowska and Denard (eds). Much like his example of the iconography of the city of Verona where two well-known sources have survived, (one of which seems to provide valid and useful details, the other known to be inaccurate (Pletinckx 2012: 208) it is increasingly clear that while the first plans of Pozzuoli provide useful and relevant information, a large number of the engravings that followed can now be easily identified as inaccurate given that in some cases, the artists themselves never visited the area.

This fact also links quite pertinently to the idea of source correlation and consistency checking between sources that contain the same details or in some cases different versions of a certain source (Pletinckx 2012: 210). The iconography of Pozzuoli was examined and compared and it was soon evident that despite the minor differences, the most reliable version identified is likely to be the oldest as predicted by Pletinckx (2012: 210).

In the case of the Iconography of Verona, both sources were recorded by Pletinckx nonetheless in order to help other researchers with any future assessments and so too were all the (known) versions of the iconography of Pozzuoli. The identification of the unreliability of these sources is a valid an important exercise in itself as is the study of the information surrounding the creators and context of the sources and the artistic conventions of the time, all of which have considerable bearing not only the assessment of the document but also on its interpretation as a reliable source during the reconstruction/ visualization process and (Pletinckx 2012: 210). In sum what we initially imagine to be a useful and relevant resource turns out to be, upon careful assessment, rather unreliable for decision-making.

4 The Archaeology and History of Pozzuoli

4.1 Introduction

The archaeology of Pozzuoli has long attracted interest both in the distant and more recent pasts and is still thoroughly being researched today. The columns of the *Macellum*, for a long time mistakenly labelled the Temple of Serapis, caught the attention of many travellers, scholars and geographers alike (Christoph Mohrange 2002: 368) and whilst this particular monument was to become an historic symbol for the study of Bradyseism in the area, other archaeological remains began to draw the attention of archaeologists and classical historians from all over the world. Yet, Pozzuoli's role as a port is generally understated in the literature, at least when compared to the ports of Portus and Ostia, with the exception of Martin Frederiksen who placed a lot of emphasis on Pozzuoli's commercial and political importance. Similarly it also appears understated as a town when compared to its neighbours Pompeii and Herculaneum. With a second more scrupulous glance at what is indeed a substantial body of research on Pozzuoli, we can further appreciate what was at the height of its success, considered to be the second most successful city after Rome (Frederiksen 1984: 337). This discussion, like that in Chapter 2 forms part of the textual rather than the visual reconstructions of Pozzuoli. However the knowledge of these aspects helps make visualisations more meaningful to the reader/viewer that they otherwise would be.

Familiarity with the site's history and archaeology is not just important when considering digital and textual reconstructions. The following description will not limit itself to just the main monuments but will also look at some of the functional port buildings. This is an interesting and necessary exercise because in practical terms, it helps identify the type and amount of data that is available for these remains. Second of all, it is imperative towards the understanding of the various forces that exerted themselves throughout the area and shaped the city not only physically (monuments) but also economically, politically and culturally.

There appear to be varying degrees of information for each monument or groups of monuments in Pozzuoli, more so for the underwater remains. This in turn will impact on the information available for the reconstructions and any subsequent decision-making with regards to the modelling of the lesser-known buildings. A noteworthy example of which are the ancient port’s warehouses located underwater. While it is easy to identify the foundations, very little can be said of what the standing building may have looked like. The same can be said about the surrounding buildings. Conversely, the mole as recorded by Dubois was executed in enough detail to provide an elevation from which an extrapolation for a simple three-dimensional model could be made.

In an attempt to avoid long lists of classical authors, monuments and potentially tedious descriptions, the chapter is divided thematically. The first section is a brief overview of Pozzuoli’s historical background that also takes into consideration the economic and political elements. The second section is a description of the main public monuments, which are by far the most researched. A third group of remains that shall be described are those belonging to the port and harbour facilities, large parts of which are now underwater. Lastly, the research on Pozzuoli’s town plan that has been particularly difficult to understand and as it is still currently being investigated, will be described prior to some concluding remarks.

4.2 Pozzuoli's Historical Background

4.2.1 The early settlements

Both the literary and archaeological evidence for the pre-Roman foundations of *Puteoli*, are regrettably scant. We know nothing of the area prior to the Greek colonisation of 530 BC, with the exception of a solitary pottery shard dating back to the 7th C. suggesting that the harbour attracted interest before the first known settlement (See also A de Franciscis RAAN 46, 1971: 100-14). The first historical reference we find to the Greek *Dichearchia* is in a late antique source known as the *Chronicon* of St Jerome who writes that the Samians founded *Dichearchia* that is now known as *Puteoli* (Zevi 1993: 11).

The *Chronicon* of St Jerome dates the founding of *Dichearchia* around 530 BC headed by a group of Samian political exiles, who fled from the tyrant Polycrates following his accession to power and who were most likely welcomed by fellow aristocrats that controlled the Cuman territory at the time, which according to Frederiksen extended well into what is now Pozzuoli (Adinolfi 1977: 19; Frederiksen 1984: 87; Zevi 1993: 11). Symptomatic of the events that led to its foundation, the name *Dichearchia* signified a place where justice ruled (Greco 2006: 179). It seems that the settlement was never a *polis* in its own right (Zevi 1993: 12) but simply a base that was controlled by Cumae and consequently must have been involved to some degree with the events of the city, including clashes with the Etruscan tribes that took place in 524, 505 and 474 BC respectively. Unfortunately, the prosperity of Cumae and consequently that of *Dichearchia*, was brought to an end after being conquered by the Samnites in 421 BC as recorded by Livy (Livy 4.44.12).

4.2.2 *Puteoli* during the Second Punic War

We remain sadly ignorant of the settlement's history following the Samnitic invasion and it is not until the 2nd Punic War that Pozzuoli is mentioned once again. Strabo tells us how the Romans discovered Dichearchia's strategic importance during these events (Strabo 5. 4.6). Despite there being other ports in the Campanian region that were more developed and better connected politically to Rome (Marasco 1988: 207), the Romans increasingly began to make use of *Puteoli* as a port so much so that Livy (Livy 24.7.10) describes the following event:

[...] *At the end of that year Quintus Fabius by the authority of the senate fortified and garrisoned Puteoli, which as a commercial centre had grown in population during the war.* [...]

Pozzuoli's (Figure 14a) rise to fame during the second Punic war may have had to do with the fact that Syracuse was no longer a Roman ally, thus denying the Roman army supplies from the Sicilian granaries. Pozzuoli would have had to be fortified in order to receive the diverted the supplies from Sardinia that were needed to reach the troops stationed in Campania (Marasco 1988: 209, 212; Zevi 1993:13). However, the ports of Cumae and Naples had always remained faithful to Rome and were perfectly equipped to receive the provisions needed implying that Pozzuoli must have offered more strategic and political advantages than anything else (Marasco 1988:209).

In 216 BC, Capua rebelled in favour of Hannibal, who had invaded Italy two years before, followed closely by Atella and Calatia. His crushing defeat inflicted on the Romans at Cannae had enabled him in the following weeks, to gain the towns of Apulia, the tribes of Samnium, the Lucanians and the Bruttians (Frederiksen 1984:238) and even in the cities that were still under Roman control, a large part of the inhabitants initially favoured the Carthaginians (Lanzenby 1978:90; Marasco 1988:210). During the course of the war, it became clear that Hannibal's political ability in exploiting the masses' discontent with Rome's rule had been underestimated by the Romans, who now found themselves on the verge of losing many of the Campanian regions they controlled.

Capua remained in revolt for five years and during this time supplied Hannibal with valuable provisions and industrial wealth (Frederiksen 1984:241; Marasco 1988:210). From here onwards, Hannibal made numerous attempts to gain control of a seaport in order to communicate efficiently with Carthage (Livy 23, 15-10; 15, 1). In 215 BC he attempted to gain control of Cumae. He twice tried to gain control of Naples and pressed on with devastating expeditions on the lands of Cumae and Naples with a final attempt made on Nola, that also proved unsuccessful (Livy 24, 13,6 and 17, 1-8). The reason Hannibal failed to gain on Campanian territory was largely due to the Roman garrisons stationed in Naples, *Puteoli* and *Volturnum* with a strong covering force stationed at the *Castra Claudiana* above Suessula (Frederiksen 1984:242; Marasco 1988:208).

Despite the careful maintenance of the Roman garrisons, it seems that at first both Naples and Cumae were under Hannibal's direct scrutiny, thus discouraging the Romans from storing any of their supplies there. In this instance, Pozzuoli's advantageous position was that is was less exposed to Hannibal's attacks as well as being easier to defend, located as it was on high ground (Strabo 5, 4, 6), presumably referring to the knoll of high ground is what is now known as the area of Rione Terra (Dubois 1907; Castagnoli 1976; Marasco 1988). Unlike many of the Campanian towns, the local population was sparse with the majority of *Puteoli*'s inhabitants made up of foreign merchants. The Roman garrison of 6,000 men that was sent in 214 BC was more than enough to secure the town's defenses (Livy 24, 13, 7) and a subsequent unsuccessful attack by Hannibal on Pozzuoli that same year was testament to her increasing importance (Livy 24, 12, 4; 13, 6).

By 212 BC the tide was beginning to turn and the initial enthusiasm with which the Campanian cities had taken up the Carthaginian cause was now beginning to falter and 211 BC Capua was eventually captured by

Rome. During this year Pozzuoli was used to send troops to Spain and her now established importance is further confirmed by the arrival of Carthaginian officials in 203 BC, who landed at Pozzuoli in order to continue their journey towards Rome (Marasco 1988:213).

It is clear at this point that during the war with Hannibal, Pozzuoli's success owed as much to Rome's need for provisions to sustain the stationed troops as to the strategic circumstances that brought about her discovery and development. Up until the war, Pozzuoli's commerce revolved around the supply and storage of grain. After the war, not only was this no longer a necessity but also, in 202 BC there was such an abundance of grain that the prices had dropped dramatically. Merchants found themselves having to leave the grain to the sailors to cover the freight (Livy 30, 38, 5). Yet Pozzuoli continued to thrive, in tandem with Rome's increasing involvement in the area (Marasco 1988:204). In 199 Scipio Africanus set up a customs post at the port to collect sales tax on imported slaves (*potoria venalicium Capuae Puteolisque* as quoted by Livy 32, 7,3), in 197 BC a decision to establish a colony at *Puteoli* was made that came into effect in 194 BC (Livy 32, 29, 3 and Livy 34, 34, 45). At this point, the question Marasco asks is particularly relevant.

Why was *Puteoli* to become the main commercial port of Campania? Now that there was no longer the Carthaginian threat, why did the focus not shift to larger ports such as that of Naples? One reason, put forward by both Dubois and Nicolet was that it was due to Rome's political motives. These being that Rome might have preferred to see Pozzuoli prosper rather than Naples, as the latter was an independent city (Dubois 1907:66; Nicolet 1984:93). This seems an unlikely interpretation. First of all, because it suggests that there was a meticulously organised political agenda at the time for the development of Pozzuoli whilst the literary evidence implies that it developed quite spontaneously. Secondly, Rome had no reason to bear a grudge against Naples, as it had remained faithful Rome throughout the entire period of the war

(Plutarch. Marc, 10, 2) (Marasco 1988:215). The reason in this case is most likely to be Geographical. Ostia suffered from repeated silting that made it impossible to enter the harbour with the larger cargo ships, which were forced to berth far from the shoreline, making them vulnerable to the elements. These constraints, which lasted until the reign of Claudius, forced the heavier ships to stop at *Puteoli*, where the cargo was then unloaded onto smaller vessels that travelled along the coast to Ostia. Pozzuoli in this case, could have been chosen for the simple reason that it was closer to Ostia along the coastal route (Marasco 1988:215-6).

The victorious Romans were quick to harness Pozzuoli's economic potential. Fifty years after the Punic wars, Polybius would call *Puteoli* one of the finest cities in Italy (Polybius 3,91,4) along with *Sinuessa* and *Neapolis*, both of which benefitted from similar causes (Frederiksen 1984:319).

4.3 The econonic history of Pozzuoli: A brief overview

Puteoli's rapid growth in both political influence and economic wealth now meant that the central government in Rome kept a close eye on the cities' internal affairs. An example of this is Sulla's involvement in the 1st C. BC, in the settling of a dispute between opposing factions and the drafting of new laws to regulate the colony's administration (Jones 2006:23). By the reign of Augustus, not only had *Puteoli* become a major entrepôt but also a manufacturing centre serving the Campanian region. Production included metal and glass working as well as the extraction and sale of the Puteolan cement *Pozzolana* (Marasco 1988:214; Jones 2006:23-4).

Even before the annexation of Egypt, that would transform Pozzuoli's chief source of wealth, the ports' foremost import consisted of slaves and by the mid 2nd C BC Campanian traders had established a base on the island of Delos, the centre of the Mediterranean slave trade So deep was Puteolan involvement in this business that the poet Lucilius would describe the city as a lesser Delos (*Delus Minor*) (Lucilius fr. 123) (Jones 2006:25).

Pozzuoli became a cosmopolitan town almost immediately and whilst it benefitted from the import of slaves and the export of wine and oil at the hands of the Campanians based in Delos, Levantine merchants too were already slowly establishing themselves at *Puteoli* and more probably followed when Delos was destroyed in 69 B.C. Already by 105 B.C, there is evidence for a Temple to Serapis (Frederiksen 1984:339; Gervasoni 1993: 17) and after Augustus's accession to power the oriental presence increased significantly. Furthermore, a consistent flow of luxury goods such as silk, perfumes and dyes, also passed through the port as did the importation of construction materials (marbles from Greece) that were used for the building programmes in the capital (Jones 2006:27).

The grain trade is what Pozzuoli's port became most famous for. In the 1st C AD Rome became heavily dependant on the wheat imported from overseas, particularly from Egypt and Africa and a department in Rome was set up by Augustus to specifically coordinate the transactions (*annona*). The headquarters were in Rome with additional branch offices at Ostia and *Puteoli* (Jones 2006:26). Further discussion of the organisation of the *annona* can be found in Meiggs 1973: 298-301 and Rickman 1980: 222-3. The arrival of the grain fleet also meant paid work for numerous boatmen and dockworkers and not just to them. It brought business for all sorts of people, even those that were not directly linked with the harbour trade. The grain dealers (*frumentarii*) would have bargained with the travelling merchants (*mercatores*). Shippers (*navicularii*) and businessmen (*negotiators*) would be checking up on the incoming consignments and outgoing cargoes. The bankers would be calling in loans and making arrangements for any new financing as well as plenty of business for *Puteoli*'s local bars, shops and brothels (Jones 2006:27). A more vibrant and dynamic picture of Pozzuoli is hard to image.

Whilst it is easy to imagine Pozzuoli as an ever-thriving and dynamic port, there remains a recurring question: Why was *Puteoli*, located 140 miles by road from Rome, chosen for this central role, when the port of Ostia is located at the mouth of the Tiber and just 15 miles from the capital? Aside from the practical reasons already described that were related to the size of the Alexandrian freighters and the availability of deep-water anchorage (Strabo.5.35) there were good commercial reasons to support the port's status (Jones 2006:29). With Campania being one of Italy's most productive regions, goods not only entered but also left the port. Shippers unloading goods at *Puteoli* would also collect cargoes for the return journey (Yeo 1946: 239). Ostia was not able to match this role, primarily because the mouth of the Tiber was considered the gateway into Rome and Rome was first and foremost a consumer city, rather than a producer of goods for overseas markets (Jones 2006: 29).

The importance of the grain trade is further highlighted by the incentives that were put forward by the Emperors in order to encourage investment in the shipments whilst becoming increasingly concerned with improving the infrastructure for the handling of Rome's grain supply. Claudius not only encouraged winter journeys by promising full compensation for any loss incurred during the journey but also began to take steps to improve harbour facilities closer to the capital (Suet.*Claud*.19). In 42, Claudius began the construction of a man-made harbour that was located 2 miles up from the coast from the mouth of the Tiber. It consisted of a large basin lined along one side with docks and warehouses and was shielded from open sea by a large stone breakwater upon which was a lighthouse. A canal then connected the new harbour to the Tiber (Meiggs 1973: 159). Nero too had proposed the construction of a canal that would connect the Bay of *Puteoli* via the Lake Lucrinus and Lake Avernus, to the Tiber near Ostia. This project however was never completed. It was Trajan who eventually completed what Claudius had started by adding to the Claudian harbour a sheltered hexagonal basin, lined with quays and warehouses and from this basin another canal was dug to connect to the Tiber (Keay, Millet et al. 2005).

Despite the shifting of the grain fleet to Ostia/Portus, there is no reason to believe that *Puteoli* suffered as severely as was originally thought (Meiggs 1973: 60). There is ample epigraphic and archaeological evidence to suggest that *Puteoli* remained involved in various aspects of the *annona* trade and played an important supporting role to Ostia in the reception and storage of grain (D'Arms 1970: 285). That Ostia's prosperity came at the expense of *Puteoli* should not be denied, however it should be remembered that in a time of general prosperity for harbour cities, the economic expansion of Ostia may well have been perfectly compatible with *Puteoli*'s continued vitality. Even if it did continue to operate at a reduced level, the choice of *Puteoli* for the trade of particular items such as luxury goods and building material reflected the independent decisions of merchants and shippers over many years and is a clear indication that there was still profit to be made at Pozzuoli, even if the bulk of the Egyptian grain was now being handled elsewhere (Jones 2006 :33).

4.3.1 The administrative organisation of the Augustan city

One of the most important discoveries regarding the constitutional history of *Puteoli* was that it was granted the title of *colonia iulia Augusta Puteoli* as revealed in the Mucerine tablets dated to AD 39 As part of the Augustan colonisation as well as to cater for the needs of the expanding city, a new system for its local government was introduced that was modelled on the local administration of Rome (Frederiksen

1984 :331). The area of *Puteoli* was therefore divided into districts, these were presumably 7 as in Rome but there is an extensive debate in Camodeca as to whether there could have been 14 (Camodeca 1977) (*regiones*), which in turn were further organised into wards (*vici*). For a detailed discussion on the *Regiones* and the *Vici* of *Puteoli* see Camodeca 1977: 62-98 and Camodeca 2000: 281-288.

Even before the reign of Augustus Pozzuoli had long outgrown its original settlement. Not only was business being conducted in the *Emporium*, which was located by the harbour but a series of dockyard and residential buildings were now spreading westwards towards Lake Lucrinus and the Portus Iulius (Camodeca 1994 :112; Jones 2006 :33). The influx of foreign traders steadily increased, as did the contributions to the city made by the offices of foreign merchants. An example of this is that In the second century, Tyrian traders wrote to their city asking for help with their annual rent.

Some of the names of the newly arranged urban units commemorated the more influential families during the reign of Augustus, although they are known to us from much later inscriptions (Jones 2006 :34). In the main part of town we find the regio *Arae Lucilliane*, the *regio Hortensiana* and the *regio Vici Vestoriani et Calpuriani*. Other areas such as the *vicus Spurinus* were located on the way to Capua while the *vicus Annianus* and the *vicus Lartidianus* were thought to be on the coastal strip leading to Lake Lucrinus. All these names belonged to families, the majority of which had a series of properties and businesses in and around Pozzuoli (Camodeca 1977; Jones 2006) Figure 14.

In some instances the name of the ward or district described the businesses of the traders that worked in the locality, such as the *regio Clivi Vitrari* (glass makers) and the *vicus turarius* (perfume merchants) where it was common for artisans and traders to group their workshops within specific areas of an ancient town (Camodeca 1977: 65). Other names of districts were given in what has been interpreted by Camodeca as a deliberate imitation of Roman toponyms. Two inscriptions of possible Puteolan origin describe a *regio Palatina* and a *regio Porta Triumphalis* (Camodeca 1977: 70-1) even though the exact location of the districts is somewhat speculative.

This mark of Imperial favour, that started with Augustus but which *Puteoli* continued to enjoy throughout its history, encouraged wealthy families to contribute towards the city's regeneration and upkeep. Public and private buildings were financed in and around the harbour including a new forum and a basilica, colonnaded vestibules and numerous altars dedicated to Augustus. For a more detailed list of the buildings described by the inscriptions see Camodeca (1996: 91-110). It therefore comes as no surprise that the surviving archaeological remains, despite their fragmentary nature, are particularly imposing. Pozzuoli's archaeology, much of which is still being slowly discovered, clearly hints at the immense prosperity and influence the town enjoyed.

4.4 Archaeological Evidence: Pozzuoli's major monuments

It becomes evident to anyone visiting Pozzuoli that the town suffered a very different fate from the likes of Pompeii and Herculaneum and having remained continuously inhabited to the present day her importance as a bustling mercantile centre, remains largely unappreciated. Even the effect of the more imposing monuments appears somewhat diminished at Pozzuoli, as a result of them being engulfed within and encroached upon by the modern town. There is no denying that while the following descriptions may seem rather laborious, they are fundamental to the very basic understanding of methodological process as well as to the understanding of the archaeology itself, the latter being the basis of any proposed interpretation.

4.4.1 The Amphitheatre

Undoubtedly the largest and most visible remains in *Puteoli*, the amphitheatre of Pozzuoli has commanded the attention of many visitors and archaeologists over time. Measuring 149 x 116m and with an estimated seating capacity of 35,700[10] spectators, it is the third largest in Italy, after those found in Rome and Capua respectively (Paolo Amalfitano 1990: 86; Johannowsky 1993 :101; Bomgardner 2000: 72) (Figures 15 and 16).

Despite being one of the most prominent monuments in Pozzuoli, it was not till the 1950s that the first systematic study was carried out by Maiuri. Based on the observed construction techniques, the amphitheatre has been assigned a Flavian date (AD 69-96). The phases identified include subterranean structures, the façade and the construction of the *cavea* consisting of three tiers labelled *summa, media* and *ima* respectively (Paolo Amalfitano 1990 :89). The *cavea* themselves rose from a terrace that was purposely levelled and rested on a series of seventy-two radial walls, each connected with barrel vaults. The walls were built out of Roman concrete and covered by roughly cut square *tufa* blocks. A layer of thick *stucco* designed to imitate *opus quadratum* covered the whole structure (Maiuri 1955: 16; Bomgardner 2000 :76).

The radial walls formed the bases for the arches of the façade. There was an arcaded gallery on the ground floor and the first floor of the amphitheatre followed by an attic storey. Like the Colosseum we find engaged columns placed between adjacent arches that were used to decorate the façade. Furthermore, architectural fragments, such as cornice blocks and socles with square holes (approx 30cm on one side)

[10] Contrasting estimates have been given; Keppie say 50,000 and Camodeca 20,000 and there was no precise indication in the texts as to what evidence these were based on.

through which the masts that secured the awning passed have been found that suggest that amphitheatre was provided with a custom-built awning system (Bomgardner 2000 :76).

During the study of the monument Maiuri discovered four marble dedicatory inscriptions each placed above the four main axial entrances of the amphitheatre. One inscription was almost intact and its text very clear. It recorded the colony of the *Flavia Augusta Puteolana* that paid for the amphitheatre out of its own resources. The inscription is what was used to give the amphitheatre its Flavian date, although there is still some debate on the matter. Camodeca (and Amalfitano) is of the belief that the construction of the structure might have started during Nero's reign, judging by the use of *reticolata* on some parts of the building and subsequently completed and decorated by the Flavians (Amalfitano, Camodeca et al. 1990: 86-7).

A remarkable feature of the Puteolan amphitheatre was the elaborate series of underground vaulted galleries, passageways, ramps and chambers on two levels beneath the concrete floor of the arena. For a more detailed description related to the underground structures of the amphitheatre (see Maiuri 1955). The entire area is solely utilitarian in nature and dates to the Domitianic or at the latest, early Trajanic period as assigned by Maiuri (Bomgardner 2000 :82).

It is understandable therefore that as *Puteoli*'s reputation and affluence grew so did the need to endow the city with structures worthy of her status. In the case of the amphitheatre however, this structure was certainly not *Puteoli*'s first.

The amphitheatre of *Puteoli* was likely to have been built to host the popular animal games called the *venationes* (Bomgardner 2000: 34), especially since there is no reason to believe that the earlier Republican dated amphitheatre went out of use. The floor of the arena had 47 trap doors, which would have opened and closed at different times during the games surprising the crowd with the exotic animals on display that appeared magically onto the arena. It also had dedicatory inscriptions which, were recorded by Maiuri and each of which was positioned on the main axial entrances of the building. The inscriptions date the building of the monument to after 69AD. The *cavea* (seating) sprang from a deliberately levelled terrace, which rested on 72 radial walls. The latter were built out of Roman concrete with a fine outer layer of *opus reticolata*. Two brick levelling courses within each of these walls ensured their evenness. The outer ends of the walls ended in 72 stone piers and these in turn formed the basis for the arches of the façade. An arcaded gallery approximately 4m wide that consisted of the ground floor, the first floor and attic storey, completed the façade. Like the Flavian amphitheatre in Rome, we find engaged columns that adorned the façade that were built using a stone core above which a stucco decoration was applied. The architectural fragments that were recovered indicate that the amphitheatre of *Puteoli* also had an awning system (Bomgardner 2000: 76).

4.4.2 Pozzuoli's Republican Amphitheatre

This monument was ultimately not reconstructed based on the fact that there is sadly almost no evidence left of the remains or much documentation of those either. Despite this, it is included here because it still played an important architectural role in Pozzuoli at the height of its prosperity.

The most famous gladiatorial schools were native to Capua and the vicinity and there is increasing epigraphic evidence recovered from Pompeii that highlights the dedication of Roman citizens to these pursuits. From an early date virtually all Campanian cities developed a passion for spectacles of the amphitheatre and *Puteoli* was no exception (Bomgardner 2000 :73).

The Republican amphitheatre was located 100m to the east of the imperial amphitheatre and perpendicular to it and was located only a few hundred metres from the forum area of ancient *Puteoli*. The arena was dug in the ground and the entire north-eastern *cavea* was built up against a hillside (Sommella 1978: 54; Welch 2007: 221). The *summa cavea* in the other parts of the building were built on vaults, of which only scant traces remain. Located above the *summa cavea* was a vaulted walkway and part of the great barrel vaulted entrance tunnel that led down into the arena can still be seen in the north-west sector of the building (Sommella 1978: 54; Welch 2007: 221) (Figure 17). Some of the vaults of the *summa cavea* show evidence of re-facing in the early imperial period. The seating capacity has been estimated by Golvin to be approximately 20,000 similar to that of Pompeii. The amphitheatre had an overall length of 130 x 95m and an arena length of approximately 69 x 35m (also similar to the dimensions of Pompeii's amphitheatre). When the larger amphitheatre was built, the Republican building remained very much in use and *Puteoli* became the first city to have two permanent functioning monumental amphitheatres further testimony to the cities' wealth and importance. For further details on this monument see Zevi's *Puteoli* 1993.

4.4.3 The *Macellum*

The market of Pozzuoli, for many years mistakenly labelled the Temple of Serapis was a landmark on the tourist itinerary even before Pompeii and Herculaneum were rediscovered (Keppie 2009: 74). The first excavations took place between 1750 and 1756 under the auspices of the King of Naples but it was not until the years between 1806 and 1818 that the entire building complex was brought to light. A statue of the Egyptian god Serapis was also discovered, giving the site its name for many years to come. It was not until Charles Dubois' research in 1907 that the building's function was correctly identified. The remains as seen today are the result of further excavations that were undertaken by Maiuri between 1930 and 1950 (Amalfitano, Camodeca et al. 1990: 105) (Figure 18).

In antiquity, the market was located close to the port about 100m from the shore behind the porticoes that bordered it to the west. Today, primarily as a result of the numerous changes in the landscape over time, the building is no more that 30m away from the shore. The overall plan of the structure is a large rectangle measuring 58 x75m, one of the largest structures known throughout the Empire and very reminiscent of the *Macellum Magnum* built in Rome under Nero (Amalfitano 1990).

The date of the building remains uncertain. The construction techniques and some of the architectural decorations suggest a date between the 1st and 2nd C AD with some restoration work that took place during the Severan period (3rd C. AD) (DeRuyt 1983: 158; Amalfitano, Camodeca et al. 1990: 106).

Shops surrounded the four sides of the building, which also had a second floor. This has been confirmed by the presence of stairs and columns that clearly belonged to the upper floor (DeRuyt 1983: 151; Paolo Amalfitano 1990: 105). The entrances of the shops were facing alternately the exterior and interior of the building. The walls of the internal shops appear to have had their walls lined with marble slabs, whist those shops that could be accessed from the outside were covered in stucco (DeRuyt 1983: 151). On the SE side of the external perimeter, one can also see the remains of the stairs that would have led to the second floor. Two main roads also flanked the sea facing and NW façades of the building, whilst a secondary road to the SE separated the *Macellum* from other buildings that might appear to have been of a more residential nature.

The main entrance to the building was via the monumental entrance (vestibule) that was preceded by a portico 5m wide accessed via 4 steps located to the west of the building facing the sea. The secondary entrances were located on the side (DeRuyt 1983: 151; Amalfitano, Camodeca et al. 1990: 106). Once inside, the exedera was located directly opposite the main entrance, with three large columns that formed its monumental façade and a covered portico surrounded the perimeter of the courtyard. Aside from the shops, the space inside the *macellum* catered for a cult shrine (on the exedera), a fountain (in the *tholos*), a covered portico and public latrines (Amalfitano, Camodeca et al. 1990: 105).

Over time the *macellum* was stripped and modified and what we see today is a far cry from its original set-up. Due to the minerals present in the area, the complex was also used as a thermal complex, the remains of which can be seen on the external walls of the *tabernae* (Amalfitano, Camodeca et al. 1990: 106).

4.4.4 The Stadium

Pozzuoli's stadium lies on a terrace west of the town centre, near and parallel to the Via Domitiana and is said to have been built following the institution of the *Eusebeia*, Greek-Style games that involved athletic rather than equestrian competition that were held every 5 years in commemoration of Antonius Pius' adoptive father Hadrian, who died at Baia in 138 AD and who for a while was also buried in the area (Amalfitano, Camodeca et al. 1990: 129) (Figure 19).

There appears however to be some uncertainty about the size of Pozzuoli's monument. Dubois' plan shows an arena measuring 370m long and a little over 50m wide. Andrea de Jorio suggested a building with two rounded ends and with arena dimensions of c. 318m by 47m. More recently, the length of the stadium described by Amalfitano is

260m x 65m, whilst Johannowsky described it as having been about 300m x 77m with an arena width measuring 41.44m (Paolo Amalfitano 1990: 128; Johannowsky 1993: 104). It is no wonder that some have questioned the building's use as solely for athletic games. Humphrey argues that whilst the width of the monument would very much suit a stadium, the figures given being closer to those of Domitian, the length would better suit a circus, even the Stadium of Domitian was only c. 275m in length (Humphrey 1986: 572). One possible explanation could be that the building was deliberately made longer than most stadia in order to include equestrian events (Humphrey 1986: 572).

In Dubois' day the visible remains on the long north side of the building consisted of a vaulted portico 3.2m wide with large windows each measuring 2.9m wide between piers, that latter measuring 1.9 x 2.15m (Dubois 1907: 347). The inner sides were punctuated by openings that led to seats supported on sloping vaults (Dubois 1907: 348). Today engulfed within a farm is a large stretch of ambulacra in *opera mista*, covered by a complex system of vaults (barrel and cross) that supported the seating (Amalfitano, Camodeca et al. 1990: 129). The eastern elevation facing the ancient *Via Domitiana* is formed of a façade in *opera laterizia* characterised by pillars decorated with half-columns that framed the entrances to the *vomitoria*. These were preceded by a portico, of which very few traces remain as a result of the subsiding terrace upon which the monument lay (Amalfitano, Camodeca et al. 1990: 129).

This situation changed in 2000 when an archaeological excavation carried out by the Naples Superintendecy not only uncovered the Stadium's original surface but also allowed for the investigation of parts of the interior of the monument (Gialanella and Romano 2008). The stadium could be accessed from two entrances. To the east was a monumental entrance for the athletes, whilst to the north was the entrance for the spectators. The monumental entrance led directly to the track and was composed of a row of two arches covered by a vaulted wall of 'piperino'. Of this monumental entrance only the pilasters remain (Gialanella and Romano 2008). The spectator entrance was composed of small abutting elements that helped filter the crowd into the various *ambulacra* that then to the exits and eventually to the respective seating arrangements (*cavea*). As with most spectator buildings, the *cavea* were organized in three parts that corresponded to the types of spectator. The lowest part of the *cavea* was reserved the more important guests and is the one that remains preserved and was separated from the track by a wall that was made of trachyte tuff (*piperino*). Of the middle and upper rows nothing remains with the exception of parts of a staircase (Gialanella and Romano 2008). The most recent information about the excavations is found on a pamphlet printed by the Naples Superintendency, kindly supplied by Costanza Gialanella.

4.4.5 The Thermal Complex: "Terme di Nettuno"

One cannot help noticing Amalfitano's opening paragraph when describing the thermal complex of Pozzuoli. The author starts by highlighting that this building was one of Pozzuoli's largest monuments and that with its main façade facing the sea, it seems almost as if it was specifically designed to impress the voyager coming from the direction of the sea (Amalfitano, Camodeca et al. 1990: 97).

The complex was built in the first half of the 2nd C AD, a date that has been confirmed by the discovery of Hadrianic stamps found on site. Various contemporary repairs were also undertaken that date all the way to the 4th C AD. The thermal baths comprised an axial plan that followed the *caldarium – tepidarium –frigidarium – natatio* path. Unfortunately despite its size (the length of the known remains is approximately 100m), a large proportion of the building is now interred and what we are able to see is not only what would have been the upper floor of the *frigidarium* but also just a fraction of the building's original size and complexity (Figure 20).

Although the floor plan is now lost to us, on entering the *frigidarium*, it is possible to identify the remains of a series of areas on both sides of the central apse, each of which had alternate barrel and cross vaults that were decorated with mosaics (Sommella 1978: 32; Amalfitano, Camodeca et al. 1990: 97). Two large opposing apses closed the short sides of the rectangular *frigidarium*. Each sector of the building most likely comprised vaulted and arched passageways on the ground floor but with the current floor level being the height it is, one is only able to see the curvature of the arches (Sommella 1978: 29). The large quantity of vaults and niches hint at what was once a very richly decorated building.

Of the *tepidarium, caldarium and Natatio*, nothing remains. What has been partially conserved however is an area of services that had access to the *praefurnia*, an area used for heating the various rooms of the baths. These are located next to warehouses on the *Via Pergolesi* and therefore beneath the recorded height of the complex (Sommella 1978: 32).

The size and plan of this complex have been compared to the Imperial baths in Rome, specifically those of Trajan and Titus (Sommella 1978; Amalfitano, Camodeca et al. 1990). Johannowsky on the other hand is of the opinion that these baths are more similar to those in Alexandria, with particular reference to Troad, Leptis Magna, Azaroi and S. Barbara of Trier (Johannowsky 1993: 107). The baths in *Puteoli* were most likely not the town's first. It is possible that smaller complexes existed, perhaps as early as the 2nd C BC, a time where cities like Pompei and Cuma already possessed buildings of this function even more so Capua, for which baths were attested as early as the 3rd C BC (Johannowsky 1993: 107). Yet there appears to be little evidence of other thermal complexes in Pozzuoli, with the exception of remains known as *Bagno Ortodonico*,, not much else has been securely identified.

4.5 The promontory of Rione Terra and the development of Pozzuoli's topography

4.5.1 The promontory of Rione Terra

Perhaps one of Pozzuoli's most unique archaeological datasets is the urban complex located on the promontory of Rione Terra (Figures 21 and 22). Years of excavation have revealed great insight into the development of a town that appears to have been in continuous use, despite the frequent disturbances led by the geological circumstances of the area. Before the excavations carried out by the Naples Superintendency in 1993, very little was known about the Roman colony in Rione Terra as is evidenced by Sommella's work (Sommella 1978: 69-74). This is by no means a criticism of the previous work but rather an indication of state of knowledge at the time. Aside from the structure known first as the *Capitolium*, then as the Temple of Augustus and part of the *Decumanus* in Via Duomo, little else was known. One of the first excavations of the area by the Naples Superintendency was carried out in 1970 and while Sommella was working on his archaeological map, they too were working on an archaeological map of Pozzuoli which was based on aerial photogrammetry (Gialanella 2001: 34). Following the earthquake of 1980, more excavations took place under the Superintendency's supervision whereby a series of structures were brought to light, in via Pesterola, via Cavour and via Portanova, thus revealing the first excavation results and more importantly, revealing the vast potential the promontory had to accommodate a systematic study of the urban development of such an important Roman town (Gialanella 2001: 43).

It's easy to see why the Romans selected the hill of Rione Terra as the area on which to found their *colonia civium Romanorum*. The area was difficult to access and easy to defend due to its steep slopes and was surrounded on three sides, by the sea (Gialanella 2000:18). Its viable area of about 240m in length by 200m wide, albeit small by modern standards, appears to have been more than sufficient to house its 300 settlers as indicated by Livy (Livy 8.21.11). A Comparison can also be made with the Roman colonies of Ostia, Terracina and *Pyrgi*, that even though they were older, were of similar size when first established, (Gialanella 1993:74, 2000:16).

With regards to the period before the Roman settlement, there so far appears to be very little tangible archaeological evidence of the Greek town of *Dichearchia*. These are so far limited to two pottery fragments (located outside any stratigraphic context) during the excavation of a Roman building at Piazza San Liborio on the Rione Terra. One is a fragment of a geometric *oinochoe* of Cuman production, the other is the handle of a ionic cup dated to the mid 6th century B.C. (Gialanella 2000:15). Outside Rione Terra, another fragment was found dating to the late 7th or early 6th C BC. This evidence is not enough to attest to the Greek colony described to us by the classical authors but it has been suggested that the occupation of this colony in the archaic period may have been short-lived given the political circumstances at the time[11]. It is also possible that while preparing the land for urban settlement, the Romans may have, as a result, removed any traces left by their predecessors (Gialanella 2000: 15; 2001: 24).

Excavations that took place in the north-eastern section of the "acropolis" uncovered structures made using the *opera quadrata* technique (Figure 22 detail A). They have been interpreted as parts of the original walls of the colony and their course appears to follow the layout dictated by the morphology of the *tufa* bedrock. Parts of these retaining walls were created by inserting large *tufa* blocks horizontally

[11] See section about foundation of *Dichearchia* in this chapter.

without the need of mortar and in some cases parts of these walls were formed by simply levelling the *tufa* bedrock (Gialanella 2000: 18; 2001: 24).

The urban arrangement within the walls of the Roman town is organised using a system whereby two central axes intersect at right angles, a characteristic very much in keeping with the principles of Roman town planning based on the *Castrum* model. This layout can be compared to other *coloniae* from Ostia to *Minturnae* and its use spans across 150 years (Gialanella 2000: 16; Gialanella 2001: 24; DeCaro 2002: 54). In Pozzuoli however, there appears to be one significant difference; the system of orthogonal axes appears to be strongly influenced by the formation and shape of the promontory, so much so that there is still debate as to whether this urban scheme followed faithfully the double *actus* measurements, like many of the contemporary sites sharing the same administrative status, or whether the area's morphology required its measurements to be one *actus* by an *actus* and a half (Gialanella 2001: 24). The *Actus* is a Roman measure of land, which formed the basis of the whole system of land measurement. In that system the name actus (from ago), which originally meant a way between fields for beasts of burden to pass (or, as some say, the length of a furrow), was given to such a way when of definite width and length, and also to a square piece of land of the same length.

The development of the road network on Rione Terra is particularly interesting, primarily because it appears to undergo significant changes that revolve around the building and restoration of monuments within the town. Traditionally, the *decumanus maximus*[12] of the colony was thought to be that of Via Duomo (Figure 22 detail B), where its basalt blocks can still be identified today under the modern road given that the

[12] *Cardo* – Referring to one of the two main streets, directed North-South. *Decumanus* – The second axis perpendicular to the *Cardo* with an East – West direction. Gallico, S. (2000). Guide to the Excavations of Ostia Antica. Rome, ATS Italia Editrice.

latter follows faithfully the original ancient course. Despite running at the back of the *Capitolium*, this road is so far the only one that appears to have connected the promontory with the flat area located opposite, where it is believed that the colony may have expanded towards even as early as 2nd C BC (Gialanella 2000:16; 2001: 28). The *cardo maximus* on the other hand was frequently identified as that located in Via del Vescovado (Figure 22 detail C). However, the considerable difference in level between the foundation floor of the *Capitolium* and the *decumanus* in Via Duomo (accessible only a series of steps) have raised questions as to whether this was one of the colony's major urban roads or not (Gialanella 2000: 16).

In the southwest quadrant, are the documented remains in Piazza San Liborio (Figure 22 detail D). These remains appear to be residential in nature but more importantly, it is from this area that traces of basalt blocks were discovered and identified as another *cardine*. The bradyseism that took place in the 1980s also brought about the discovery of a series of vaulted structures that were located beneath a medieval secondary entrance to Rione Terra. As a result of this discovery, it became possible to assume that there existed an axis parallel to the above-mentioned *cardine*, but located further east that connected the "acropolis" of Rione Terra to the lower part of the town where the buildings of the *Emporium* were located (Gialanella 2000: 16-17).

Excavations have also brought to light another *decumanus* located south of that on via Duomo. This *decumanus* seems to lead directly to the *Capitolium* (built in *tufo*) of 194 B.C., leading scholars to believe that this was the original *decumanus* of the settlement. A section of this chapter is dedicated entirely to the study of the building known both as the *Capitolium* and the Temple of Augustus, which is why it is not described in detail at this stage of the text. This road also intersects with a *cardo* located under the modern road of Via San Procolo. It was during the Augustan period following the monumentalisation of the area surrounding the temple, which was rebuilt entirely in marble on the foundations of the previous sacred building, that this first *decumanus* was then blocked at its western-most point by a wall constructed in *opera reticolata*. The *decumanus* on via Duomo, via the *cardine* of via del Vescovado, was what now led to the newly erected temple, taking on the role of the new *decumanus maximus* (Gialanella 2000: 18).

Years of excavation have brought to light many buildings along the length of the *decumanus* of 194 B.C. A number of these buildings have been identified as *Horrea* or *Tabernae* (Figure 22 detail E) underneath which archaeologists discovered a series of cisterns that had been dug in the *tufa* bedrock during the Republican period (Gialanella 2000: 18; 2001:24). Further west, but south of this *decumanus* a grand architectural complex was located. It consists of four large vaulted areas, described as crytoporticos (but more likely to be *Horrea*) upon which a large public building was later constructed. This second building was likely to be part of the Augustan sanctuary. Due to the building techniques used, researchers were able to identify the various construction phases the building underwent. The walls that were built using a mixture of polygonal and *opera incerta* dated this construction to the Republican period, which was followed by a second building phase in the *opera reticolata* technique, thus making it Augustan. During this second building phase this building complex was then attached to the road by a fifth cryptoportico that was placed parallel to the road (Figure 22 detail F) (Gialanella 2001: 28). The nature of the restoration works, together with the numerous marble architectural fragments discovered during the course of the excavations are perfectly placed to support the idea that, as with many other cities, the promontory of Rione Terra underwent a series of refined yet complex aesthetic changes, in line with the Imperial influence of the time (Gialanella 2001: 28).

In front of the above-mentioned complex and still along the *decumanus* of 194 B.C., another grand building was located and which served as a link to the road. It is formed by way of an imposing portico, with pillars in *opera laterizia* resting on piperino marble bases. This elaborate system of porticoes is not unique. Other buildings, that are located on the later *decumanus* of Via Duomo, as well as those on the *caridne* of Via San Procolo, share the same parameters. Areas built of archways and columns in *reticolata* resting on piperino bases. Fausto Zevi suggested this monumental arrangement was likely to be part of the Neronian building phase of the colony. It is no secret that Nero had some very ambitious projects planned for *Puteoli* and like Rome, these porticoes were built as a safety feature following the fire that engulfed Rome in 64 B.C. The Neronian phase of the town also included the building of many new entrances using the above-mentioned system, on the eastern side of the road, thus causing it to narrow (Gialanella 2001: 29).

Archaeological evidence dating to the late antique period is harder to come by. The north western part of the area seems to have already been abandoned by the end of the 2nd C and beginning of the 3rd C. A.D., as has been demonstrated by the material evidence found during the excavations of the sewers that run beneath the western limit of the *decumanus* on Via Duomo (Gialanella 2001: 29). A wall of unknown date made in *opera vittata mista* also blocks the cardine on Via San Procolo. Some burials that were discovered inside the *tabernae* that open up onto the *cardine* that crosses the old *decumanus* date the blocking wall to the end of the 3rd C beginning of the 4th C A.D. At the same time, the pathway of the *decumanus* of 194 B.C. loses its function completely as a public thoroughfare at the height of the cryptoportici and become annexed to a public building (Gialanella 2001: 29). We do not know the original purpose of this building but its last phase was that of a *pistrinum*[13] as evidenced by its grinding stones (Figure 22 detail G).

[13] *Pistrinum* –A mill or bakery.

Underneath this a series of small rooms were located and these were identified as *ergastula*[14]. The *pistrinum* was likely to be supplied by the *frumentationes* of the Constantine period that were imposed on Capua and other Campanian cities at the time (Gialanella 2000: 33; 2001: 29).

During the 4th C. A.D., the life of Pozzuoli slowly began to fade. During the middle ages, on the promontory at least, parts of the population still lived in the Roman buildings. During this period the urban area now revolved around the Cathedral. The latter was built at the end of the 5th and beginning of the 6th C. A.D. engulfing the Temple of Augustus and which fortunately during this phase was not heavily tampered with (Gialanella 2001: 33).

4.5.2 The *capitolium* of Rione Terra (commonly known as the Temple of Augustus)

The so-called "Temple of Augustus" is located in the heart of *Puteoli*'s road network, a part of which, as we have already seen, is faithfully reproduced in the modern roads. There is little doubt about the monument's importance both in antiquity and for scholars today as it is one of the most striking architectural examples of Augustan age. It became part of the church of *San Procolo del Rione Terra* and was, for a long time, left intact. That was until the 17th Century, when the Bishop Martino de Leon y Cardenas drastically altered the shape of the ancient building during the extension works of his cathedral. As a result of these works, extensive parts of the temple was completely destroyed. These included the façade of temple and its inscriptions, the walls of the back and sides of the temple and the floor level, which was also removed and dug out (Zevi and Valeri 2001: 22) (Figure 22 detail H).

In a twist of fate, a fire that engulfed the cathedral in 1964, provided the perfect opportunity to explore and restore the ancient building to its

[14] *Ergastula* – Prison on large estate to which refractory slaves were sent for work in chain gangs. (Definitions taken from the Morwood J. (Ed) Oxford Latin Dictionary. OUP)

former magnificence. In the restoration works of the 1960s and 70s an underlying structure of Republican date was brought to light that was slightly smaller in size and was built partially out of *tufa* blocks and partly by smoothing and levelling the promontory's bedrock (Zevi 2001: 35). The chronology of this earlier podium fit well with that of the colony's establishment and the few decorative elements discovered *in situ* further confirmed the Republican date connected to the *deductio* of 194 B.C (Zevi 2001: 35).

The name "Temple of Augustus" to which we have all become accustomed to is somewhat of a misnomer. For a long time, the interpretation of this building as the "Temple of Augustus" was based on the interpretation of the dedicatory inscription partially preserved on the façade of the building. Despite the scholarly tradition, interpreting this inscription was never a straightforward affair as even early scholars were forced to admit that not only was the last part of the inscription lost to us, but also that some of the surviving letters were completely illegible, as a result of fire damage (Zevi 2001: 36). Castangoli was one of the first to challenge the "Augustus" interpretation[15] and by carefully re-examining the inscription, he was able to conclude that the inscription is a reference to *L. Calpurnius* who personally financed the building's restoration and who was possibly later rewarded for his generous gift to the city, by having the *cognomen 'Capitolium'* added to his name in a later inscription (Castagnoli 1976: 56; Zevi 2001: 36; Valeri 2005: 40). *L. Calpurnius* and his brother *C. Calpurnius* were merchants who traded with the east, including Alexandria, Asia and Syria. They formed part of *Puteoli's* minicipal elite, whose wealth very much depended on this vast commercial network. The discovery of the earlier structure beneath the temple further supports this interpretation as it indicates continuity of a cult, which the deified Augustus was not yet a part of (Castagnoli 1976: 56).

[15] For a detailed description of the interpretations related to the dedicatory inscriptions see Castagnoli 1976: 55-57 and Zevi 2001: 36

Thanks to the drawings by the Florentine architect Giuliano San Gallo (Figure 23) we know that despite the *Capitolium* becoming part of Cathedral of San Procolo in the Middle Ages, it remained relatively untouched. Some discrepancies in the plan by San Gallo and the actual dimensions have however been noted in the meantime (See Zevi 2001: 37). We know that the temple is formed of a pseudoperipteral[16] hexastyle[17] with nine Corinthian columns on the length of its side walls (Valeri 2005: 36) and built entirely using white marble blocks. Zevi further emphasizes that this temple was not built by using the "appearance" of marble, which involved covering bricks with marble slabs but was built in its entirety using only marble, making it an even more outstanding example of Augustan architecture (Zevi 2001: 37). The *cella* was made out of almost perfectly square blocks of marble and was preceded by am ample porch (*pronaos*). The columns on the lateral colonnades of the temple were built in a semi-circular relief. We are now only able to see the latter's imprints, however the Corinthian capitals are still *in situ* and are clearly identified.

A large part of the trabeation, the beams supporting a roof rather than arches or vaulting, and other elements of the rooftop no longer exist. The architrave however has survived. It consisted of three smooth bands on top of which a course of blocks was placed in order to support the marble frieze. The podium (which we now know covered another of earlier date) measures 15.50m long and was preceded by a platform that was accessed via two lateral stairways (Valeri 2005: 36-7). The plan of Pozzuoli's temple is very much in the Vitruvian tradition, particularly because of its pseudoperipteral style. Comparisons have been made with other examples of Augustan architecture, such as the *Maison Carrè*

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[16] *Pseudoperipteral:* Falsely or imperfectly peripteral, as a temple having columns on the side attached to the walls and an ambulatory only at the ends or at one end (http://www.thefreedictionary.com).
[17] *Hexastyle:* Part of a temple that uses six columns on the front of the building (Oxford dictionary Online - http://oxforddictionaries.com/)

in Nimes (Figure 24), the Temple of Apollo Sosianus near the Circus Flaminius (Gros 1996; Zevi 2001: 37,40-2; Zevi and Valeri 2001: 22; Valeri 2005: 37, 8). For a detailed reading on the debate about the comparisons, with particular detail to the marble elements of the Temple of Pozzuoli see Zevi (2001: 40-47).

Much to scholars' delight, the restoration and excavation works that took place in the Temple brought to light a vast quantity of decorative marble fragments, which have been the focus of detailed studies (see Valeri 2005 and Demma 2007) but which will not be described further in this project. Suffice to say that the quality of the marble and craftsmanship point at a technique that was likely to have been developed during the building of the Forum of Augustus, where certain formal styles were being encouraged throughout Roman centres in southern Lazio and Campania (Valeri 2005: 39; Eck 2007: 141). The also confirm the Augustan date of the temple's construction.

Given the undisputed importance of the *Capitolium*, how did the location of temple affect the urban layout of the promontory? It appears that the temple despite being located on a major road axis did not have a forum square in front of it. This is not unusual for a maritime colony; Republican Ostia too shared this feature. For a long time scholars have surmised that this open space was therefore designated somewhere outside the city walls, on the plain opposite the promontory in the vicinity of Via Carlo Rosini where the so called "new" forum, or at least a public space, was identified (Gialanella 2001: 48; Zevi 2001: 47).

Fausto Zevi rightly points out that the creation of this new public space was fundamental to the development of the city's urban fabric and tries to establish a more accurate date for its establishment. It is already known that *Puteoli* became a *Colonia Iulia Augusta* thanks to the Sulpicii wax tablets. Having outgrown its city walls, the town reorganized its *regions* and *vici*[18] and upon receiving its new title the town now had an adequate space in Via Rosini (Zevi 2001: 47). This site suffered the same fate as that of the temple and during the building of a school in the 1950's a large part of these remains were destroyed, leaving archaeologists with very little material to work with (Gialanella 2001: 48). In Gialanella (2001: 48-50) one can find a more detailed description of the remains that archaeologists have managed to excavate.

For a long time, scholars assumed that buildings rose around a monumental piazza where perhaps the "real" temple of Augustus was likely to be situated together with all the monuments built by the many wealthy Puetolian families. Work by Filippo Demma however reassessed these assumptions by stating that the architectural elements and the wall structures do not date any earlier that the second half of the 1st C. A.D. Zevi does not provide a reference for the following assumption even if he attributes it to Filippo Demma. What this means is that while the architectural and decorative elements of the Rione Terra are indisputably Augustan in typology, those of the Forum suggest that it was established under the Emperor Nero and re-founded as a *colonia Flavia Augusta Puteoli* by Vespasian (Zevi 2001: 48). Until then, Rione Terra was likely to have maintained its function as the centre of public life within the city and it is likely that as a result of this, many public monuments were added and built around the marble temple of *L. Calpurnius*.

This section is most certainly not an exhaustive description of all the archaeological research that has been done in the area of *Puteoli* and the Rione Terra. It does however try to highlight some of the more salient archaeological aspects of the town, which strongly support the idea that there was a lot of vested interest in the area by all members of the Roman ruling classes, from thriving merchants to the Emperors

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[18] See the section about Administrative organisation of the town.

themselves. Even as the town continued to expand beyond the walls of Rione Terra and a new business forum was established outside the city walls, the promontory most likely maintained its status as the political and religious centre of the townas excavations also brought to light honorific bases for a number of illustrious figures of the 2nd C. AD (Zevi 2001: 49). In the time between Augustus and his immediate successors, we are beginning to better understand how the rich merchant classes reaped the rewards of the *pax augusta*, how their commerce boomed and how their devotion to their *Princeps* led them to further transform *Puteoli* into the second most powerful city after Rome.

4.6 Port and Harbour Facilities

[...] *But into the harbours they came, their great bulk and crushing mass guided and subdued with ropes [...] Stevedores swarmed up stout planks to carry out from the hold heavy sacks or baskets, large ceramic containers full of precious foodstuffs, or crates of delicate glass and ceramic tableware. Somehow, enormous timbers and blocks of stone were removed as well, perhaps with quayside cranes. All these goods had to be shifted across the busy platforms surrounding the harbour to open-air storage areas or conveniently located warehouses* [...]

(Olsen 1988: 147)

The above description illustrates beautifully what the heart and soul of Pozzuoli could have been like and the reason this town was able to prosper to the extent that it did. It was ultimately Pozzuoli's port that enabled its inhabitants to enhance the city with the impressive architecture we have become accustomed to. The successful expansion of a port was often the result of available technology combined with the coast's morphology and the economic context within which these developments took place (Salvatori 2008: 431). In antiquity, anchorages were also very common especially if they formed part of a sanctuary, as were unprotected ports, small local harbours and facilities dating back to the Greek period or the Bronze age, that survived into the Empire (Blackman 1982: 185; Olsen 1988: 148).

The port of *Puteoli* therefore possessed all the ingredients for success. It was located in one of the few natural shelters on the Tyrrhenian coast that was close to Rome, the economic context within which it developed was one of the Empire's most pressing concerns and the appearance of Roman lime mortar and *Pozzolana* mortar concrete in the late 3rd and 2nd century B.C. brought about a dramatic change in subsequent patterns of harbour constructions all around the Empire (Olsen 1988: 148).

Despite the underwater remains of the *Portus Iulius* evidence for many of the port structures of *Puteoli* are largely missing or fragmentary at best (Figure 25). Although researchers suggest the town was likely to have been limited to the walls of Rione Terra up until the Augustan period, contemporary sources suggest that the town had already expanded considerably by the 2nd C B.C. (Gialanella 1993: 76). The Greek historian Polybius (who lived between 200 and 120 B.C. describes *Puteoli* as one of the most magnificent cities in Italy, a description that would have been inappropriate if he were just describing the walled town of Rione Terra. The poet Lucilius, who is mentioned at the beginning of this chapter, also recalls how the city extended to a thousand paces. Scholars have interpreted these thousand paces as a reference to the *Emporium* of the town, a name used by Cicero when referring to the dockland area located in the lower part of the town where the day-to-day business took place that was connected to the promontory by steep hills (*clivi*). An inscription with the words *...cleivom a summo ad emporium...*(*CIL*. X. 1698) further confirms this (Ceraudo, Gialanella et al. 1998: 73). The location of *Puteoli*'s *Emporium* is likely to have been located at the foot of the Rione Terra (Figure 26) but its extent remains unknown. Also unknown are the types of buildings that formed part of this *Emporium* with the exception of four barrel vaulted structures, most likely *Horrea* in *opera incerta* that were discovered 150 metres north-west of the *Macellum* (Gialanella 1993: 77) that was also most likely part of this business centre (Ceraudo, Gialanella et al. 1998: 73).

The ancient port was divided into two parts by the Rione Terra promontory. South of the promontory we find basins as well as system of *pilae*[19] that were grouped together in two overlapping rows to form discontinuous breakwaters (Brandon, Hohlfelder et al. 2008: 375). *Pilae* are stout rectangular piers built of hydraulic concrete on top of a rubble-mound foundation. They broke the brunt of the sea's force but at the same time allowed free enough circulation of water within the basin for the sand and silt to stay in suspension. When the water is calm and clear, one is still able to see the remains. North of the promontory was the actual dock that was protected from the southern winds by what came to be known as the “caligulan” mole (Salvatori 2008: 432).

This is perhaps one of the most striking elements of the puteolan harbour, so striking that it was also found to be represented in a number of contemporary depictions, the most famous of which are those on the late antique souvenir glass flasks and what came to be known as the Bellori drawing[20] (Figure 27). This impressive structure consisted of at least 15 square plan *pilae* that were slightly arched to withstand the force of the waves. Each *pilae* had a stone mooring link and was aligned east-west as protection from the winds (Gianfrotta 1996: 67). The mole measured 15 metres in width and 372 metres in length. The ancient iconography suggests that at the end of the pier was a triumphal arch or perhaps a lighthouse (Ostrow 1979: 115). The initial construction of the mole has been dated to the reign of Augustus and its restorations following storm damage were attributed to Hadrian and later to Antonius Pius (Gianfrotta 1996: 67). The remains of this

[19] See Olsen 1988 for an overview of the use of hydraulic concrete and harbour construction in Roman ports.
[20] These will be described in more detail later on the chapter, with a section dedicated entirely to them.

imposing structure remained visible, and were frequently depicted, all throughout the 19thcentury[21] and Dubois was perhaps one of the last scholars to record and describe what was left of the mole in 1907 (Dubois 1907: 254-7) as by then, works had already begun to construct the modern pier under which the Roman *pilae* now lie (Figure 28).

Moving immediately north-west from the Rione Terra the coastline was marked by a porticoed quayside known as the *ripa* an example of which can be found depicted on the Prague glass flasks (Gialanella 1993: 77) (Figure 29). The name written on the flask is "*ripa Hortensiana*" which we know was the name also attributed to one of Pozzuoli's districts[22]. Scholars were able to identify other wards (*vici)* along the coast such as the *vicus Lartidianus* and the *vicus Annianus* thanks to underwater discoveries that included architectural elements, inscribed marble bases and altarpieces (Gianfrotta 1993: 118-9). It must be noted however that these discoveries appear to have been rather sporadic and took place over a number of years. There is also little reference to the architectural remains that still lie underwater in these areas between the Rione Terra and the *Portus Iulius*. All we know is that there were a variety of buildings that included warehouses, residential quarters, religious structures and thermal complexes (Camodeca 1994: 110-1).

Apart from the systematic excavation by the Naples Superintendency of a thermal complex that was located in a modern dockyard (Ceraudo, Gialanella et al. 1998: 76-83), the majority of the submerged remains were largely identified thanks to outstanding calm water conditions that allowed for some incredibly clear aerial photographs, their description however is still very generic (Gianfrotta 1993: 118; Ceraudo, Gialanella et al. 1998: 74; DeCaro 2002: 60). In 1987 Giuseppe Camodeca published a comprehensive map of the underwater remains that ran along Pozzuoli's *ripa* followed by a revised copy in 1994 (FIG)

[21] See chapter 3.
[22] See sub-section in this chapter: The Augustan administration of the city.

(Camodeca 1994). What these observations have confirmed however was that the port of *Puteoli* and that of the *Portus Iulius* together formed an impressive system of port facilities that had become necessary to accommodate the drastic increase in maritime traffic that made its way to this Phlegraean city before reaching their final destination, Rome (Camodeca 1994: 112).

The *Portus Iulius* was constructed during the tumultuous years of civil war in 37 B.C. when it was feared that Sextus Pompey might shift the war at sea thus threatening Rome's provisions. Following Octavian's wishes Agrippachose the area in front of the lake *Lucrinus*(Figure 25) to build the military port (Suetonius, *Life of Augustus* 16; Scherling, 1953) . Unlike Lake Avernus, the Lucrinus was a shallow coastal lagoon that was used for mussel and fish farming. It was however much larger than it is today. The eruption of Monte Nuovo in 1538 filled up a large part of it and the resulting bradyseism submerged a large part of the area close to the sea (DeCaro 2002:64). The lake was transformed by cutting through the isthmuses that separated the lake from the sea and from the *Avernus* respectively. Lake Avernus is a volcanic crater of staggering proportions with a circumference measuring 2,86 km and was believed to be a sacred place (DeCaro 2002: 62). The engineering challenges were such that when completed both Virgil (*Georgics*2.161–4)and Pliny (*Natural History* 36.125)describe the harbour as one of the man-made wonders of Italy (Brandon, Hohlfelder et al. 2008: 375).

Despite its successful engineering, the life of the *Portus Iulus* as a military base was short-lived and in the 12th C. B.C. the Roman navy was moved to the nearby Misenum. The port structures on the lake *Lucrinus* took on a commercial role instead. Still visible to us underwater at a depth of 7 metres are a series of architectural remains. Easily spotted is the entrance channel that is about 300 metres long and at the end of which are a series of *pilae* (Figure 30 detail A). Towards the interior of the lagoon are basins separated by a pier measuring 100 metres (Figure

30 detail B). Southwest of this pier is an overlying structure that immediately caught the eye of archaeologists examining the aerial photographs. This is a large rectangular structure, located at an oblique angle when compared to the rest of the underwater remains (Figure 30 detail C) (Gianfrotta 1993: 118). The exact function of this building is unknown but it has helped archaeologists detect possible building phases for the port complex.

One is also able to identify a series of *horrea* and *tabernae* that appear to have been located between two parallel roads (Salvatori 2008: 434). Northwest of the parallel roads is an impressive *Horreum* made up of a series of *cellae* set around a square courtyard; warehouses for the storage of travelling goods. The walls were built in *opus reticolatum* in front of which was a stone threshold. These rooms opened up onto a central area and were likely to be preceded on one side by a colonnaded porticoe of tufa columns (Gianfrotta 1993: 120). The smaller rooms, measuring just over one metre indicate that there were once stairs to access at least one floor above. Relatively thick floors made of *opus signinum* can still be identified in some of the *cellae* and in some instances well-persevered vertical wooden poles were also documented. These were most likely used to support scaffolding inside the warehouse's individual rooms (Figure 30 detail D). It has so far been difficult to assign an accurate chronology for these structures but it has been suggested that they might date to the 1st C. B.C. or beginning of the 1st C. A.D. (Gianfrotta 1993: 121).

On the western side of the warehouses are the remains of a *domus* that might have been part of the *Horrea* complexes. It appears to have had various entrances on its northern side and a clearly defined peristyle surrounded by stuccoed columns in *laterizio* that surrounded a garden with fountains on the southern part. To the west of this building, the remains of another structure have been identified, despite being almost completely covered by sand deposits. The building appears to have been reduced to ground level but its floors remain surprisingly well preserved. It is possible that this was another maritime villa or another *domus* that may have been removed to make way for the above-mentioned building (Gianfrotta 1993: 121).

4.7 Contemporary Observations

4.7.1 Observations of landmarks and descriptions of sea-faring

The following section takes a brief look at some ancient contemporary descriptions by some of the most prominent authors of the time. Whilst this section is most certainly not a historiography nor does it include all the available texts, it is possible to gain an understanding of certain elements of the landscape and more importantly how they were viewed and understood in the past. This section is divided into three parts: The first part looks at contemporaneous ancient descriptions of sea faring and landmarks as viewed from the sea. The second part describes some contemporary observations of certain geological phenomena, while the third part looks at ancient visual representations of port landscapes.

The authors considered in the next section are Seneca, Pliny the Elder and Rutilius Namatianus. Ptolemy's geography was not included in this list because there is as yet no reliable translation of his work.

4.7.1.1 Seneca's *Naturales Quaestiones*

His *Naturales Quaestiones* written between 63 and 64, stands in a category by itself and its title may be somewhat misleading. The closest translation of the Latin form of *Quaestiones Naturales* is Physical Enquiries (what we now call Physical Science) even though the terms Physics and Science had a very different meaning to the ancient Roman than to us. The extent of such a title was determined by the choice and range of topics the author decided to include (Clarke 1910: xxxi). In Seneca's work the areas dealt with are Astronomy, Meteorology and certain aspects of what we can now be called Physical Geography including Seismology.

Before looking at the text we must bear in mind that *N.Q.* was composed at different dates with material that was gathered at various times depending on the available opportunities. The final arrangement belongs to the last years of his life (63, 64) and the publication is likely to have taken some time, possibly carried out by Seneca's literary executor, Lucilius. This implies that the text that we have become accustomed to is not the work that left the author's hand (Clarke 1910: xxxiv). As the text stands, it is full of interruptions, odd transitions and inconsistencies and it is hard to believe this would have left the author's hand in preparation for publication. There have been many attempts to restore the book in its possible original sequence but for practical purposes it is best to accept the book as it is and work with the relevant information from it.

Unfortunately it is not possible to dwell on every aspect of the vast work that form part of Seneca's treatise. However there is plenty of information that can be extracted with regards to ancient seafaring and way finding. As with the section on modern Pozzuoli, here we can look at what the contemporary Roman authors' knowledge was and a good place to start would be the winds (See Volume 2 Appendix 1 pg 133) for Seneca *N.Q.* book V: XVI).

4.7.1.2 Seneca's Letters

It is believed that the letters were written between the years 63-65 BC. In them we find possible references to the Campania earthquake of 63 and many other hints that the philosopher was travelling around Italy in order to forget politics. The structure of each letter is interesting. Seneca begins by mentioning a fact or an event such as an illness, a voyage by sea or land or an adventure, a picnic or a group of friends discussing philosophical questions. This narration is then used to introduce the reflection that followed (Gummere 1916: x).

This collection of letters is particularly useful as they form a handbook of Roman elements of the very widest scope and interest. Two particular letters (or rather parts of letters) by Seneca are particularly interesting with respect to the project: The first is a description of a short but ill fated journey by sea, which, despite its brevity, allows us to glean a number of elements related to sea faring (See Volume 2 Appendix 1 (pg 134) for Seneca' Moral Letters to Lucilius: Letter 53: On the faults of the spirit).

The translated textin Appendix 1 has been inserted as an entire quote, precisely because any tampering or rewording would greatly alter our understanding of the sense of the journey (and its related distress) that was experienced by the author and the accompanying sailor.

The second most widely quoted text from Seneca in relation to *Puteoli* is the arrival of the Alexandrian grain fleet, greeted with joy by the population of *Puteoli* (See Appendix 1 pg 135 for Seneca's Moral Letters to Lucilius/ Letter 77: On Taking One's own life).

4.7.1.3 Rutilius Namatianus

The poem written by Rutilius Claudius Namatianus that describes his home-coming journey from Rome to his native Gaul is of particular interest not only from a literary and historical point of view but in this case, from a topographical point of view. His vivid descriptions provide us with some important information of the places he visited. It must be pointed out that the journey undertaken by Rutilius takes place in a period well outside that of the project's focus, in fact what we are looking at here is the beginning of the 5th C AD. However useful information about ancient sea-faring may still be extracted for the project's purposes (Keene and Charles 1907: 1).

The portion of the poem that has survived covers a period of about two months from September to November and is more like a journal of his wandering than anything else and whether the poem was written during the actual journey of afterwards is not known (Keene and Charles 1907: 8). Rutilius is likely to have set sail in the autumn of 416 AD and his journey was arranged as follows:

He left Rome and proceeded to the mouth of the Tiber and was forced to remain there (at Portus) due to adverse weather for about fifteen days. After that the weather improved he was able to set sail. The first day's voyage takes him to *Centumcellae* where he spends the night and he resumes his voyage the next day. Rutilius describes the mouth of the Munio and the scattered rooftops as well as the pine groves of *Graviscae*. He sighted Cosa and by the night the sun set the travellers had made their way to *Portus Herculis*. Setting out just before dawn on the third day of their journey, they sailed along the coast of Monte Argentario that runs out into the sea (Keene and Charles 1907: 10). They touched the mouth of the river Umbro where despite Rutilius's wishes, the sailors refused to take shelter and pressed on and when the sun set, were forced to stop close to the shore and build makeshift tents. At daybreak on the fourth day, they set off again (using their oars) and progressed slowly where they got sight of *Ilva* (Elba) and then tired of rowing landed at Faleria (Keene and Charles 1907: 10). Unfortunately, their landing was short-lived and despite the unfavourable wind (Boreas) they once again picked up their oars and headed to Populonia, the landscape of which is described at some length. On the fifth day the wind (Aquilo) blew once again in their favour and after sailing past the views of the mountains of Corsica and Capraria, they reached the region of Volaterrae (known as Vada). As the wind began to then rise to a gale (Corus), Rutilius and his travel companions took refuge in the Villa of a friend named Albinus (Keene and Charles 1907: 11).

On the sixth day of the voyage, the wind was once again favourable and they glided through the smooth seas and spotted the island of Gorgon rising from the water but are concerned about its infamous rocks, which were the cause of a recent tragedy which the travellers had witnessed while on their way to the port of Pisa (Keene and Charles 1907: 11). Returning from Pisa to Triturrita, their sailing is once again postponed by a sudden storm, whereby the travellers are once again obliged to postpone their departure. They then occupy their time by hunting in the neighbouring woods and they do not resume their journey for a while (Keene and Charles 1907: 12). Sadly, only sixty-eight lines of the second book of Rutilius' poem are available to us. They chronicle a day's voyage from *Portus Pisanus* to Luna (Keene and Charles 1907: 13) (See Appendix1 page 137 A Voyage Home to Gaul: Book 1).

4.7.1.4 Pliny the Elder

Book II of his *Naturalis Historia* deals with many of the subjects that were also treated in Seneca's *Q.N.* including the description of the winds. In some cases, Pliny merely expands (See Appendix 1) but in others Pliny gives little more than a summary of what has already been written. Most surprising is that there is no mention of Seneca in the list of authorities in this book. Seneca's name is mentioned in the lists attached to Books VI, IX and XXXVI, the first dealing with the geography of Asia and Africa, the second dealing with the subject of fish and aquatic life and the third with the natural history of stones (Clarke 1910: xxxiv).

4.7.2 Observations of geological phenomena

4.7.2.1 Description of winds

(See Appendix 1 Pliny the Elder Chap. 46.(47) The different kinds of winds page 140).

The four winds described by Pliny the Elder mentioned are twelve and give us the following card: N. Septemtrio, S. Notos or Auster, N.N.E. Boreas or Aquilo, S.S.W. Libonotos, E.N.E. Cæcias, W.S.W. Libs or Africus, E. Apeliotes or Subsolanus, W. Zephyrus or Favonius, E.S.E. Eurus or Vulturnus. W.N.W. Argestes or Corus, S.S.E. Euronotus or Phœnices, N.N.W.Thrascias.

4.7.2.2 Description of earthquakes

We know that there was no evidence of bradyseism in Roman times and Frederiksen believes, with good reason that the local subsidence was a post classical phenomenon, there is however a small note by Strabo and Highlighted by Rabun that may suggest otherwise. This will be dealt with at a later stage. In the meantime one ever-present geological phenomenon were earthquakes that were observed and described by both Seneca and Pliny, the extracts of which are below.

Seneca describes the earthquake in AD 62 that first destroyed a large part of Pompeii and Herculaneum along with the buildings in Naples and Nuceria that were also damaged. He gives us a detailed account and hereunder are some excerpts from his *Naturales Quaestiones* book VI, On Earthquakes;

> *[...] We have just had news, my esteemed Lucilius, in that Pompeii, the celebrated city in Campania, has been overwhelmed in an earthquake, which shook all the surrounding districts as well. [...]*
> *[...] this shock occurred, involving widespread destruction over the whole province of Campania ; the district had never been without risk of such a calamity, but had been hitherto exempt from it, having escaped time after time from groundless alarm [...]*

Seneca seems to have had an understanding that these causes were natural;

> *[...] It will be useful also to be assured that none of these things is the doing of the gods, and that the moving of heaven or earth is no work of angry deities. Those phenomena have causes of their own [...]*

And then he proceeds to debate the various current theories that cause earthquakes, namely, water, fire, air and the earth itself. Seneca then joins the majority of the authorities on the subject and assigns the cause of earthquakes to air.

> [...] The chief cause of earthquake, therefore, is air, an element naturally swift and shifting from place to place [...]

Pliny gives a much shorter description of the phenomena of earthquakes:

(See Appendix 1, Pliny the Elder Chap. 8. (79.) Of Earthquakes page 141)

4.7.2.3 Bradyseism in antiquity

Referring back to the previous point Taylor highlights that Strabo comments on the extreme shallowness of the waters behind the harbour mole of Lake Lucrinus. Given that we know the trend the land followed was mainly downwards (see chapter 2) Strabo's observation seems incongruous. The harbour should have been getting deeper, if anything (Taylor 2010). Taylor thus suggests that Strabo may have noted what was a temporary uplift in the area that took place before the eventual sinking began. This may well be possible as we know that Bradyseism is unpredictable and reversible and two periods of uplift are known to have occurred in the seventh and sixteenth century (Taylor 2010). What remains unclear at this point and within the context of this chapter is whether Strabo's observation was a result of an awareness of this phenomenon or simply an observation. Essentially it might be evidence of the uplift but that they would not have known what it was.

4.7.3 The relevance of ancient observations

What can these texts tell us about ancient sea faring/way finding? We have descriptions of the winds and what is done to counteract them and an apparent understanding by the authors of the behaviour of the winds. We are also presented with the reasoning behind not choosing to sail close to the coast and the consequences of such choices.

What knowledge of wind does Pliny the Elder transmit to us? How similar is it to the work of his predecessor Seneca? Pliny here simply copies a lot of what Seneca has already said about earthquakes, with regards to the calm that is experienced before (Bostock 1855).

Thanks to the descriptions of Rutilius Namatianus, we are able to learn something not only about the sea-faring conditions of Rutilius and his crew but also of the islands, which without landing on them they were able to sight from the deck of their ship. This is a vital element to needs to be carefully considered in the context of this study.
How does the poet describe these islands? What features draw his eye? Can we gain an understanding of the landscape as experienced by him through this description or not? These extracts are useful as an understanding of how contemporaries described their journeys, what they identified as being noteworthy during their travels.

4.8 Ancient Representations of Pozzuoli: The Glass Flasks and the Bellori Drawing

The most famous representations of the Puteolean landscape come in the form of etchings on glass flasks, known and studied by early academics such as Dubois and have provided scholars with ample elements for debate. The glass flasks attracted a lot of scholarly attention and even before Steven Ostrow tackled the subject of their topographical importance, comprehensive accounts were described by Picard (1959) and Painter (1975). However, it was Ostrow who discussed the individual scenes specifically related to Puteolan topography.

Despite the fragmentary evidence we have for the topography of ancient *Puteoli*, we have been handed down a unique document that has been able to assist scholars in the study and understanding of the topography of *Puteoli*. These are no less than eight glass flasks, six of which have survived almost intact while for two others we only fragments remain (Ostrow 1979: 77). The flasks belong to a lager class of bulbous flasks the associations of which suggest a date in the 3rd or 4th C AD (Painter 1975: 54). On four of these flasks an inscription is located just below their vertical necks. The nature of these inscriptions is varied, ranging from commemorative to exhortation, possibly engraved at the request of the purchaser (Ostrow 1979: 77). The main bodies of all eight flasks are decorated using a superficial abrasion technique and have scenes depicting the architectural features of *Puteoli* and the neighbouring territory of Baiae to the west (Ostrow 1979: 77).

Before moving to the description of the flasks, it is important to mention at this stage one other important document. This is what has come to be known as the Bellori drawing. This is a painting based on an ancient wall painting of Rome. In keeping with previous scholarly debate that always included this element alongside the glass flasks, Ostrow chooses to include it in his catalogue.

4.8.1 About the Flasks

The Prague Flask (Figure 29)
Height 13.9 cm
Diameter 10.1 cm
This Flask was part of a private collection "and was probably found in Italy". It must have become part of the Prague Museum sometime before 1924 (which is the date of its first mention by Cadik). Picard goes on the say that it is of uncertain provenance (Picard 1959: 37).

The Pilkington Flask (Figure 31)
Height 15.1 cm
Height (neck 5 cm)
Vertical height of decorated area 7.1 cm
Dia*meter* (body) 10 cm
Diameter (rim - external) 2.1 cm
Currently in the Pilkington Glass Museum. It was bought in Germany and is said to come from a North African Collection, perhaps from a site in Tunisia (Painter 1975: 59).

The Odemira Flask (Figure 32)
Diameter: 10.5 cm
Height: Unknown (see Ostrow 1979, pg 81 for discrepancies with measurements).
It is said that the flask was discovered in the Roman mines of Odemira, in the district of Alemtejo, Portugal. The date of when this discovery was made remains however unspecified. It was then bought, again at an unspecified date by the Marquis de Souza Holstien and was displayed in the Paris *Exposition Universelle* in 1867. The Marquis later donated the flask to the Academy of Fine Arts in Lisbon and in 1868 Jordan published a careful description of it, which is fortunate for us because by 1892, the vase disappeared from the Academy and was never to be found (Ostrow 1979: 81).

The Ostia Flask

Dimensions: Unknown

What Ostrow here calls the Ostia flasks are really just a series of fragments that make up one larger fragment. These were discovered in *Via dei Vigili presso la fontana* at Ostia. The date when they were discovered and their current whereabouts remain unknown (Ostrow 1979: 82-3).

The Cologne Flask

Dimensions: Unknown

In 1924, eleven glass fragments were found near the Church of St Severin in Colgne and sent to the Rom. Germ. Museum in Cologne where they can still be found today. There is mention of two additional fragments of unstated provenance that arrived later at the Museum but only 10 fragments have ever been illustrated (Ostrow 1979: 84).

The Populonia (Corning) Flask (Figure 33)

Height 18.4 cm

Diameter 13cm

Circumference 39 cm

This flask was discovered in an ancient tomb near Piombino (ancient Populonia) around 1812 and for a long time its whereabouts were unknown. Many scholars including Picard and Frederiksen were unaware that it was privately owned by a certain R.W. Smith and that it came into the possession of the Corning Museum of Glass as of 1962 (Ostrow 1979: 85).

The Ampurias Flask (Figure 34)

Height 16.5 cm

Diameter*: Unknown*

Discovered perhaps in 1920 by clandestine diggers near modern Ampurias, the locality of Inigo in an inhumation tomb along with many other funerary furnishings. The vase stayed near Ampurias at least until 1954 in the possession of a certain Dona Catalina Albert. In 1930 drawings of the vase and of its surface decoration were made (Ostrow 1979: 86).

The Rome (Warsaw) Flask (Figure 35)
Height 10.9 cm
Diameter 7.9 cm
This flask was found "*nel suburbano di Roma*" sometime before 1794. Picard (1959: 34) reports that the vase came from a catacomb without giving any source for this knowledge, as do others such as Fremersdorf (1967: 191) who simply describes the vase's provenance as the Roman catacombs without further details. In 1853, the flask was in the *Museo Borgiano di Propaganda* in Rome, where it was studied and drawn (DeRossi 1853: 133). After that its whereabouts are somewhat unclear but it resurfaces in 1899 where it is referred to as being part of the Craztoryzky de Goluchow Collection in Poland and in 1956, the vase became part of the Warsaw National Museum (Ostrow 1979: 87).

The Bellori Drawing (Figure 27)

The Bellori drawing is an engraving by P.S. Bartoli who many believe is depicting the important architectural features of ancient *Puteoli*, several of which have been labelled with abbreviated Latin inscriptions. In 1764, G.P. Bellori published this engraving in his work entitled *Ichnographia*. The Roman painting on which the engraving is based on was probably one of the wall paintings that were discovered in a building of unknown purpose on the Esquiline hill in 1668 (Ostrow 1979: 88).

The painting was first described in 1668 in a letter by Ottavio Falconieri to Heinsus and as far as we know the original painting was never described again and was lost soon after its discovery. Accompanying this engraving is a set of 12 drawings depicting individual details of the engraving. These seem to have been based on the original wall painting rather than on the engraving because the labels on the drawings are in their original spelling (as reported by Falconieri) as opposed to the abbreviated forms used by Bartoli (See Dubois 1907: 201-201, n. 5). All 12 drawings were inscribed and reproduced in Hulsen (1896: 216-17) plates IV, V, VI and VII.

Function

There is considerable debate about the function and dating of these flasks. The general understanding was that these were "*souvenirs des touristses*" intended for those who visited the Bay of Naples, whilst other scholars believed that these were not merely souvenirs but because of the depiction on several flasks of a great temple (possibly of Serapis), these were sacred vases that were carried home by those initiated into the cult of Isis and Serapis (Ostrow 1979: 89). Also, because of there are (as yet) so few examples all similar in the workmanship and decoration, there has been a general assumption that these were the product of a single workshop. It has also been suggested that given the nature of the scenes coupled with the glass industry that flourished in Pozzuoli (Camodeca 1977: 65), the flasks were manufactured in or near *Puteoli* (Ostrow 1979: 90). The technical aspects described in detail by Ostrow (1979) suggest that these flasks date between 3rd and 4th C. AD (Ostrow 1979: 91).

4.8.2 Topographical representation: The glass flasks

This is of particular interest to the project for a variety of reasons. First of all we get an understanding of the idea of prominence and what was considered important to be depicted (regardless of the use of the vase). Secondly as we shall see, Ostrow undertakes an interesting exercise by trying to assign the position of the viewer in relation to what was chosen for depiction. This will be computed and a comparison will be made between Ostrow's deductions and the digital observer.

Four of the flasks: Odemira, Prague, Pilkington, Ostia and possibly the Cologne together with the Bellori drawing depict the various architectural landmarks of *Puteoli*. The Ampurias and the Populonia flasks combine views of the coastal area around Baiae and those of *Puteoli*'s harbour. The Rome vase deals exclusively with the Baian coast (Ostrow 1979: 93). Three of the first four flasks mentioned deal with views of *Puteoli* alone and are the most important to this project. From these three depictions, Ostrow is able to establish

"[...] a fairly consistent observer's viewpoint for the entire scene [...]

" [...] it lies somewhere offshore in the midst of the city's harbour, perhaps directly north of the western extremity of the great harbour mole (designated as PILAE or PILAS on the three intact vases) thus lies to the right of the observer's visual field and as the southernmost feature that he sees, while his viewing field is closed at the northwestern end with views either of the stadium (Prague and perhaps Pilkington vases) or of the city's two amphitheatres (Odemira and, again, Pilkington flasks)"

(Ostrow 1979: 93)

Between these iconic landmarks which frame the scene and which still survive today, we find the other architectural features of the cityscape and of these few can be correlated to surviving remains in modern Pozzuoli. It is made clear by Ostrow and will be reiterated in this text that these flasks are by no means seen to represent a coherent spatial relationship or a true sense of perspective, as it is very clear that these depictions are schematic (Ostrow 1979: 93). The intent of these depictions is that of presenting recognizable visual elements of the individual buildings rather than the spatial relationship between them. One must also bear in mind that the panoramas were created selectively, a point to which this project will also come back to.

> "...*each artisan choosing what he apparently deemed the most memorable or otherwise significant features of the city...*"
> (Ostrow 1979: 93)

With Ostrow's help, this discussion, like his, will follow those flasks that are primarily concerned with *Puteoli*'s views. The most detailed of these views is found on the Prague flask and it contains the most richly documented scene of all. The left half of this decoration is divided into four successive horizontal rows of building features representing mostly colonnaded facades. These four bands are then divided vertically with a depiction of a temple façade that occupies the full height of the decorated area. Many of these buildings are labelled with neat, mostly abbreviated, inscriptions and it is sometimes unclear to which building the label is referring to. The great harbour mole dominates the right half of the scene and its relevant decorations (Ostrow 1979: 94).

THE PRAGUE FLASK (Figure 29)

Ostrow begins by describing the complex scene on the Upper left hand corner where the stadium is depicted and labelled - STADIV(M) and which we can confirm does exist thanks to the recent excavations in the north-western part of the city by Costanza Gialanella (Gialanella and Romano 2008). Immediately to the right is a set of columns labelled SOLRARIV(M). This could be referring to either a sundial and/or to a terrace or balcony exposed to the sun. The interpretation remains uncertain (because there are depictions for what could be interpreted as both meanings on different flasks (Ostrow 1979: 94). Further right is a second colonnade underneath the inscription LARI. The *Lares Augusti* were indeed known in *Puteoli* but the arrangement of the texts in this case suggests to Ostrow that this may indeed be a dittographic mistake (Ostrow 1979: 94-5).

Beneath these buildings we see, drawn using a bird's eye perspective, the arena labelled AMPITHEAT(RUM), incongruously superimposed above the schematically rendered supporting walls and arcades of the same structure. Ostrow presumes that this is the later and grander Flavian amphitheatre to be portrayed here (Ostrow 1975: 95) while on the Odemira and possibly the Pilkington flasks both amphitheatres are portrayed and we know that the city was one of the few in the Empire that possessed two amphitheatres. The depictions on all three flasks include the masts of the *velum*. The supporting structures of the amphitheatre on the Prague vase also spill onto the decorative band below, while the arena is flanked on either side by colonnaded façades. These types of façades appear to have been employed repeatedly on the flasks' architectural decoration and, from what we know of *Puteoli*'s town plan so far, might suggest that these may have been used to fill space rather than represent actual buildings (Ostrow 1979: 95).

Still in the area to the left of the Temple façade in the third row from the top, we find two more sets of colonnades depicted on the side of the amphitheatre each with an inscription above them, one ORDION and PALES respectively. These inscriptions are unique to the Prague vase. This inscription has been interpreted as *(H)ordion(ii) Pal(s)es (tra)* (Picard 1959: 39). If this interpretation were correct, it would be the only known Palestra in ancient *Puteoli*. This is quite possible given that other public monuments bore the name of the wealthy Puteolan family of the Hordeonii. The Mucerine tablets found in Pompeii have also described an *ara Augusti Hordioniana* that stood in the forum of *Puteoli* (Camodeca 1977: 63; Ostrow 1979: 95). It is also appropriate for the *palestra* to have been located close to the Amphitheatre.

In the last band to the left of the temple and below the *palestra*, instead of the rows of columns we find a web-like pattern labelled ORTESIANARIP. This is another inscription which is unique to the Prague flask and which scholars believe to be the (H)ORTE(N)SIANA RIP(A) (Ostrow 1979: 95). Topographically, we have now moved from the plateau of the amphitheatres directly down to the water's edge and dock area. It has often been suggested that the Hortensius who gave his name to the *Ripa* was the famous orator himself and that his holdings were so vast that they lent his name not just to the Ripa but to an entire sub division of the city, the *Regio Hortensiana*, (Camodeca 1977: 70) which is known from an inscription dating to the year 241 A.D. and is likely to have included the *ripa Hortensiana* itself (Ostrow 1979: 97).

We must bear in mind that all the accessible evidence of the engraved scenes on the vases comes from published line drawings. These themselves are reproduced in a variety of publications and without clarity of detail often representing details on the glass surface that are obscure, whether through the carelessness of the artisan or through the effects of time (Ostrow 1979: 97). Much of the controversy surrounding the debate of the Temple's representation and identification is not because of the different interpretations of certain observed iconographic details but because of different basic visual observations which themselves differ perhaps even just by a single drawn/incised line (Ostrow 1979: 97).

The façade on the Prague, Odemira, Pilkington and perhaps also the Ostia flasks is that of a distyle pedimental temple. On the three flasks that are complete we find the depiction of a standing, draped human figure with rays emanating from the head with arms upraised each of which holds an object. Most of the debate surrounding the temple's identification revolved around the iconography of the statue[23]. The result of the extensive debate was that the iconography of the cult figure on the glass flasks is consistent with the known iconographical features of a range of Serapis images (Ostrow 1979:103). Coupled with

[23] See Ostrow 1979 pages 98 - 103 for a detailed description of the debate.

this is the architectural adornment of the structure itself noted by scholars such as Dubois (1902: 50) and Picard (1959: 34). Evidence of the *lex parieti faciendo* suggests that the temple of Serapis in *Puteoli* was situated near the sea, while a statue of Serapis was discovered in the *Macellum*, close to the harbour (D'Arms 1972: 269-70, Ostrow 1979:107).

Accordingly, the inscription DECATRIA on the Prague flask can be seen close to the great harbour mole although the design on the flask is not very clear with regards to the vicinity of the DECATRIA to the INPVRIV (*emporium?*) designated in the lowermost zone presumably at the water's edge (Ostrow 1979:107). On the Pilkington vase, the inscription INPV(RIVM?) is located immediately right of the theatre and left of the breakwater as does the DECATRIA on the Prague vase which may suggest that the two were at least in general proximity to one another (Ostrow 1979:107). Furthermore Camodeca's work has shown that the area known as *Decatria* (and the *regio* to which it gave its name, was situated a bit further up the hill from the area of the *emporium* but not far from it (Camodeca 1977: 68). This is very important information as these glass flasks give clues not only about the topographic evidence and locations of some of the key architectural landmarks of *Puteoli* (some which no longer survive) but also on the state of knowledge of the artisans who created these engravings.

On the uppermost banner of inscriptions in the area to the right of the temple, we find the words STRATA.POS.FORV above two colonnades. Although there has been much puzzlement amongst scholars, Camodeca offers a plausible explanation who proposes that STRATA POS(T) FORV(M) and FORV(M) POS(T) FORV(M) are expressions which he considers to be the equivalent and possible designations for the *forum transitorium* of *Puteoli*, which we know of through an inscription (Camodeca 1977: 68-70). The *forum transitorium* would therefore lie just behind the main forum of *Puteoli*, which Camodeca has identified in the area of the former Villa Cardito, now property of the *Educandato Femminile Maria Immacolata* in Via C. Rosini.

In the next row on the Prague vase we find THEATRV(M) and DECATRIA inscribed above two more colonnades which abut an engraved theatre building. The supporting walls and arches of the theatre are almost identical to the supporting structures of the amphitheatre on the same flask (Ostrow 1979: 111) and they too, like the amphitheatre sub-structures reach into the new row of buildings below. The orchestra, similar to the amphitheatre is viewed again in a bird's eye view and it was made recognizable as a characteristically Roman semi circle. Unfortunately we know nothing about the remains of a theatre in *Puteoli* despite the discussion by Dubois (1907: 193-4).

In the lowermost level of this second area, we may have presumably reached sea level and the following designations seems to reflect this. INPVRIV and SACOMA. The former is most likely the *emporium*, the commercial trading centre of *Puteoli* (Picard 1959: 42). The *emporia* depicted on the Prague and Pilikington flasks are as close as we get to seeing the indication of the location of the famous surviving *macellum* of *Puteoli*, which must have been quite an imposing feature within the emporium (Ostrow 1979: 113). This is an interesting point. On what does Ostrow base his assumption that the *macellum* was an imposing building? Is it based on the fact that it was this building that was deliberately chosen to be depicted out of all the buildings in the Emporium or is it because it is found on all three flasks?

The memorable landmarks from the Puteolan mainland depicted on the Prague flask also find their counterpart in the great works at sea. In order to depict the famous harbour mole and its decorations, the engraver devoted nearly a full half of his decorative design. The drawing of the mole represents the massive *opus pilarum* (PILAE), a breakwater some 372m long supported by fifteen concrete piers, which constituted the principle man made feature of *Puteoli*'s harbour. The *Pilae* of the Prague flask are not only reproduced on the Odemira and Pilkington flasks but also on the Cologne, Populonia and Ampurias flasks (See figures 34, 35) that have not been so far considered. We also find this representation on the Bellori drawing. The unlabelled breakwater is so similar in detail to those on the Prague and Pilkington vase that it is the feature scholars have used to identify the Bellori drawing with the representation of *Puteoli* in the first place (Ostrow 1979: 113-4). Ostrow understandably suspects that judging from the prominence on the flasks and the Bellori drawing, this construction was perhaps the most celebrated of all Puteolan landmarks in Antiquity (Ostrow 1979: 114). On every one of the flask inscriptions we find inscribed vertically the two honorary columns standing on the mole the label PILAE (PILAS on the Odemira vase and PIL[AE] on the Apmpurias). Only on the Prague scene however do we find the additional inscriptions PELAGV(S) and PVTIOLI, which allows for a more precise identification of the geographical and topographical setting (Ostrow: 114). Of the original 15 freestanding piers, each flask displays its own number. The Prague and Pilkington flasks reveal five, the Bellori depicts seven, the Populonia and Ampurias flasks four, the Odemira, just two (if these have been correctly identified). The parallelograms depicted near the top of every pier have never been explained but Ostrow suggests that they must represent the mooring blocks of stone described by Dubois on the basis of De Fazio's account (Dubois 1907: 257-58). The seaward extremities of the breakwaters, particularly those of Prague and Populonia appear to be fitted with features more of less in the shape of a ship's prow. The structures that stand upon the harbour mole divide the several representations into two groups: those that depict two triumphal arches, one closer to land crowned with Tritons and one closer to the sea with *hippocampi* (Prague, Pilkington flasks and Bellori drawing) and those with a single arch crowned with *Hippocampi* near the seaward end of the mole and a gabled structure of some sort closer to land (Odemira, Populonia and Ampuria flask).

Ostrow notices that the architectural renderings of the various arches are not unambiguous. The mole itself is clearly represented in profile so to speak, while the arches show us a variety of viewing angles. Whilst the visual representation may be difficult to comprehend, it does not mean that we are viewing nonsense (Ostrow 1979: 115). This is perhaps a deliberate attempt by the engraver to capture as many visually significant elements as possible even at the expense of spatial coherence. The disadvantage for us is that we are unable to say with any certainly what the original ornamental scheme of the mole was like. Did it have a single, double or triple archway? Where there two triumphal arches or an arch plus a gabled structure? Were there two honorary columns or four? (Ostrow 1979: 115). What we do know is that every representation of the breakwater both on the vases and in the drawing appears to have a double arch crowned by *Hippocampi* standing at the end of the mole that is closer to the sea (Ostrow1979 118). Ostrow comments that the extremities of the various moles on the vases as looking rather "prow-like" (Ostrow 1979:119). The "prows" of the Prague and Populonia moles each bear a T-bar like projection - Horizontal on the Prague flask and nearly vertical on the Populonia one. The Bellori drawing depicts a short projecting platform at the end of the mole with a figure standing inside his arms extended: He also notes the flame-like depiction that rises from a stand at the end of the Odemira mole and that a narrow curving line (a stylized flame?) can be seen in the same location on the Ampurias flask. Dubois was the first to suggest that this may be representative of *Puteoli*'s harbour lighthouse(Dubois 1907: 198).

Finally Ostrow proceeds to examine whether any chronological evidence for the date of the flasks can be deduced from the details that were observed. Ever since the publication of the Populonia flask at the time of de Rossi in 1853, there appears to have been a misconception concerning one or two of the triumphal arch or arches present on the mole. De Rossi suggested that the arch that stands on the mole of the Populonia flask was identified as that of the "*Capitolino in Antonio Pio*". This fact was based on a passage in the *Historia Augusta* and most scholars have accepted it. Furthermore, since the time Dubois' time, two monumental descriptions dating to the reign of Antoninus Pius that testified to the repairs of *Puteoli*'s *opus pilarum* have been cited to further support the identification of at least one of the arches as that of Antoninus (Dubois 1907: 198). As a result, it was assumed that the glass flasks were produced after the Antonine period (Osrtow 1979: 120). Other scholars however have pointed out that there is in fact no passage in the biography of Antoninus Pius by "Capitolinus" that makes any reference to the supposed arch, at *Puteoli* or anywhere else for that matter. Ostrow himself looked for this fabled passage without any success (Ostrow 1979: 120). One cannot exclude the possibility that one (or both) of the arches depicted on the Bellori drawing and on the glass flasks may have indeed been dedicated to that Emperor and the inscriptions that were cited by Dubois both found at sea close to the breakwater itself may suggest this (Ostrow 1979: 121). The letter sizes of one of the inscriptions (*CIL*. X 1641) were described by antiquarian sources as being of such a size as to suggest that they were part of a crowning inscription of a triumphal arch. This assumption was then challenged by Dubois suggesting that these inscriptions may have been in another position on the mole rather than on any one of the triumphal arches (Dubois 1907: 261). Whilst the Antonine association of the arches will remain unclear, what we know for certain is that if there was an Antonine arch, it must do without the support of De Rossi and the *Historia Augusta* (Ostrow 1979: 121).

THE PILKINGTON FLASK (Figure 31)

Of all of the flasks that have come to us intact, the overall scene of the Pilkington glass flask is the one that comes closest to the Prague case. Yet, the number of buildings depicted was reduced by almost half and the craftsmanship is of considerably lower quality than that of the Prague vase (Ostrow 1979: 121).

The inscription STADIV in the upper zone of the scene is placed over a structure that resembles an amphitheatre rather than a stadium. The engraver of the Prague flask as we have already seen chose to illustrate the stadium and one of the city's amphitheatres, whilst the artisan of the Odemira flask chose both amphitheatres instead. What the intention of the engraver of the Pilkington vase was, remains unclear. Did he wish to portray all three monuments in a restricted area using a combination of inscriptions and depiction? (Ostrow 1979: 122). Filling the remainder of the zone to the left of the temple is a colonnade with a curious T-shaped object, with the inscription SOLAR(IVM) above them and below the AMP(H)ITEAT(RVM) accompanied by two additional colonnades on the right. Next comes the temple of Serapis with its area to the right divided into two levels. The upper strip consists of a series of columns over which is an inscription FORVOISFORV. On the lower strip we find the THEATRV(M), not as well executed as that of the Prague flask. On the right we find another series of columns with the label INPV(RIVM) and although this is in a different location from that on the Prague flask, it is still correctly placed close to the water's edge. The breakwater then completes the scene with its two fish set rather incongruously below the amphitheatre structure initially observed (Ostrow 1979: 122).

THE ODEMIRA FLASK (Figure 32)

The overall scene of the Odemira flask is also very similar to the Prague flask but also much reduced. It does however bear one inscription that is unique to the flask: THERMEAANI. To the left we find the two amphitheatres but only the lower one is labelled (Ostrow: 1979: 122). To the right of the amphitheatres we see two stylized column sets, the uppermost set of which bear the inscription SOLARIV(M). Next comes the temple of Serapis and further to the right are two additional sets of columns, the lower one interrupted by a depiction of the theatres and above which is the inscription THEATRVMRIPA. (Ostrow 1979: 123). The long continuous upper colonnade is labelled THERMEAANI (THERMAE AANI). Therefore in an area where other flasks (such as the Pilkington, Prague and Ostia) portray an area apparently belonging to a public forum, here we are presented either with baths (THERM(A)E) or with baths plus a second structure labelled AANI. The ligature -A has proved difficult to interpret and as yet no explanation has been found (Ostrow 1979: 123). Dubois plausibly identifies the *Thermae* on the flask with the bath complex the meagre remains of which have survived to the southeast of the amphitheatre under the medieval name of *Bagno Orthodontico*. Their position on the flask, that is to the right of the amphitheatres, would thus remain consistent both with our supposed observer's viewpoint, lying in the midst of *Puteoli*'s harbour and also with the actual location of the forum as it has now been identified (Ostrow 1979: 125). The remainder of the scene on this flask is occupied by the breakwater with its honorary columns, triumphal arch and lighthouse platform (Ostrow 125).

The Ostia, Cologne Populonia, Ampurias, Rome Flasks will not be described with the same level of detail as the above three flasks firstly because the Ostia and the Cologne flasks come to us as fragments, making interpretation even more speculative and therefore more difficult from a visulalisation point of view. The main features related to *Puteoli* on the Populonia and Ampuria flasks have already been mentioned and the rest of the engravings on both flasks are dedicated to Baiae, which is unfortunately outside the remit of this project as is the Rome flask which depicts Baia in its entirety. For a detailed discussion about the remaining flasks see Ostrow (1979) pages 125 - 130 who addresses and discusses the minutiae of the engravings with the same attention to detail as he did for the larger more complete vases.

4.8.3 The Bellori Drawing

The Bellori drawing is often cited even in the more recent archaeological studies of ancient *Puteoli* (DeCaro 2002). With the assumption that this too represents the port of *Puteoli*, we can also take a closer look at this representation. The topographical features of the *antiqua pictura* from which the Bellori drawing was derived, was for a long time attributed either to the Tiber banks in Rome (Hulsen 1896: 220-24) or to the Coastal area of *Puteoli*. It was Dubois who provided the definitive account and established that *Puteoli* must be the city in question (Dubois 1907 216-19).

The most striking feature in the scene is naturally the breakwater, immediately recognizable as the Puteolan mole also found on the glass flasks because of its supporting piers, triumphal arches and honorary columns. The promontory that forms the right hand part of the "mainland" as Ostrow describes it seems to be indicated as "high ground" in contrast to "low ground" evident elsewhere on the mainland (Ostrow 1979: 131). Should this promontory represent the hill of Rione Terra, the abutment of the mole at the edge of the acropolis would match exactly the actual abutment of the ancient mole against the Puteolan shoreline (Ostrow1979: 131). On this so called "promontory" of the Bellori drawing and in a position that is facing the sea, there stands a T(EMPLVM) APOLLONIS. It appears to be in the same position where we find the *Capitolium* or so called Temple of Augustus. No Temple to Apollo has been specifically attested for *Puteoli* but we know from inscriptions (*CIL* X 1544-1545) that the divinity was worshiped at *Puteoli* and a temple might have been expected (Ostrow 1979: 131, Dubois 1907: 205).

The schematic rendering of the architecture on the Bellori drawing is similar to artistic quality of the flasks. It consequently reflects very few architectural features of the existing temple on the Rione Terra, the architecture of which has been discussed in detail in a previous section of this chapter. The FOR(VM) (H)OLITO(IVM) and FO(RVM) BOAR(IVM) are drawn as large rectangular enclosures. Although not explicitly known in *Puteoli*, the presence of such areas named after their Roman counterparts, like other features at *Puteoli* and elsewhere across the Empire, is not new (Ostrow 1979: 132). The AQVAE PENSILES, like the BAL(INEVM) FAVSTINES further left will have been bathing establishments (Dubois 1907: 217). While we once again have no certain evidence for these particular baths, their location in *Puteoli*, famous as it was for its thermal properties comes as no surprise. Whether the citizens of *Puteoli* honoured the Faustina in question by having baths named after her or whether these baths bore her name because she financed them, we do not know (Ostrow 1979: 133).

Of the remaining details in this magnificent drawing only the HORREA, depicted here as four narrow, windowless structures are labelled. In a port like *Puteoli*, these would have provided the vital function of storing and safe-guarding the enormous quantities of grain that passed through the city *en route* to Rome and these buildings must have been a very common site (D'Arms 1979: 81-2, Frederiksen 1984: 2043). Even though the archaeological, literary and epigraphic evidence of these warehouses in comparison is not very much. Interspersed among the main buildings we find a number of unlabelled structures consisting of general building motifs, depicting porticoes and towers.

Naturally, many scholars have cautioned against using the details of various buildings as faithful reflections of the original structures (Hulsen 1896: 224 Dubois 1907). Not only do the Bellori and Windsor drawings show slight differences in detail of the *antiqua pictura* but the original painting itself may have taken considerable liberties in reproducing the architecture of ancient *Puteoli* and the location of its individual buildings. The use of stock themes, such as clusters of towers and near identical porticoes denotes the strong possibility of such schematization. Despite this, certain details and the evidence of the glass flasks further confirm the identity of the Bellori scenery with that of *Puteoli* (Ostrow 1979: 135).

The technical characteristics of the flasks, their shape and engraving have already suggested a date ranging from the late 3rd C to the second half of the 4th C. AD. Further evidence of this late imperial date are the inscriptions STRATA and DECATRIA (on the Prague and Ostia flasks). The word STRATA is not epigraphically attested before the first half of the 3rd C. AD and the word DECATRIA is known on three other inscriptions from *Puteoli* dating to the 4th C. AD (Ostrow 1979: 136). With regards to the original Esquiline wall painting Hulsen and Dubois were in agreement in giving it an approximate date in the 3rd C. AD (Hulsen 1896: 219, Dubois 1907 204). One can therefore surmise that even if they were not contemporary, the flasks and the painting were, if nothing else, all products of the late imperial age (Ostrow 1979: 137).

4.9 Conclusion

In light of what we know, how much of these representations can we use in the digital reconstructions? Does any of this knowledge affect the decision making process in light of the buildings I choose to represent? Pletinckx points out a very relevant point with regards to the above question highlighting that one should bear in mind; That all the sources described above have already been subjected to numerous interpretations when they were first created and there is no way of knowing with absolute certainty the extent of errors, omissions and alterations be they accidental or deliberate (Pletinckx 2012: 208).

With this point firmly embedded, will any of this information be useful for the gap filling exercise of this project? How? Does any of this information have implications on the reconstruction of Pozzuoli's ancient harbour? How reliable are these sources? It feels that looking at these representations can be very useful even if they have to be approached with a high degree of caution and flexibility in terms of understanding to what extent they can aid the reconstruction. I have chosen to focus on how the main buildings have been represented in this case because we have archaeological evidence to back up these rather skewed representations. However a salient point that Ostrow brings to the fore almost immediately is the possible position of the viewer and this is something that a digital reconstruction can greatly contribute towards our understanding of.

However, even before moving towards a digital reconstruction a textual reconstruction based on the archaeology is also possible. Based on the archaeological evidence and on its likely urban developments, it is clear that *Puteoli* was a densely populated town having first been established on the promontory of Rione Terra and the spreading westwards on the coast towards the *Portus Iulius* and the lakes *Lucrinus* and *Avernus*. The archaeology of the Rione Terra suggests that there were a number of buildings huddled around the *capitolium*. A number of these have been classified as porticoes or *tabernae* so we can assume that even on the promontory itself the majority of the buildings were commercial in function. Just behind the promontory sloping NE towards the sea would have been the forum. There is near to no archaeological data in this area but various scholars have suggested this area to be its likely location, which is not altogether improbable if we imagine that rising behind the forum would have been the two amphitheatres in their full splendour, reminding locals and visitors of *Puteoli*'s status. Moving westwards along the coast towards the lakes we see the town spreading with a mixture of commercial and administrative buildings, shops, and for the select few, some residences, although the archaeology thus far suggests that the more common residences would have been found just outside the city. Given the archaeological and textual data it is likely that this stretch of coast was primarily dominated by warehouses, shops, cisterns and all other varieties of commercial buildings, perhaps interspersed with one or two residential buildings of the few families that owned warehouses or who traded in the areas.

That is not to say that public buildings were not present, indeed in this area we find both the stadium and the large bathhouses. When it comes to public buildings the glass flasks form an important part of this reconstruction because they act as highlighters to the buildings' importance and prominence despite the questions that arise about their location. We will never know what the artists' original intentions were but we can safely surmise that they were primarily focused on representing the more notable buildings of the *Puteoli*. From an art historical perspective this is particularly interesting as well as from a representational point of view especially if we consider these flasks as part of the many representations of ancient *Puteoli.*

If we add colour to the different buildings such as marble to public buildings stucco to the more commercial ones, increase the density of the architecture and place the buildings close to one another as well as the different heights, it is possible to imagine a rather active and crowded city such as that described by Seneca during the arrival of the grain fleet. It is likely to have been quite densely populated too with many people transiting to and fro, which may go some way towards explaining the various locations of the *tabernae* that can be found in various part of the city. By looking at the archaeology of the city coupled with the ancient representations and the way Romans described their surroundings it is easy to understand the appeal the city would have had on its locals and visitors despite its commercial nature. It is also clear that there was a lot of vested interest in the port during the height of its use. Commercial, residential and public buildings were carefully located to sit side by side, sharing in both importance and magnificence, because after all in *Puteoli* one could not exist without the other.

5 Theoretical considerations and issues

5.1 Introduction

Cities are complex, lively and three dimensional, often experienced by kinetic observers. So too the original occupants of Rome express frustration when attempting to understand the expanding Imperial metropolis (Favro 2006: 321). In classical archaeology, it is only recently that scholars began to pay attention to the ancient viewer. It has been all too easy to put oneself in the place of the ancient observer for any given period and in any context, whether it is the scholarly analysis of a banquet scene or the location of a certain building. In the mind of the modern observer the ancient viewer is often an ideal concept, already possessing all the necessary knowledge of antiquity. One reason for the reluctance shown by archaeologists to examine the role of the viewer is the fragmentary nature of the existing monuments. Yet, literary criticism and art history have long shown that an “aesthetic of perception” can yield to new research paths, even for the archaeologist (Zanker 1997: 179).

Having described at length the archaeology of Pozzuoli, it only remains to place the archaeological evidence, particularly that of the public buildings, within their deserving architectural context. The subject matter and the techniques used raise a number of theoretical considerations which have to be carefully considered not only in light of having a better understanding of these themes but also in order to evaluate to what extent an understanding of these themes affects the methodology used as well as the analysis and interpretation of the data. It must also be pointed out at this stage that each theoretical aspect considered here is a vast academic field each with it its own history and theoretical evolution. This study does not presume to outline every aspect of these theories and it will only touch on details that are relevant to the project. In some parts the theoretical descriptions will be but an overview of the subject.

The main theoretical themes that will be dealt with are first and foremost those related to Roman architecture, which start broadly with a very brief overview of the phenomenology of architecture following which, these ideas get slowly narrowed down to Roman architecture and Urbanism, the Imperial Urban image as defined by Augustus followed by an understanding of public monuments and how these ideas have been applied to cities outside Rome. The next broad theoretical umbrella is that of visualization, which will look at how this developed in Archaeology and how it affects our thought process. The reason visualization is also tackled from a theoretical point of view is because it is what the methodological tools employed throughout the project aim at. Visualisation has had a considerable bearing on many parts of the project from the selection of the data collected through to the final conclusions reached.

5.2 The Phenomenology[24] of Architecture

The theoretical and historical aspects of Architecture are such wide-ranging subjects that any attempt at a synthesis would not only risk causing confusion within the aims of the project but also, it would not do the subject area any justice. RIBA's definition of Architectural theory is the following: Architectural theory encompasses all the principles and concepts underlying the practice of architecture, from the fundamental theories of classical proportions to theories about the social or cultural role of architecture. (http://www.architecture.com/). During this chapter's research however, a couple of relevant books, such as

[24] For Phenomenology in archaeology and archaeological theory. See Matthew Johnson, *Archaeological Theory: An Introduction*, Ian Hodder, *Interpreting the Past* and Christopher Tilly, *The phenomenology of Landscape: Places, Paths and Monuments*. The definition of the word phenomenology is: an approach that concentrates on the study of consciousness and the objects of direct experience (Oxford English Dictionary).

Mallgrave's *An Introduction to Architectural Theory*: *1968 to the Present* and Rasmussen's *Experiencing Architecture* did surface but it is one book that is particularly relevant to this section. One of the major advocates of the phenomenological approach in architecture is the historian-theoretician, Christian Norberg-Schulz. Schulz started out with a book entitled *Intentions in architecture* (1968) and this was originally influenced by structuralist[25] ideas. He soon however shifted towards the phenomenological approach in his second book, *Existence, Space and Architecture* (1971) followed by *Genius Loci* (1980) and *The Concept of Dwelling* (1985). These last three books were written with the intention of establishing the foundations of a phenomenological interpretation of architecture (Haddad 2010: 88).

Of the Trilogy, his most influential work was indeed *Genius Loci* as it was published at a time when questions of meaning, history and mythology were of particular importance and it was in this work that he specifically considered the interpretation of phenomenology in architecture. More specifically, he emphasized the relationship between the man-made world and the natural one, as evidenced historically by places from around the globe. A three-point process of visualization, complementation and symbolization was what formed this relationship (Norberg-Schulz: 1980: 17, Haddad 2010: 93). His main thesis rested on the combination of two concepts, Heidegger's concept of "gathering" and the old Roman concept of *genius loci.*

"Genius Loci is a Roman concept. According to ancient Roman belief every "independent" being has its genius, its guardian spirit. This spirit gives life to people and places, accompanies them from birth to death and determines their character and essence. Even the gods had their genius, a fact which illustrates the fundamental nature of the concept"

[25] See Lisbeth Soderqvist, 2011, Structuralism in Architecture: a definition in *Journal of Aesthetics and Culture*, Vol. 3

(Norberg-Schulz, 1980: 18)

Heidegger was an author who greatly influenced Norberg-Schulz's work particularly with his essays gathered in *Poetry, Language and Thought,* 1971. Using a mixture of philosophy and theory, Norberg-Schulz further developed this theory which he supported using a series of carefully selected photographs that depicted various conditions and sites (Haddad 2010: 93). These photographs also included selected examples of historical periods from Greek to Baroque as well as modern architecture. His Greek examples were purposely chosen in order to reiterate the concept of *genius loci* with its mythological aspects and how these might have been experienced. With landscapes Schulz refers back to Heidegger in describing a "phenomenology of natural place" (Norberg-Schulz 1980: 37) where he proceeds to describe the different topographic contexts and their etymological source in order to try and uncover their original meaning (Norberg-Schulz 1980: 37).

One would think that at this point we are presented with a wide range of interpretations, however his categorization of landscapes into three basic types is rather surprising. They are Romantic (The Nordic region, Cosmic (represented by the desert) and Classical (varied yet orderly as exemplified by the Greek landscape). He uses the same reductive approach to categorize architecture; "Romantic architecture", "Cosmic architecture" and "Classical architecture". Fortunately, Classical architecture lends itself well to categorization as it is easily recognized, the same cannot be said for the other two categories so the author chooses some very select readings and applies the same geographical approach that he used for the landscape (Haddad 2010: 94).

Schulz's concluding chapters are dedicated to a selective study of three settlements that best illustrate his categories and which somehow transforms itself into something between a travel guide and an architectural survey of the three cities: Prague, Khartoum and Rome. It is worth noting at this point what happens to the description of Rome. While it was probably selected to illustrate the example of “Classical architecture” the *genius loci* of the city appears to escape the author’s definition and turns out to be a “complex” case that “contains everything” (Norberg-Schulz 1980: 164).

It is not the first time Rome and its architecture feature in architectural theory. Steven Holl in his work entitled *Questions of Perception*, 26 years after Schulz, describes how architecture, more fully than other art forms immediately engages our sensory perceptions, with light, shadow, colour, texture material and detail, all contributing to the experience (Holl, S. et al. 2006: 41). There are a myriad of sensations that can be evoked by experiencing architecture in person. This is different from viewing architecture in a two dimensional representation (such as a photo or a painting), because here one’s experience is limited.

The author here also puts forward an interesting argument about how we experience architecture. He notes that while a cinematic experience of a stone cathedral might draw the observer through it and above it, and through imagery even moving back in time, he believes it is still:

"[...] only the actual building allows the eye to roam freely among inventive details; only the architecture itself offers the tactile sensations of textured stone surfaces and polished wooden pews, the experience of light changing with movement, the smell and resonant sounds of space, the bodily relations of scale and proportion."

(Holl 2006: 41

This point is particularly relevant because the elements he describes as a "cinematic experience" are also the elements offered by three dimensional and/or virtual models. So this has to be kept in mind. The next important theme Holl considers is the question of intention that underlies architectural perception. He states that this "intentionality" sets architecture apart from other phenomenological approaches (Holl 2006: 41).

"In the modern cities phenomenal and experiential complexities develop only partially by intent. More frequently, they result accidentally from the semi-ordered, yet unpredictable overlapping of individual intentions." (Holl 2006: 42)

In order to illustrate further his point the author describes a series of experiences of different architectural buildings in different cities and below is an extract of his experience of the Pantheon.

Rome February 1970

"*In the tremendous space of the Pantheon, I first felt passion, the forceful capacity, of architecture to engage all the senses. Nearly every morning for months, I passed through the huge double doors and stepped into the spherical silence of this 2,000-year-old work. Each day, its appearance varied with the dramatically changing shaft of light that passed through the open oculus. On rainy mornings, the cylinder of down-pouring light contained flashes of raindrops reflected as they slowly fell to the floor and drained into the ingenious marble pavement grooves, which led into the ancient drainage system. The guard would rope off the circular area where the rain fell to keep back distracted tourists. A hazy day rendered the light from the great round orifice more visible, like a solid cylinder of morning sunlight. The surrounding city fabric, with its various buildings crumbling stone walls, and haphazard, moat-like spaces filled with sleeping cats, stood in contrast to the pure, hollow interior. Its silent clarity, ordered by light and darkness, and embraced my imagination with its abstract inversion of interior and exterior space. Simple Roman brick arches, embedded in thin, flat exterior brickwork opposed the complex, curvilinear stone coffering of the dome's interior.*"

The reason this project chose to touch on the subject of the phenomenology of architecture is because it has a bearing on our visual vocabulary, given that as human beings we interact with it every day, often unaware that we are doing so. This implicit, or explicit awareness of architecture and the experiences associated with it, have a bearing on many other aspects, ranging from a building memorized during way-finding to the choices we make when navigating through a three-dimensional model. For this project, even though this subject has only been touched upon very briefly, an awareness of these theoretical strands will have an impact on the understanding of how people in the past experienced architecture. In other words, we must be aware of how we respond to architecture before we can begin to understand how ancient Romans responded to it, even with the full knowledge of these experiences will be very different from one another.

5.3 Theoretical Considerations on Roman Architecture

Just as it is not possible in this chapter to describe the entire plethora of invaluable work devoted to the development of Roman cities, it would also be perilous to try and define 'the Roman city' as there is a vast degree of variation between cities, even if formed by the same process of urbanisation (Morely 1997: 54). A brief overview of the development of such a process is however not without scope. Moreover, it seems particularly relevant to focus on two elements that may shed some light on the port and its wider visual significance. The first element is the creation of a Roman urban image as described by Paul Zanker and further elaborated by Diane Favro. The second is the consideration of monumentality. An understanding of these two ideas can help us further appreciate Pozzuoli not just as a functional port but also as an imperial stronghold.

One seminal work, upon which many other works cited in this chapter are based, is that by MacDonald in his book, *The Architecture of the Roman Empire: Vol II*. The underlying theme is that mature Roman design was shaped largely in response to urban needs and civic ambitions and that Empire-wide principles proved stronger on the whole that regional impulses. Public buildings are discussed both as independent parts of their extended context and as entities in themselves. In his chapters MacDonald attempts to show the architecture as a whole, using a whole range of evidence. His main objective is to suggest that the cities and towns of the Empire all belonged to the same architectural community (MacDonald 1986: 2). We find chapters dedicated to "urban armatures" (the city's core, made up of the main road and all the buildings that flanked it), "passage architecture" (arches, arch façades, way stations), connective architecture (thoroughfares, plazas, stairs) and a chapter dedicated to public buildings marked by an extensive typology. Furthermore, he describes the monuments not as isolated individual buildings but considers them in terms of the space they occupy and the vistas to which they contribute. His argument, although from a formal perspective is the study of Rome's conspicuous achievement in creating, rebuilding and expanding hundreds of cities and towns and he studies these qualities from a city-oriented point of view.

5.4 Rome and the creation of an urban image

5.4.1 An overview of Roman urbanism

The ancient views on urbanism and cities remain as yet unclear to us as Greek writers made most commentaries. These at times were neither accurate nor flattering, particularly when describing the Greek *Poleis* in the Roman Empire (Lomas 1997: 22). They do however shed important light on the assumption that by the end of the first century AD one of the dominating views held by classical authors is that the city is both the symbol and definition of civilization. This is further attested by a change in importance of what constitutes a city's strengths, weaknesses and outlook of its citizens (Lomas 1997: 23). As early as the 6th C BC, a *polis* was defined by its citizens but by the Roman period the emphasis is directed towards the structures of a city. Symptomatic of this is Vitruvius's work *De Architectura* enumerating the necessary buildings for the ideal Augustan town (Lomas 1997: 23). Complimenting this work are other authors such as Dio Chrysostom (31:159-60) and Aelius Aristides (14:93-6) who both highlight the structures of a city, or lack of them, as indicators of its status and importance. Moreover, towns and cities in Italy became bound together - some more loosely than others - by the movement of goods, people, information and power. Within this system was above all a hierarchy determined primarily by the proximity to the main source of political, social and economic power – Rome - and it is here that major ports like *Puteoli* flourished (Morely 1997: 51).

Romans were quick to turn the founding of towns into a corollary to the spread of their power and influence, beginning in Italy and then spreading across the Mediterranean world and eventually as far as northern Europe. Often, particularly in Italy, Romans re-founded conquered towns sometimes by moving them to a new location near the original settlement or at times incorporating elements of the earlier street plans into the Roma versions such as in the case of Pompeii (Anderson 1997: 183). In order to make Samnites or Oscans adopt the status of their conquerors, the Romans would make them move and inhabit urban spaces that were designed to look and feel "Roman" and this together with the more subtle process of education in the Latin language and Roman dress, was the most effective way of altering the conquered territories (Anderson 1997: 183).

Over time, the Roman grid layout was tried, tested, manipulated and rediscovered in all sorts of settings, first in Italy and then throughout most of the Empire. However, one must not be misled into assuming that Roman city planning was a rigid principle that was forced upon landscapes and topography (Anderson 1997: 193). Within Italy, it appears that methods and experiments in Roman town layouts were influenced by two major factors inherent in the overall population of ancient Italy. These were the Etruscan and Greek influences even though it is particularly difficult to infer much about Etruscan towns, as so little is known to us and from the little we know it appears that town layouts and street patterns in Early Etruscan sites appear to have been rather organic (Anderson 1997: 183)

Although the Romans' own historical traditions claimed Etruscan town planning as the main source of their methods, and indeed Etruscan elements did effect Roman sacred and domestic architecture, the roots of Italian orthogonal planning can be better traced in the planned Greek colonial foundations of southern Italy and Sicily (Anderson 1997: 189). By the 5th C BC cities such as *Paestum* reveal that the grid plan with all its possibilities, was well established in south Italy. The meeting point for this Greek system with the Etruscans who adopted it was most likely Campania, where the orthogonal system seems to have had an effect on the plan of archaic Capua (Anderson 1997: 191, (Gros and Torelli 2007).

The very point that had attracted Romans to the orthogonal plan was the apparent simplicity that masked a remarkable ability to be applied, with variations and shifting, to almost any topography no matter how uneven (Anderson 1997: 193). Examples[26] of this can be found in Pompeii, which was a pre-Roman town that was adapted to a Roman plan, in Ostia, which was a commercial and military settlement that grew into a major port city and Cosa, a purely military foundation on a difficult and uninhabited stretch of terrain (Anderson 1997: 193; Patterson 2006: 92). Rome on the other hand grew very slowly and over the centuries took on a very individual form. Due to this slow and

[26] For more detail see Zanker (1998: 27) especially with relation to Ostia.

unusual development, it was no surprise that it was not the ideal role model to be copied. If we are to understand 'Romanisation' as an incorporation of the cities' outer appearance, then it is best limited to a few political structures or architectural forms such as baths or basilicas (Zanker 1998: 26).

Ostia is perhaps one of the best examples of the notion of how Romans imagined the ideal city. As part of the senate sponsored colonial foundations, all of the *Coloniae Maritima*, starting around 380 B.C., which Ostia was a part of, all followed the same basic plan and apart from the strictly axial-asymmetrical streets that we find in early Greek cities from the 7th C onwards, this new plan included three significant features that had no precursors in the earlier Greek foundations: The first was that, the city had a principal axis, its *Cardo* or *Decumanus*. This main road then led to or past the *Capitolium* that was situated at the intersection of the *Cardo* or *Decumanus* and lastly, the communities' gathering place lay in front of the *Capitolium*, which would then later develop into the Forum (Zanker 1998: 27). This basic city plan would be repeated in later foundations, albeit with many variations but always keeping to the same basic idea (Zanker 1998: 27).

5.4.2 The Augustan building programme and Imperial initiatives

Cicero repeatedly described the Republican city-state as extremely beautiful but while some urban spaces and a couple of individual buildings were impressive, the city as a whole was not physically attractive, neither was it safe (Favro 1996: 45). Towards the end of the Republic and subsequently under Augustus, Rome was characterised by increasingly lavish and competitive public building programmes and it is under the dictatorship of Julius Caesar[27] that we begin to see a

[27] For this see pages 212-214 in Anderson. See also Zanker 1998: 154 and Gros and Torelli 2007: 201).

calculated re-arrangement of Rome's urban layout, some plans of which horrified Cicero (Anderson 1997: 212; Patterson 2006: 125). The last years of the Republic are characterised by turbulence and upheaval and when it finally collapsed into civil war, people began to search for an explanation for the widespread sense of dislocation they now experienced (Zanker 1988: 2).

Upon Caesar's death, his architectural and civic improvements were not so much abandoned as suspended until his adopted heir Octavian (Augustus) was firmly entrenched in power in Rome. Augustus now began a radical transformation of the city both physically and conceptually. He repaired existing public buildings, built and further encouraged the building of impressive public monuments, established offices for monitoring and undertaking of urban care and promoted an enduring aesthetic (Favro 1996: iii). This immense programme was documented by himself in his *Res Gestae*, by contemporary poets such as Virgil, Horace and Ovid, by his biographer Seutonius, and by the 3rd C AD by historian Cassius Dio (Anderson 1997: 214). Directed by a single vision, the results were forceful and unified (Favro 1996: iii). Augustus encouraged others to erect public and sacred monuments to the city. Suetonius documents an impressive list that includes the *porticus* of Livia and Octavia and the theatre of Marcellus – all built by Augustus but dedicated to his relatives (Gros and Torelli 2007: 205). Many others, encouraged by Augustus, financed public buildings such as Cornelius Balbus who built another impressive theatre and Stalius Taurus who built the first permanent amphitheatre in Rome (Gros and Torelli 2007: 202). These were imposing monuments, first to Roman wealth and secondly to Augustus' desire to make Rome a city truly architecturally worthy of standing as the centre of the empire (Anderson 1997: 216).

Throughout the Imperial period, there were frequent programmes that brought about variations in the urban plan of different parts of the city and much as Augustus and Agrippa changed the look of the *Campus*

Martius, other sectors of the city benefited (or suffered) urban development over the course of several different reigns (Anderson 1997: 218). Possibly the two largest overall projects were the development of the public entertainment complex in and around the Flavian amphitheatre that began in 70 AD with Vespasian and completed under Trajan in 109 AD, and the slow development and amalgamation of the once independent elements of the Imperial towns; a process that did not become a designated project until late in its development that started with Caesar's land purchases and was completed only when Hadrian dedicated the temple to the deified Trajan in 118-122 AD. These two major processes reflect schemes of monumental urbanisation that were considered important enough to be passed on from one emperor to the next until they were eventually completed (Anderson 1997: 218).

Lavish and competitive public buildings extended well beyond Rome throughout many towns in Italy up until the 1st C AD. The latter depended on a variety of factors such as the length of tradition of urbanisation, the date in which the citizens were annexed to Rome and the potential wealth of its territory amongst others (Patterson 2006: 125). It becomes clear that there are significant patterns identified for different types of monuments and during the first century, expenditure was directed towards temples, theatres, amphitheatres and large-scale infrastructural projects such as aqueducts (Jouffroy 1986: 63-105). All these types of monuments were inevitably linked to the new social priorities established under Augustus (Patterson 2006: 128).

5.5 Understanding Public Monuments

Public buildings in Roman architecture fall into three broad categories: Religious or sacred, municipal or civic and recreational or entertainment

(MacDonald 1986; Anderson 1997: 241)[28]. It is appropriate at this point to examine the evidence of the 1st century public architecture if we are to ask the questions such as how were these buildings set within the urban fabric of Roman towns and how they were made accessible, visible yet separate from other building types? From a planning point of view, Zanker noted that in contrast to the forum these monumental buildings had no fixed allotted space within the highly ordered city plan nor did they have any particular spatial relationship to the old political and religious centre of the city. Instead the buildings were built depending on the preferences of the patron or on the available land (Zanker 1998: 39). Theatres and amphitheatres could have been adjacent or far apart, near a forum or at the edges of the walled city. Very often amphitheatres were built near a main road outside the city walls both for reasons of security and to accommodate visitors from neighbouring towns. Often these buildings were used by the cities to compare themselves to one another (Zanker 1998: 39).

This random placement of these monumental buildings is a result of the fact that these buildings did not yet exist at the time that basic city plans were being drawn up for the early colonies and the theatre in particular was considered unnecessary. It is interesting however to note that the Augustan colonies did introduce both theatre and amphitheatre at a very early date sometimes even when founding the city, such as at Merida, even though these buildings did not have a fixed location (Zanker 1998: 40). Then what are we to say of Pozzuoli with not one but two amphitheatres one next to the other?

Zanker summarises his brief survey by describing how the typically Roman city plan arose by the 2nd half of the 4th C. BC and how these monumental structures so typical of Roman cities under the principate could not be integrated into the rigid city plan but instead created their

[28] For a more formal study of public buildings see MacDonald pages 111-142.

own space, dominated whole areas and generated their own buffer zones (Zanker 1998: 40). Zanker also believes in contrast to MacDonald for example is that aside from the monumental city centre, Roman cities of the principate at least, seem to have been unconcerned with achieving the visual effect so impressive to us today. They were more concerned it seems, to possess all the necessary public buildings and that these were built and outfitted in a fashion worthy of the city's importance (Zanker 1998: 40).

5.5.1 Amphitheatres

Undoubtedly the most popular, the most important and the most characteristic structure devoted to spectator sports in the Roman world that was uniquely a Roman creation (Anderson 1997: 279). The rise of the arena as a place for social and political significance also reflected a basic need in Roman society. The amphitheatre played an important role in the ushering of the Romans of the late republic into the new world of the monarchy and Empire (Zanker 1998: 38). Amphitheatres were some of the few places that brought together the entire population of a city including slaves, women and foreigners and each had their designated places reflected in what was effectively a microcosm of the society at large (Zanker 1998: 38).

Gladiatorial combat is thought to have been a familiar feature of Roman public life since 264 BC and the favoured featured site for these games was the *Forum Romanum* itself (Anderson 1997: 130; Patterson 2006). Temporary structures were set up to allow privileged spectators to follow the action and the characteristic oval/elliptical form of the later amphitheatre appears to be derived from the designs of these stands. These temporary mechanisms in Rome were replaced by the Flavian Amphitheatre (Coliseum) that begun under Vespasian, dedicated by Titus and improved by Domitian (Patterson 2006: 130-1).

The history of the amphitheatre outside of Rome appears to have adopted a different route. Permanent amphitheatres were particularly popular in Campania at a fairly early date and it is clear that Campanian cities and towns had permanent amphitheatres long before these were built in Rome. This is not surprising as two of the most famous gladiatorial schools were native to Capua (Bomgardner 2000: 73) The oldest securely dated amphitheatre surviving in Italy is that of Pompeii, which was built around 80 BC.

Whilst it is now clear that the 1st century was notable for high levels of public constructions in towns of Italy, one must not forget the variety of considerations that lay behind the priorities given to the building of amphitheatres. Amphitheatres were constructed in imitation of the monuments in Rome so as to demonstrate loyalty to the cultural programmes of the emperors, to outdo neighbouring cities in prestige and to assimilate the role played by the by the games in constructing the civic identities of the communities themselves (Patterson 2006: 135). *Puteoli* possessed a Republican amphitheatre dating to the mid 1st century BC that was consolidated in the Augustan era. Worthy of mention is that this theatre never went out of use even after the construction of the larger and more functional Flavian amphitheatre perhaps because each hosted different types of games. It has been suggested that the older amphitheatre hosted the gladiatorial games, whilst the more recent one hosted the *Venationes.* In any case, the building was still very much in use in the late 2nd and early 3rd century AD (Caruso, Corso et al. 1979: 187).

Amphitheatre building continued beyond the impetus injected by the Flavian dynasty. Some of these late 1st and early 2nd century projects involved the constructions of arenas in towns that (as far as one knows) were devoid of such structures but others had as their main focus the construction of monumental buildings in towns that were already equipped with more modest facilities as with *Puteoli*. During the Flavian dynasty, when the town was at the peak of its power and to commemorate its status as the most important port of Rome, *Puteoli* built a second amphitheatre and until then, no Italian city had possessed two permanent monumental amphitheatres (Bomgardner 2000: 72). Another factor that may have contributed to the construction of a second amphitheatre in Pozzuoli was that the monument lay alongside the main coastal route to Rome. Every major vessel bound for Rome from the southern or eastern shores of the Mediterranean would have passed Pozzuoli. This critical element of political and economic geography meant that *Puteoli* was located on the main artery of the trade in wild beasts for the arena of Italy, chiefly Rome (Bomgardner 2000: 73).

It is therefore surprising that amphitheatres in Italian towns were used only a few days a year, with the Colosseum also being used infrequently. The impact on the civic landscape was disproportionate to the amount of practical use made. The physical height of the building meant that the arena imposed itself on the city's skyline and as Hopkins put it, 'amphitheatres must have towered over cities, much as cathedrals towered over Medieval towns' (Hopkins 1983: 2). Even with the amphitheatre out of sight, the roar of the crowd inside the arena would have been heard throughout the streets of the city. The amphitheatre therefore was of considerable importance as a symbol of its community (Patterson 2006: 139).

The various events that took place within the amphitheatre reflected the various concerns in Italy of the high Empire: social hierarchy and mobility, loyalty to the imperial house and its ideologies and generosity towards fellow citizens coupled with the reciprocal acts of loyalty and respect. The definition of the audience was of great importance: the public inside the amphitheatres was also that of neighbouring communities as well as the city's own and a grand amphitheatre with impressive shows staged within it, provided an effective way for a city to stake a claim to regional leadership (Patterson 2006: 148).

5.5.2 Public Baths

Public bathing was an activity that defined Roman culture. Zanker considers the bathing establishments and their social significance as centres of leisure and enjoyment and like theatres they occupied large stretches of the imperial cities and shaped the city's image in the same way churches did in a Medieval landscape (Zanker 1998: 39). To its inhabitants these sponsored buildings greatly contributed towards the quality of city life. The buildings with all the trappings they offered was the Emperor or patron's guarantee of a new standard of living, which its citizens soon got used to. Needless to say, these buildings highlighted the most conspicuous of donations. Smaller elements such as porticoes, fountains, aqueducts, sewers and many other features were all part of the city's daily life and may have contributed in equal measure to defining the urban landscape for residents and visitors alike (Zanker 1998: 39)

The origins however, like the gladiatorial games remain somewhat mysterious. Despite the great volume of archaeological evidence, the physical record displays a series of shortcomings that limit the tracing of the historical development of the bathing habit. Most urban centres, including Rome offer an incomplete picture of growth and a full picture cannot be reconstructed from the archaeological evidence alone (Fagan 1999: 56)[29]. There is also little direct evidence as to why Romans took to bathing the way they did and more specifically why it increased in popularity in the 1st C BC and AD and while classical authors pondered the baths' great popularity, they offer little by way of explaining it, perhaps because to do so, for them, would be explaining the obvious (Fagan 1999: 75).

[29] Fagan also provides a more in depth discussion on the origins of Roman baths.

Literary evidence points us to bathing in Rome from the 3rd century BC onwards and the 'Roman baths' with their characteristic combination of hot, cold and warm rooms, communal and exercise areas, drew on a variety of traditions including the Greek baths known from Sicily and southern Italy. There is also evidence that the combination of wealth, cultural heterogeneity and innovation which characterised Campania in the second century BC was particularly important for the development of baths in this style (Anderson 1997: 269; Patterson 2006: 149).

Like amphitheatres, baths created an environment where the emperor was on show to the Roman populace and whose behaviour was significant in determining how a particular ruler was viewed by contemporaries and portrayed for posterity. Literary sources strongly emphasized the role of the baths when describing the emperors, describing not only their construction merits but also the ways in which their behaviour at the baths was indicative of their character (Patterson 2006: 150-1).

Some of the first extant examples come from the Campanian region, most notably the 2nd century Stabian baths and the early 1st century Republican baths at Pompeii and Cumae. The earliest baths were relatively modest in scale, called *Balnea* but by the later Republic and even more under the Empire, the lavishly decorated *Thermae* as they became known came to provide facilities for sporting and leisure activities as much as they did for washing. They further became centres for the social life of the community (Anderson 1997: 269; Patterson 2006: 149).

Just as the spread of amphitheatres in the Italian towns partly reflected the development of gladiatorial combat in Rome, so it is possible to identify close links between the development of the immensely complicated bathing facilities in Rome and the pattern which emerged in the towns of Italy (Patterson 2006: 152). There were very few cities in Italy that could afford to build baths on a scale similar to those in Rome. The baths of Neptune and the Forum baths as well as the *Thermae* of Pozzuoli were exceptional. After all Ostia and Pozzuoli were among the chief ports of the Empire.

The bath complex in Pozzuoli rose from the southern part of the city at the base of the road that led from the *Via Domitiana* to Naples. The remains indicate that the structure was a particularly grand one of Imperial date. This is inferred not only by its relatively large scale but also from its shape, which denotes, at least from the visible remains, a medium sized "imperial *thermae*" (Johannowsky 1993: 105). The nucleus with mainly bathing functions appears to have occupied approximately 7,500 m^2 which is approximately the expected size of these buildings in the more important cities of Rome, although when compared to the Trajanic baths, these were somewhat downsized (Johannowsky 1993: 107).

In an important city such as Pozzuoli, this would not have been the only bath complex present, although it was perhaps the largest. On the other hand, the port's priorities might have been different to the priorities in Rome when it came to water distribution. A lot of the water provision depended on the aqueducts of the area as the ground did not permit the formation of watercourses. Water had to be collected in small wells. While the two main aqueducts in the area seem to have provided sufficient water, the various reservoirs and cisterns that dotted on various levels around the town indicate a continuous preoccupation with this "service" that the public buildings, including those for public spectacles, made full use of (Johannowsky 1993: 107).

The importance of the baths is primarily a social one: here Romans were able to enjoy a pleasant and relaxing environment, pursue intellectual and sporting interests and deal with the more practical business of getting clean (Anderson 1997: 276). Like the amphitheatres, baths were an ideal canvas upon which to display Rome's many achievements. Chief among these were man's domination of the elements, fire and water. The fine marbles used to decorate the baths were brought from all over the Mediterranean reflecting Roman control over the known world (Patterson 2006 : 160).

5.5.3 The *Macellum*

Another familiar feature of Roman towns in the high imperial period and central to the world of entertainment and hospitality was the *macellum*. A purpose built enclosed market building, typically designed around a central courtyard, with alcoves or stalls opening onto a central space. There are various shapes and forms but often *macella* included circular elements. In some cases the courtyard itself was round as at *Alba Fucens*, or there may have been a circular feature, a *tholos,* well or fountain, which formed the centrepiece of the courtyard, as in the case of the building in Pozzuoli (Patterson 2006: 161).

The chronology and geographical distribution of the *macella* in the towns of Italy is difficult to reconstruct precisely, for a variety of reasons. Chiefly amongst these is that the layout of the *macellum* was subject to local variations and never took on a single canonical form, although some forms became predominant nonetheless (Patterson 2006: 163). The earliest example dates to the second half of the 2nd C BC and this is the *macellum* found in Alba Fucens (De Ruyt 1983: 25-30). Other examples of *macella* can be found at *Brundisium* and *Buxentum* that date to the late Republican and Augustan periods and there are several examples dating to the second half of the 1st C AD that had been lavishly built or restored; the *macellum* of Pozzuoli being one of these outstanding examples (Sommella 1978: 70).

As with many other public monuments, it is likely that the model of the *macellum* in Rome served as a template for the development of similar buildings around Italy. The Puteolean example in particular appears to have imitated the design of the *Macellum Magnum* in Rome (De Ruyt 2000: 182). However, as with other buildings around Italy that had a counterpart in Rome, there appear to have been considerable differences in the role and location of the *Macellum*. In Rome the primary concerns were to first remove the sale of food from near the forum and to then establish new *macella* in the more residential areas of the city, making it more convenient for customers (Patterson 2006: 165). In the towns around Italy however, the *macellum* was located at the very heart of the community, near the forum. At Pompeii, *Alba Fucens* and *Paestum* for example, the *macellum* either opened immediately onto the forum or was separated by a single building (De Ruyt 1983: dep 2). The exceptions to this are the buildings of Ostia and *Puteoli* but it is understandable that in a port city these market buildings were located closer to the harbour.

So why was the *macellum* marginalized in Rome and so central to the Italian towns? Patterson suggests that the answer lies in the activities of the *macellum* that were associated with civic life in Italy during the high Empire as well as the complex trading that took place in the Italian context at the time (Patterson 2006: 166). The *macellum* might not have been considered solely for the income brought to the city but more importantly, it was likely considered to be an important civic amenity (Frayn 1993: 8). It was of course not the only place where food could be bought but because it was a permanent structure, it allowed for precious and specialist goods to be stored and sold. Many of these goods were favoured and bought by the elite and this association may explain the central location of the *macellum* in Italian towns. It was an enclosed space that provided protection for the goods and allowed the supervision of business transactions within it, something that would not have been possible in moving, temporary market stalls (Patterson 2006:

168). There are also suggestions that by the late first and second century AD a lot of the activities that took place in the *macellum* formed part of a broader set of civic and religious rituals.

5.5.4 The Stadium

The Circus was a long narrow racetrack that was curved at one end and with seating on both elongated sides- a design copied from the Greek models and that was originally intended for chariot racing. The stadium on the other hand, although very similar in shape was shorter in length and was designed to accommodate sporting events other than chariot contests such as foot races and other forms of track and field events (Anderson 1997: 276). Both styles had a very long tradition in central Italy. In Rome, formal circuses other than the Circus Maximus, who Livy claimed was founded by the Etruscan kings, were not built. Caligula started the building on one on the campus Vaticanus west of the Tiber and was later completed by Nero. It did however fall out of use by the early second century AD suggesting that the Circus Maximus was sufficient to satisfy Rome’s need for chariot racing events (Anderson 1996: 277).

The Roman stadium adopted the elongated form of the circus but was smaller and lacked the central *spina*. This was the name given to the island in the centre of the circus around which the race had to run and where the lap recorders (*metae*) were located. The only major independent stadium in Rome was that built by Domitian on the Campus Martius but it appears not have enjoyed the same popularity as chariot races and gladiatorial *ludi* (Anderson 1996: 279).

5.6 Monumentality

5.6.1 The idea of "Monumentality"

As MacDonald so aptly put it, "*Monumentality was most definitely a Roman specialty if not a passion".* The frequency of imposing high-rise buildings is striking and while it is understandable that the handling of large crowds required bulk, we find structures with far less functional justification for their size created as part of official policies (as seen in the section above) or simply because of pride and/or vanity (MacDonald: 133). The numerous and extensive studies of Roman architecture are testimony to the importance of this period in architectural history. However, in the ancient world, buildings were not simply backdrops and settings for social interaction but also formed part of a social language. This language was not to be understood solely by the architects who constructed those buildings but for the whole population who consequently experienced them (Thomas 2007: 1).

The adjective "monumental" is one of the most commonly- some say overused - terms applied to the ruins of ancient architecture and to public architecture in general, but what does it really mean? The derivation of the term from Latin *monumentum* implies that a 'monumental' structure is a memorial, commemorating something or someone. This is the concept in which the term was originally used; that of a memorial left as 'warning' (*monere*) to posterity (Thomas 2007: 2). It was towards the end of the nineteenth century that architectural writers began to refer to 'monumentality' as an ideal with a different meaning from the etymological one.

According to 18th century French architectural theory, monuments were public memorials serving a pedagogical and aesthetic function of which classical public buildings constructed in materials such as marble best served these functions (Thomas 2007: 3). However, by the early 20th century there was unease amongst scholars that monumentality might be achieved only by buildings of the past and an attempt was made in the late 1940's to reintegrate the idea of monumentality amongst modernists.

Today we tend to label 'monumental' those structures that correspond to our own pre-conceived notions of monumentality and therefore judge buildings by criteria such as great size, bulky or expensive materials, long-range visibility and relation to human scale amongst other things. The idea of monumental architecture being of great size is not an arbitrary one and is based on the simple human analogy according to which 'normal' buildings possess a human scale and those exceeding that scale appear as somehow, 'superhuman'.

Other factors contributing to the monumentality of a building are its durability, often related to the materials chosen to build it and the structure's importance exceeding its practical use (Thomas 2007: 5). To highlight the above-mentioned examples, Thomas uses the bridge erected over the Danube in 103/5AD during the emperor Trajan's Dacian wars. Its 'monumentality' was certainly enhanced by its location, on a river in the most remote part of the empire that had never before received a bridge of durable materials. However, the fact that it was also depicted on the emperors' memorial column in Rome in 112 AD and on Trajan's coinage, indicates that it was perceived as a monument from the moment it was built and its visibility in Rome by these means was more important than its visibility of its obscure location on the river Danube thus ensuring its memory survived even after its unceremonious dismantling soon after Hadrian's accession (Thomas 2007: 5). The same can be said of the amphitheatres, which were large imposing structures built throughout the empire with fine materials that needed costly maintenance only to be used a few times a year.

However, monumentality was not only designated to memorials or underused buildings. In the classical world buildings had an active function in the life of the community. This was true not only for the structures such as bridges or aqueducts, where monumentality was achieved through their formal properties alone but also for buildings such as amphitheatres, basilicas and baths, where the gathering of a community created a context for the structures' monumentality (Thomas 2007: 11). Just as the presence of certain buildings in various cities outside Rome were intended to portray a unified and powerful empire, so too did they cement a civic community or define a smaller sub-group within a city.

The archaeological remains that survive today are but a fraction of what existed in antiquity but they still provide priceless evidence for the way in which Roman buildings shaped contemporaries' experience of their world. An interpretation of architecture based on archaeological remains is inevitably incomplete. The final decorated appearance of these buildings, which most likely had the greatest impact on contemporary perception, is the least well documented. If we are to understand how Roman architecture was perceived at the time we must try to understand how these places were used and enjoyed through the interplay of light, materials and decoration (Thomas 2007: 12). The descriptions of buildings in contemporary literature are particularly relevant in this case because very often literature was used in order to understand a society's perception of the importance of its buildings. Architecture was sometimes used as a metaphor in ancient texts and consequently metaphors became important in their own right because they provided the ancient Romans with a visualisation of their own, perhaps because even then, buildings must have been prominent in ancient minds (Thomas 2007: 12).

Buildings feature in our thoughts just as often as in our physical and visual experience. Even without realising, we memorise them and place them in a world of ideas by thinking about them in terms of their basic form. Even when finding our way around a town or city, inevitably we make mental notes of landmark buildings. These ‘mental buildings’ are perhaps even more important than the physical structures themselves because they are the boundaries that we construct to define our experience (Thomas 2007: 12).

There are therefore a number of different issues involved in the idea of ‘monumentality’. Thomas rightly points out that although the word is often synonymous with commemorative structures or buildings of an unusually large size, the word monumentality has a much wider range of meanings including the social ambition of the builder, the political identity of a community or the sacred identity of a cult and that the user instead responds to it not just in a practical sense but also as a work of art (Thomas 2007: 13).

5.6.2 Responding to Monumental Architecture

The way an individual perceived a building in Carthage or Pozzuoli and the particular emotions these buildings may have generated are difficult to recover today and apart from what has be put in writing, any conversations or discussion of individual's reactions have been lost to us. We rely therefore on anecdotes or on specific reports of the experience of a building that have survived in ancient literature (Thomas 2007: 207). Even using these sources is not as straightforward as one might think but they are of historical value and coupled with the more general theories of perception can help throw light on the ways in which an ancient Roman experienced architecture.

Early inscribed accounts such as the 11th C BC accounts from the Assyrian Palace in Nineveh describe the decorations of palaces and temples with an emphasis on the precious materials they were made of, giving us some indication on the kind of objects that attracted attention

(Thomas 2007: 207). In Greek architecture the impact of the monument depended on the aesthetic criteria as identified by Aristotle in his treatise *On Sensation*. Aristotle identified four main areas as “the common perceptible characteristics” of human experience. These were shape, size, number and movement and they formed the basis of ancient Greek visual theories on sculpture and architecture. Despite these being measurable qualities, they still depended on the viewer's subjective impressions (Thomas 2007: 207).

Sheer size, the second of Aristotle's characteristics is clearly the most identifiable in monumental architecture. A building's prominence is what observers in the classical period usually noted and while artistic refinement drew praise, physical grandeur elicited wonder, even in nature. It was mountains, great rivers and events such as volcanic eruptions and earthquakes that caused amazement (Thomas 2007: 208). However part of the visual impact of these natural phenomena was that they were not part of everyday experiences and monumental architecture imitated these extraordinary dimensions. The lighthouse of Alexandria was typical because of its 'irrational' conspicuousness. For Aristotle, his experience of grand architecture at *Smyrna* or *Pergamon* was like seeing a thunder flash or a lightning bolt (Thomas 2007: 208). For Romans, Aristotle's first two categories were easily reconciled. Colossal seated statues were chosen for Hadrian's *Olympieion* in Athens and the Temple of Venus in Rome.

After physical size came Aristotle's third quality 'numbers' or in other words, measurement. Important buildings were not only measured in feet but also by comparison with the human scale. On the other hand, the mark of a truly great monument was if its exact height was vague (Thomas 2007: 208). Monumental buildings looked almost indefinitely large. Under the Empire, the concept of *Eurhythmia*, which was based on the material concept of matter to be formed, became central to the appreciation of buildings (Thomas 2007: 209). Although this concept was established using the solid laws of measurement, it had little to do with giving measurement. It was a more dynamic quality of spatial experience and it encapsulated Aristotle's fourth quality: movement. The term *Eurhythmia* implied movement within or along a building and unlike *symmetria, eurhythmia* did not refer to exact measurements but was directed at the stimulation of the senses (Thomas 2007: 209).

These four qualities, identified by Aristotle were the basis of the ancient experience of architecture. Looking at monumental architecture meant seeing something of incredible scale or identifying a particular shape, the symmetry or rhythm of its parts or the changing colours of its materials in different light (Thomas 2007: 209). While in modern times we consider sound to be an integral part of an experience, the ancients were less concerned with it (even though it still played a significant role) than they were with sight. Sound and moreover the resonance, which was a result of the building's spaciousness, became a valuable guide to appreciating the buildings size and as vaulted architecture became more common, sound had an increased possibility to produce a sense of monumentality (Thomas 2007: 209-10). There are other senses too such as taste, smell and touch but in contrast with sight and sound, touch and smell receive little attention in ancient architectural descriptions (Thomas 2007: 210).

Monumental architecture was above all a visual experience and it became increasingly recognized as a subjective one (Thomas 2007: 210). The effect of such dazzling architecture must have been overwhelming. In written sources we often find references to response of 'wonder'. This sentiment however, had both positive connotations (awe, amazement) as well as negative ones (shock, intimidation) (Thomas 2007: 210). One might have simply stood, open mouthed too awe struck, intimidated or simply too tired to investigate the building further as more often than not approaching a monumental building also often involved an arduous climb (Thomas 2007: 211). Many of these reactions we will never know but not all are lost to memory. Some written accounts of ancient buildings record how these were experienced, especially when they were visited for the first time and how they were either admired or reviled (Thomas 2007: 211). In public architecture, large scale coupled with beauty and expense induced in the viewer a sense of 'shock' and 'consternation'. Below is an excerpt of the writer Lucian who imagines the terror of the Scythian sage Anacharsis when first seeing the architecture of classical Athens because he was a ‘barbarian’ who was supposedly intimidated by such signs of superior culture:

“When I first settled in your city, I was terrified (kateplage-n) as soon as I saw its vastness and its beauty, the size of its population, and all its general authority and splendour, so I was dumbfounded by all this for ages and could not take in how amazing it all was, the same way the young man from the island felt towards Menelaus’ house.”

(Lucian, *Anacharsis* 9)

Such was the typical response to urban architecture on a large scale. Lucian's words were very likely influenced by the response his own contemporaries had to the buildings of imperial Rome. Both extremes of admiration and terror became part of the later responses to Roman buildings depending on whether the people viewing these buildings were Rome's allies or enemies (Thomas 2007: 212). These responses raise the question of the 'intended audience' of Roman public buildings and it has even been suggested that they were not intended to have an audience at all (Thomas 2007: 212). The latter suggestion is hard to reconcile with the Roman ideals of magnificence and greatness. A great man's gestures and contribution towards the town or city whether as part of an official policy or simply because of pride and vainglory as discussed by MacDonald (MacDonald 1986: 133), had to be viewed by a definite public (Thomas 2007: 212).

Yet, not all architectural spaces were visible to all viewers to the same degree and these responses also depended on political and social circumstances. Public architecture did not have the same effect on everyone. Tonio Hoschler compared the two great imperial f*ora* of Augustus and Trajan in Rome and distinguished their appeal to different sorts of Roman viewers (Thomas 2007: 212). The forum of Augustus was a reduced and intimate precinct, with allusive iconography and messages that relied on the observer's proper historical and mythological knowledge. This is what Paul Zanker calls "pictorial spaces" (Zanker 1997: 183) that will be dealt with in more detail later in the text. The Forum of Trajan was more open and included a wider range of imagery that allowed more people to identify themselves with as opposed to the more local aristocratic and royal images found in the Forum of Augustus.

Just as domestic architecture encompassed a variety of 'public' and 'private' spaces within a single building so too did public architecture have different parts that were distinguished architecturally according to the level of the audience to which they were being directed (Thomas 2007: 212). In the *Horrea Epagathiana* et *Epaphroditiana* at Ostia for example, the outer entrance with its pediment and complex capitals made a statement of monumentality to those who passed it even if they had no business with what went on the inside. That was reserved for a privileged few (Thomas 2007: 212). The tension between open and closed elements of architecture was felt even more with regards to religious architecture and those who related their experience of scared architecture showed they were highly aware of the building's sanctity and this prevented the viewer from divulging all the characteristics of the building to others even if they were in awe of it (Thomas 2007: 212).

In imperial palaces and public buildings visitors often stopped to take in the delights but here, understandably, there was political purpose to their gaze. They were however careful not to be distracted by the architecture and petitioners to the Emperor had to avoid being overwhelmed by their surroundings. In the late 170s the writer *Athenagoras* described Marcus Aurelius and Commodus in the following way:

Nor do those of your subjects who come to you neglect to pay obeisance to you,their lords and masters, from whom they make and gain their requests, and turnrather to the splendour of your dwelling; but rather, while they admire the beautiful adornments of the royal palace as they happen to observe them, it is you who are in every way uppermost in their minds.

(Athenag. *Leg*. 16.2)[30].

In the Antonine age, (although this is not the same period this project deals with) there appears to have been a dilemma in how best to react to monumental buildings. Their interiors were so imposing that the visitor was stunned into silence but at the same time also had to voice their appreciation and give credit to their patrons. The more privileged a viewer felt the more he wanted to voice his approval (Thomas 2007: 212). Some went as far as to believe that praise of something could also enhance its beauty. Public buildings in an Antonine city needed to be appreciated (Thomas 2007: 212) and popular approval was one of the main criteria on which to judge their worth. I believe this to be true for most public Roman architecture throughout the Empire following the age of Augustus.

5.7 The Roman viewer

The above section about the response to monumental architecture highlights a very important element, one that was given little attention

[30] In W. R. Schoedel, *Athenagoras: Legatio and De Resurrectione* (Oxford, 1972), tr. Millar, *Emperor*, 564.

until recently: The ancient viewer in Classical Archaeology. In the past, scholars simply put themselves in place of the ancient observer of any given historical period and any scholarly analysis, even those involving a specific type of description such as banquet scene or a votive offering in a sanctuary, questions of perception have rarely been considered (Zanker 1997: 179). Moreover, in the mind of the modern observer the viewer is often only an ideal construct and tends to have all the knowledge of all antiquity acquired from all the relevant sources, because he has read all of Latin and Greek literature and has the advantage of photo archives and history books (Zanker 1997: 179; (Clarke 2003: 12). No ancient viewer had the advantages of the modern scholar and trying to examine Roman art exclusively from the scholar’s point of view would only distort its purposes and meanings for the ancient viewer - the character one is ultimately trying to understand.

It is no wonder that over the years, the ‘ideal’ viewer resembled more and more the modern academic of classical art and literature (Clarke 2003: 17). The Roman viewer is a very different character from the modern scholar and his knowledge of myths, visual models, literary sources and styles had limits no matter how educated he or she was (Clarke 2003: 12). One reason archaeologists were so reluctant to examine the role of the viewer is the highly fragmentary state of the monuments. The other is the striking lack of contemporary literary sources. Written sources on ancient Roman attitudes towards visual culture are sparse.

One passage from Ovid's *Art of Love,* shows us how unlike the modern historian the ancient Roman view could be. Ovid advises the young man confronted with the confusing panoply of topographical paintings to simply concoct interpretations to impress his girlfriend-

> *"And when some girl inquires the names of the monarchs,*
> *Or the towns, rivers, and hills portrayed,*

Answer all her questions (and don't draw the line at
Questions only): pretend
You know even when you don't.[...]"

Even though Ovid's work is a satire aimed at amusing his readers, he is really poking fun at the elite practice of *ekphrasis*, the explaining of paintings. Elite Romans, it seemed valued the ability to make connections between what they saw and what the image could mean (Clarke 2003: 10) and the connections they saw were meant to tell a good story and not give a scientificly accurate description (Clarke 2003: 10, 11).

However scholars have recently began to pay more attention to the role of the ancient viewer stripped of modern constructs. Authors such as Paul Zanker followed by John Clarke re-examine the ancient viewer. Both authors ask particularly relevant questions: Zanker looks at the pictorial environments and how these influenced an observer's perception of an individual work (Zanker 1997: 179), while Clarke addresses how ordinary people living in Roman Italy used and understood visual art and the part it played in their lives (Clarke 2003: 2). Featuring regularly in both authors' works are the examples of the imperial f*ora* that lend themselves perfectly, with their wealth and variety of imagery, to the authors' analyses.

Zanker looks at the particular conditions under which visitors to the imperial *fora* perceived the specific placement of statues in these spaces. The imperial *fora* were closed self-contained areas. Each was strictly closed off from the next, even though they were close to one another. The visitor entered individual spaces through splendid gateways that emphasized the transition from one unit to the next (Zanker 1997: 183). Zanker further highlights this difference with a passage from Ovid, a rather effusive contemporary observer who we have already encountered in a previous paragraph. This Augustan poet says that the Forum *Iulium* is similar in style to the garden porticoes of Pompey and Octacvia in the *Campus Martius*, that are filled with gods of love and to whom not even the practicing lawyers are immune to (Ars Amatoria i. 79-88) (Zanker 1997: 184).

The impression of the forum as experienced by Ovid's visitor was defined by large fountains installed directly in front of the temple of Venus and by the love-struck erotically charged statues whose characters may be compared with that of a well-known group in the *sala degli animali* in the Vatican museums (Zanker 1997: 184).

Setting the precedent for imposing decorations and complexity of message was the Forum of Augustus, and the atmosphere created by it was altogether different. In his *Fasti* (5.550-568) , Ovid describes the master of the house, Mars, personally inspecting the new construction and praising its size and grandeur. Everything here brings to mind war and triumph. The artistic agenda here constitutes statues that allude to Augustus and this time Ovid has no room for distraction (Zanker 1997: 185). The reconstruction of the area confirms that the space was dominated by the temple and cult and eventually by the single monument in the form of Augustus. The temple, projected into the square with its grand steps was no longer available for different associations or independent expression. It became part of a very coherent political programme and eventually this programme did not allow for any images with independent statements (Zanker 1997: 186). Like the Ara Pacis[31], Augustus's forum highlighted the emperor's role as restorer of the republic and its religious institutions (Clarke 2003: 29).

If the Forum of Augustus emphasized traditional religion and heroic service to the Republic, the message Trajan intended to communicate was instigated by a very different agenda. Harvesting the immense

[31] For a truly interesting debate about the imagery of the *Ara Pacis* and particularly the depiction of family and children see Clarke 2003.

success that unbridled imperial power had brought the city of Rome, he wished to show the results of imperial warfare and illustrate how and why the Roman army always won its wars (Clarke 2003: 30).

These separate spatial entities also constituted specific "pictorial spaces". They differed not only in the subject matter of the visual program but unmistakably also in "ambience". We see this with the examples of the difference between the forum of Augustus, with its religious imagery, the forum Trajan, with its images of war, weapons and slaves and the forum of Vespasian (Temple of Peace) with its gardens, fountains and promenades (Zanker 1997: 184) that unlike the Forum of Augustus, were not part of a coherent program (Zanker 1997: 187). The visitor encountered these monuments with very different expectations in terms of the atmosphere created by individual spaces and therefore, one's visual perception might have resulted in correspondingly different associations. The ancient viewer would also have used this imagery for more practical reasons, if one wanted to set a meeting point in a great square, it was often near a great sculpture or pictorial work. One ancient source tells us that the meeting point for one legal settlement was "*in foro Augusto ante statuam Gracci ad columnam quartam proxume gradus*" (TPSulp. 19. tab. 1, pag. 2). Lastly, while many describe the significance of the images and the intent to impress, Zanker also suggests that the Roman viewer may have also become bored with the barrage of images he must have been constantly subjected to (Zanker 1997: 186).

Despite these different messages and "pictorial spaces" as Zanker calls them, it is unlikely that the typical Roman visitor grasped the entire pictorial program of the various *fora* and that in light of the abundance of images, one's perception may have been selective. Regardless, it is hard to image how the visitor may have escaped the many images of Rome's proud past and its many achievements (Zanker 1997: 186). At the same time, the visitor must have also noticed the changes that took place as successive rulers took it in turn to surpass one another in expense and ornament. The facts that many buildings (of which the *fora* are perfect examples) were not only close to one another but had a similar purpose, emperors were under constant pressure to compete with the existing public buildings (Zanker1997: 189). This in turn influenced the style, something that will not have escaped the astute ancient observer (Zanker 1997: 189). If one had to try and put himself in the place of the many thousands of people who visited the Forum of Trajan, it becomes clear that the whole architectural complex was designed to impress. The Forum, Basilica and Column each proclaimed Trajan's importance in a different way and even the fact that the forum was the largest ever built showed that Trajan was even more powerful than Augustus. Few ancient viewers would have missed the similarities between the Forum of Augustus and that of Trajan (Clarke 2003: 31).

Today we are used to a rather comfortable view of Trajan's column as the surrounding ancient architecture is much reduced. In antiquity however, there was no clear view of the entire column as the architect had enclosed it in a small courtyard between the Greek and Latin libraries so as to further highlight its huge base and impressive height[32] (Clarke 2003: 32). So what could the viewer actually see? The viewer could read the dedicatory inscription and view the relief of the captured Dacians on the base. Walking around the column he could understand that there was a narrative that was told from left to right but he would not have been able to examine the relief in detail because of the foreshortening of the spirals as he craned his neck to look upwards (Clarke 2003: 34). The one advantage the ancient viewer might have had was that the column's relief was painted using realistic colours and bronze weapons, that no longer survive, would have been found in the hands of the figures (Clarke 2003: 34). Memory together with visual and verbal accounts would have helped the contemporary viewer of the

[32] For detailed description of the iconography of the column see Clarke pages 32 - 34.

Column and some scholars also argue that a vertical reading of the column was indeed intended by the artists (Clarke 2003: 36).

As to whether there is any indication that architects and sculptors worked with the viewer in mind. Zanker believes that the column of Marcus Aurelius is an example of a conscious awareness of the viewer's experience. The relief on the column of Marcus Aurelius is clearly more pronounced than those of the column of Trajan (Zanker 1997: 189). There are less figures but these are larger in size, with the composition trying to achieve an overall billboard effect. Zanker has little doubt that these changes were the result of a reaction to the frustration viewers of the column of Trajan must have felt (Zanker 1997: 189). Trajan's column however was surrounded by an abundance of elevated viewing positions, such as the upper stories of the Basilica Ulpia, arguably making its reliefs more viewable than the Column of Marcus Aurelius.

5.8 Conclusion: urban image and monumentality in Pozzuoli?

To begin with, we must look back at why the theoretical considerations on architecture are considered relevant to the work. The reason that the ideas of Norberg-Schulz, MacDonald, monumentality, physical dominance and Aristotle's "movement" principle are explored is not so much to see if these could be directly reflected in the digital or textual reconstruction from the outset because it becomes clear in the later phases of the visualisation that some of these ideas cannot be reproduced. They were identified in order to give the researcher a theoretical reference within which to work. Meaning that it would have been perhaps simpler to just start working on a reconstruction with no theoretical knowledge of any of the above but it would perhaps have limited the decision making process of the visualisation, it would have also perhaps meant that these models were created completely detached from their potential past significance, which would have decreased the visualisations' value as a tool for generating new questions and hypothesis. In simpler terms, if I wanted to visually recreate an amphitheatre, even if the reconstruction itself did not reflect the theoretical issues directly, the process of visualisation of this amphitheatre would be more useful and bear more significance to me if I had an idea of the theoretical implications that such a monument had outside the computer screen.

If these theoretical visualisations were to be explored directly - and I believe they should be once more information becomes available - one visualisation method would be to include human figures or cameras that stand at a human figure's height in order to explore how these buildings were used for the display of power and status.

So what of the above discussion can be applied to Pozzuoli? Well we know that it had not one but two amphitheatres which stayed in use even at the height of the city's importance. We also know it had a *Macellum,* a Stadium and monumental bathhouses. Most of these large buildings, as noted by Zanker were indeed placed at the edges of the city, outside the main city limits. The amphitheatres were even located on the main road, *Puteoli*-Capua, which would have facilitated the coming and going of locals and foreigners.

If we are to consider the importance of Pozzuoli not only commercially but also symbolically, with its wealthy traders and patrons, it is easy to see how these ideas about the Augustan building programme as well as the scope of monumentality was applied to the city. We can also add here that in Pozzuoli there wasn't just the "Roman" viewer but the "Foreign" one too and if travellers first docked at *Puteoli* before heading up to Rome, then perhaps the importance of visual representations was even more critical. Even though architectural elements developed in Pozzuoli much earlier than they did in Rome, such as the case of the amphitheatres, it is easy to see how quickly the city adapted to the agendas issued by the Capital. Repairs were carried out under Imperial patronage (such as on the Flavian amphitheatre, the *Macellum* and the mole) and benefactors were continuously rewarded for their contributions. What about the reference to the *Horrea* at Ostia as described by Thomas? Could the same have been applied to the Horrea at Pozzuoli? . Could they have had imposing facades for all to see even if what went on inside was mere day-to-day business? Given Pozzuoli's importance, I would hazard a yes, they would have. What about the viewers of Pozzuoli? The viewers of Pozzuoli were most likely bombarded with a variety of visual and other stimuli given the commercial nature of the port. On landing in Pozzuoli the viewer would have had to navigate his way along the docks, via the crowds of port handlers, merchants and all those involved in the commercial logistics. The areas would have been full of cargoes waiting to be loaded or unloaded onto the ships. Add to this the detritus that these activities produced and you have a dense, dirty, crowded first impression. On moving past the waterfront and into the city the viewer would have been confronted with a tapestry of commercial buildings of various sizes and decoration looming over these would have been the public buildings which the viewer may have even gotten a glimpse of while still on the ship entering the port. The viewer, particularly the foreigner or newcomer might have found this mixed tapestry overwhelming and chaotic, while the resident businessman in Pozzuoli might have not given the public buildings a second thought within his day to day activitied.

If we look at the above-mentioned text, one will see that the theoretical considerations moves from the development of Roman architecture to the responses it elicited. Towards the end of this section one will notice the increasing recurrence of a word in many forms, "visual", "visualization", "viewer". This is not a casual occurrence. This word is what leads to the next important theoretical aspect: Visualization. The following section will look at how digital visualization developed in the field of archaeology and more importantly why visualization is considered to the be such a vital cognitive tool, that as usual, we have come to take for granted.

5.9 Theoretical considerations on Visualisation

5.9.1 A brief history of visualisation in Archaeology: That fifth category

At the first CAA[33] (Computer Applications in Archaeology) meeting in 1973 J.D Wilcock predicted four main uses for computer applications in archaeology: Data storage and information retrieval; statistical analyses; recording of fieldwork; and the production of diagrams. He also had a fifth, somewhat miscellaneous category, where he allocated computer reconstructions of temples and other monuments (Wilcock 1973: 20). In the 12 years that followed, indeed most of the papers presented at CAA did fall in the first three of Wilcock's categories and it was not till 1989 that the first example of hand modeling a monument was presented (Arnold, Huggett et al. 1989).

As the field advanced so did the reconstructions of sites, monuments and artifacts. In 1997, Forte and Silotti's *Virtual Archaeology* described what the current scene was at the time by looking at several dozen digital reconstructions around the world. The trend that emerged was that these reconstructions served as primarily illustrative tools, so much so that subsequent publications were dedicated to the improvement of the methods and technologies that supported the creation of such illustrations (Frischer 2008: vii). In his forward, C. Renfrew defined the purpose of virtual archaeology as harnessing 'the power of the computer in helping us to recreate and to visualize anew the sites that

[33] The meeting's full title is Computer Applications and Quantitative methods in Archaeology. The mention of CAA here is deliberate. Whilst there are now many conferences and meetings dedicated to computing visualisation such as VAST and EVA to name a couple, the CAA meetings were the first of their kind and for a long time acted as good indicators of the trends in computing for archaeology.

archaeologists have excavated and studied' (Forte and Siliotti 1997: 7).

Interestingly, almost all the models described in Forte and Silotti's publication were built by private companies and no authorship or credit was given to a professional archaeologist. There was also no connection between the descriptions of the archaeological sites and the models used to illustrate them; we don't know whether there was any consultation between the model maker and archaeologist and more importantly which parts of the model were certain and which were hypothetical (Frischer, Nicolucci et al. 2000: 4).

This may in part explain why the reaction in the 1980s and 1990s of academic archaeologists was one of great resistance and mistrust, almost as if any information represented in the third dimension was superfluous to the scientific results of the research (Forte 2008: 22). Understandably this opinion was very much a product of its time. First of all, it was not uncommon that the creation of 3D models lead to aesthetic inventiveness to the detriment of content. Secondly, 3D modeling techniques were also very expensive at the time, which is why many early projects were carried out solely by private companies and finally, 3D reconstruction was thought appropriate mainly for didactic purposes, or rather it was considered part of the dissemination, not the discovery of information. In sum, 3D was relegated to the task of illustrating the knowledge that had already been gained after the "serious" scientific investigation had been wrapped up (Forte 2008: 22). Consequently, as Maurizio Forte notes, it was no accident that a high percentage of digital reconstructions in the 1990s were created "without taking into account spatial and philological data" (Forte 2008: 22).

In the late 1990's this situation began to change and many archaeologists started working on their own 3D projects, many of which were presented in 1998 at the CAA meeting in Barcelona. This was also the time that a shift began from simply making models to developing and encouraging best practice. The first attempts to set standards were made (Ryan 1996) and consequently, researchers began to put forward structured methodologies, critique the accuracy of the models (Kanter 2000; Frischer et al. 2000) and strive towards transparent data (Forte 2000). This now meant that along with the model, one had to provide clear scientific documentation, a visual language that enabled users to distinguish attested and hypothetical elements of the model and create metadata standards (Frischer 2008: vii).

Despite the enthusiasm, wariness and criticism that early 3D projects attracted, by the early 1990's the term "virtual reality" had replaced earlier terms such as "artificial reality" and "simulation" so much so that it was also during this time that there was some confusion about what "virtual reality" really meant (Frischer, Nicolucci et al. 2000: 4). In 1997 Carolina Cruz Neira expressed her exasperation about the term's misuse as a catchall for anything computer generated that "reeked of the bizarre and science fiction" (Cruz-Neira 1997: 2-2). For the most part "virtual reality" (VR) is best understood as described by Frischer to be "the use of three-dimensional computer graphics (CG) in a system that is (at a minimum) real-time, immersive and interactive." Frischer makes a further important distinction between VR and CG. "While all VR models can be called CG, not all CG constitute VR. The difference is that whereas CG is simply 'pictorial representations of objects and data using computers', VR is CG requiring immersion, interactivity and a real-time delivery system" (Frischer 2000: 4). While the current project will use neither of these definitions to describe the work, it is important to mention the role of the use and definition of VR as it generated considerable debate that thanks to which we are now ever more self-aware about the implications and resonances our digital methodologies have on archaeological research. For the purpose of clarity, a note must be inserted at this stage about what kind of 3D visualization this project will be implementing. This project will not be making use of virtual reality because the models are not immersive and the graphic rendering does not occur in real-time[1]. However the term ‘computer graphics’ is equally limiting for this project because the models do carry a certain degree of interactivity and thus cannot be simply considered ‘pictorial representations’. The term ‘digital model’ will therefore be used throughout the project as it implies the use of computer applications to the modeling of data without imposing any limits about what can be done with the eventual results.

One of the most extensive debates that VR in archaeology generated was the issue of ‘historical credibility’ that many felt was lacking in Forte and Silotti’s publication and which was then the subject of Ryan’s 1996 publication. His concern was the appearance of a computer model and the resulting inferences that unsuspecting users might draw about the quality of the archaeological data on which the model was based (Frischer 2000: 5). It seemed that many end users were taking for granted the “real” nature of virtual worlds and the impact this would have on their subsequent analysis. This “emotional response” also identified by Earl and Wheatley in 2002 was and still is a very relevant notion to bear in mind particularly because once the end user deems himself to be part of an environment they feel they are able to manipulate elements of it in a natural and intuitive fashion (Earl and Wheatley 2002: 6). It thus became important to highlight that “visualizing” the real world was not the same as “picturing” it, because the model and the graphical means for creating and visualizing the world are distinct (Frischer 2000: 5). Even more so for archaeologists, who not only start at a disadvantage due to the incomplete archaeological data but also who as Wheatley and Earl describe, must:

‘[...] *consider the contextuality of that which is represented, and its contingency upon personalities. […] with a virtual past the context within which any experience is generated is totally devoid physically from the present upon which the archaeologist bases his or her experience and from which the difference of the past and present is* *explored. Virtual worlds offer great potential for representing difference, but the very significant difference introduced by the machine is one that can never be escaped '* (Earl and Wheatley 2002: 7).

As a result of this debate, it became evident that when interpreting a virtual model, the subjectivity of the their creation should be made as clear as possible and yet up until the late 90s a lot of the literature had not highlighted the fact that virtual reality and its derivatives (such as interactive or still models) describe an artificial environment, and there was no notion of 'reconstructing' the past (Earl and Wheatley, 2002: 7).

The implementation of three-dimensional modelling techniques for archaeological data that began as early as the late 1980s and early 1990s[34] has generated a myriad of results, countless literature and a perpetual debate that is still very much ongoing today. Up until 2008 authors such as Hermon (2008: 36) were still highlighting the fact that a large number of publications still focused primarily on two main points; the importance of communicating cultural heritage to the public and new methods for improving the quality of the 3D reconstructions, at least up until 2008. In contrast, very few articles examined the role of visualisation in cognition and its use as an investigative aid for an archaeological problem (Hermon 2008: 37). This came as no surprise and as Frischer points out, was perhaps no more than a theory-lag, given that for many years the focus was indeed on illustration and interpretation (2008: vi), it seems logical that theorists would debate these aspects.

Indeed, in the same year Martin Jessop re-evaluated the current applications of visualisation in the humanities (2008: 283-285) and then proceeded to create a context within which to examine what is required so as to ensure that digital visualisations were created with identifiable

[34] For a detailed summary of the development of VR in Cultural Heritage see (Frischer 2000).

intellectual rigour using the London Charter as a case study for the setting of appropriate methods and standards (Jessop 2008: 289-291). The London Charter defines a set of principles for the creation and use of computer-based visualisation methods in relation to intellectual integrity, reliability, documentation, sustainability and access. Frischer's Rome Reborn project, Beacham's reconstruction of Pompey's theatre and Orengo and Fiz's reconstruction of Tarragona (Orengo and Fiz 2007) are already projects that are testimony to the shift in the role of visualisation as desired by Hermon. That of an archaeological tool that was not only able to illustrate -but more importantly generate- questions and impact upon the subsequent interpretation.

5.9.2 Why visualization?

More importantly, why Information Visualization? The traditional sciences have made it possible for us to understand complex phenomena by reducing them to small understandable units. Understanding inherent complexity however requires a different approach, one where the system being studied is not broken down but rather, is represented and viewed as a dynamic whole (Anderson and Woodill 2004: 229). Some simplification will always be required but in this instance the links and relationships between the main components must still be preserved if we are to understand anything about them and for many years the humanities lagged behind the physical sciences that have been using digital models since the mid 90s (Frischer 2010: ix). Maurizio Forte believes that in an era of digital globalization, whereby we are generating enormous amounts of information, archaeology too, cannot escape the dynamic of complexity (Forte 2010: 21). If the process from research to communication becomes fragmented or begins to evolve on a parallel path, information will inevitably be lost along the way, weakening the impact of research (Forte 2010: 21).

Although complexity has often found its representation in mathematical equations or in textual descriptions, many scientists also use visualization as a pedagogical tool. One is very likely to find diagrams, graphs and illustrations accompanying texts and mathematical formulas. It seems that complexity scientists (perhaps intuitively) realize that words are not enough to talk about complex systems (Anderson and Woodill 2004: 230). In short, some subjects are not easily explained verbally or textually, more so when the author is trying to communicate a process that is non-linear (Denard 2012: 60). Moreover there is an ever-increasing overlap between complexity science and archaeology especially when we consider the use of network analysis (Brughmans, Isaksen et al. 2012) and agent based modeling (Campillo, Cela et al. 2012).This begs a further question: why does information visualization work so well?

The field of information visualization began in France in the late 1960’s with the work of Jacques Bertin (1967,(1983). The field further developed until Edward Tufte extended Bertin’s theories in two of his self-published books (Tufte 1983; Tufte 1990). Since then there has been a steady increase in publications on information visualization and scientific visualization, with works such as those by Card, Mackinlay and Schniederman (1999), Spence (2001) and Ware (2004) (Anderson and Woodall: 2004: 230). There are two main uses of information visualization: the first is to communicate ideas, the second is “to discover or create an idea by revealing hidden patterns” (S.K.Card, Mackinlay et al. 1999: 16). The latter sense is “the process of forming a mental model of data, thereby gaining insight into that data” (Spence and 2001: xiii). This mental model as described by Spence is what is often referred to as a “cognitive map”. Learning in this context means that one is able to recognize and identify new patterns and is in turn capable of changing existing “maps”.

When we are undergoing the process of learning about a complex system, our insight, particularly in recent years, is often best achieved through the use of three- dimensional displays driven by a computer sorting through extensive and apparently chaotic data sets looking for patterns. Our capacity to “see” is therefore limited both by the structure of our brain and by our sensory apparatus. It is also limited by our previous experiences with visual pattern recognition, our “visual vocabulary”. In other words, we need to know something about what we’re looking at *before* we are able to recognize, cognitively, what is we see (Anderson and Woodall 2004: 231). This point is illustrated beautifully using an example of the work undertaken by Oliver Sacks in his book *An Anthropologist from Mars* (1996) who devotes an entire chapter to “Virgil”, a man blinded at an early age who then had his vision restored as an adult. Sacks describes how following his surgery, Virgil was unable to make sense of what he was now able to see. Virgil frequently resorted to the information gathering process that he had used as a blind in order to make sense of what he could now see. For instance, he would feel the contours of the object he was looking at and only then “know” what he was seeing.

This point is particularly relevant to the archaeologist, more so if working with visual techniques in order to sort through complex archaeological data. This in itself is a rather complex question. How do we know what we are looking at as archaeologists? How far has the primary (unsorted) archaeological record been able to tell us what it is we’re looking at and how much of what we think we’re looking at has been influenced by previous studies, collective memory, previous visual aides and elements such as film etc?

Furthermore, part of our biological make up requires us to categorize the visual information that we are constantly being fed. To begin with we should consider what happens when we look out of a window. Our eye has 100 million light-sensing cells, but only 1 million fibers leading to the brain. The brain does its own neural categorizing so that the houses, people, trees, cars or whatever we “see” outside our window –

whatever we become conscious of – are understood as 'trees', 'cars', 'houses' and people and not just as individual objects distinct from one another. The fact that we categorize is not just an important aspect of our biological make-up; it is tied directly to our learning process (Anderson and Woodall: 2004: 235).

Whilst mentioning the sensors of the eye, it is worth noting an important point put forward by Kate Devlin about visual perception in her article *Just how Predictable is Predictive Lighting?* in Bentkowska-Kafel *et al.* (eds.). Understandably, the goal of predictive lighting[35] is for the virtual scene to be viewed using the same conditions of a real world scene. Yet, given the limitations of the current technology this is rarely possible compounded by the fact that access to good quality data that warrants the use of physically accurate simulations is rare (Earl 2013: 7). Moreover, the human visual system can accommodate a wide range of luminance in a single view. Added to this is the fact that the human eye is capable of adapting to its light surroundings, whereas an image displayed on a standard CRT or LCD screen is very restricted with the image being adjusted to accommodate a display device only capable of low dynamic output (Devlin 2012: 130).

Psychophysical research also tells us that there are a number of factors that influence perception when viewing displayed images (Devlin 2012: 130). The human visual system adjusts (imperceptible to us) to the stimuli received. As a result, this adaptation enables us to respond to large variations in luminance therefore; a person within that scene will have adapted to the environment and could well have a different perceptual response to the person looking at the virtual equivalent on a small monitor (Devlin 2012: 131).

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[35] For a more detailed description of predictive lighting see Devlin in Bentkowska-Kafel *et al.* (eds.) pgs 125-134. See also Lensch *et al* Siggraph 2005, Wilkie et al Siggraph Asia 2009, Weidlich and Wilkie SIGGRAPH ASIA 2009, Devlin et al 2002 (intro to spectral rendering) and implementations like the sky simulation of Haber et al 2005

This point is of particular importance not just for the person reviewing the final visual output but also more importantly for the person working and creating that output via the computer screen[36].

Learning requires conscious attention and the more one learns about something, the less we have to attend to it consciously and the more it becomes part of our unconscious. When we pay attention to what it is we're learning, one's consciousness is strongly involved, involving strong neural activity in our brains as new neural pathways are set (Anderson and Woodall 2004: 235). Once we have learnt something, much of what goes on can be relegated to the unconscious. We "know" something when we no longer need to attend to it consciously. This has implications to how we proceed with learning tasks. The implications related to this process and to how we learn specifically about past environments (for which we have only limited sources compared to trees and cars which are in our daily visual input) must also be kept in mind. This salient point together with that describing the acquisition of our "visual vocabulary" will be addressed in further detail when describing the data acquisition and reconstruction processes related to the project.

According to the information scientist Colin Ware, visualization can promote understanding in five following ways:

- It facilitates the cognition of large amounts of data;
- It can promote the perception of unanticipated emergent properties;
- It sometimes highlights problems with the quality of the data;
- It clarifies the relationship of both large and small-scale features;
- It helps formulate hypotheses (Ware 2004: 3).

Across all areas of knowledge today, scientists have found that alongside logical and quantitative analysis, visualization is a powerful

[36] See also Earl 2013: *Modelling in Archaeology: Computer Graphic and other Digital pasts* for a detailed discussion about the complexities and implications the creation and interpretive processes used in predictive rendering and physical realism.

tool for understanding and discovery (Frischer 2008: 3). Researchers in cognitive psychology found a positive relationship between the ability to visualize and the use of visualization tools (Sein *et al.* 1993) meaning that the better the visual tool, the better the explanation and the comprehension of information (Hermon 2008: 38). Semir Zeki, a neurobiologist emphasized vision rarely involves mere sensation; it usually leads spontaneously to cognition. In other words, first we look, and then we see and understand (Zeki 2003: 21, 24, 26, 93). Information visualization can therefore be a great heuristic device, as long as the recipient is familiar enough with the with the conceptual framework being used by the sender so that he or she can unpack its meaning (Anderson and Woodall: 2004: 238).

Taking an example from archaeology, it is only when presented with a visualization that we become aware of features that are always present but never apparent to the naked eye and unaided mind (Frischer 2008: 3). In archaeology where the very beginning is the unknown, even the best-preserved cities such as Pompeii or buildings such as the Pantheon have changed so much over time that it is only after dredging through a series of scholarly reports that one may begin to imagine what they looked like and more importantly how they functioned. Just as with the more traditional methods, the 3D representation of a building can be viewed captured and analyzed. However in the case of the 3D model additional data is made available for interpretation such as building height and shape and can go further as it allows for experiments or simulations (based on scientific rules and constraints). These elements are not possible with artists' impressions, to name one of the traditional visualisation methods.

Before moving on to the more etymological description of visualization, it is perhaps worth pausing to look at some examples taken from the history of digital visualization in archaeology that correlate to the uses outlined in Colin Ware's five points.

The computer reconstruction work that was carried out during the 90s (such as the projects presented in Forte and Silotti's publication) can be considered examples of the first and fourth use of visualization. For example a computer model can help us to understand how thousands of architectural fragments can be put back together and how a particular fragment related to the monument as a whole (Frischer 2010: viii). In the late 90s, as the focus shifted from simply making models to developing proper scientific documentation, Ware's third use of visualization, comes to the fore. These are but a few examples to highlight which of Ware's five applications have been embraced by archaeologists and to also see which still remain to be employed (Frischer 2010: viii). Ware's second and fifth categories: promoting the perception of emergent properties and facilitating the formulation of hypotheses still need to be employed, at least on a large scale in the field of archaeology (Frischer 2010: viii). This is not to say that examples of these don't already exist. The field of GIS has been found to promote Ware's fifth category. Geographic Information Systems is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographically referenced data. In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology. The field developed and expanded rapidly in archaeology. In the early years GIS was viewed primarily as a tool for assembling and viewing digitised information about terrain but this field too has developed to include hypothesis formation, visualization and analysis (Frisher 2010: viii). GIS is as large a discipline as 3D modelling and although it shares the visualization points pondered in this chapter, it has purposefully only been mentioned briefly. It is too vast a subject that has its own theoretical and methodological development. Any attempt to delve into this subject would at this stage be counterproductive.

Aside from the cognitive element of visualization, many would define the word ‘visualization’ as a group of techniques for creating images, diagrams or animations to communicate a message. This form of communication has been used to transmit both concrete and abstract ideas throughout human history (Jessop 2008: 282). Furthermore, the use of images to communicate during the larger part of our history is reflected in images produced by hand and in the print media. With this historical perspective in mind three important questions are raised, each of which has a bearing on the examination of visualization as a scholarly activity (which is how visualization is being employed throughout this project):

- What role have visualizations played in the past in humanities scholarship?
    - If we are to consider the majority of images in print as ‘illustrations’ what is the distinction between ‘visualization’ and ‘illustration’?
    - How has the emergence of digital media affected the development of visualization (Jessop 2010: 282)?

All three questions raised by Jessop (2010) are valid in their own right and the distinction between illustration and visualization provides ample ground for discussion but like Jessop ,the focus at this stage should be on the word *digital* in ‘digital visualization’ and it is this same word that enables us to move beyond method and towards methodology.

A digital visualization varies from a printed illustration in two ways: it is interactive and it permits both the graphical representation and the data it derived from to be manipulated (Jessop 2010: 283). That is all very well but this definition can also be applied to all graphics produced by a computer including a simple scatter graph plotted using the data from a spreadsheet. Selecting different sets of data, refining displays, changing algorithms or performing statistical operations on the data can all be part of an interactive process of exploration (Jessop 2010: 283). At least in the style of its usage, a spreadsheet can also be correctly described as visualization because it is effectively applying a visual interface to a method of exploratory data and thus renders the above definitions inadequate. Visualization is no longer merely an illustration when it becomes the principal means of communication. The term 'illustration' implies an image whose role is simply to support written language, the main information being transmitted through the written text. Many consider an image to be a true visualization when it is the principal carrier of information, not an addition to part of a text. Jessop settles on the following distinction:

" […] *an illustration is intended merely to* support *a rhetorical device (usually textual) whereas a visualization is intended to* be *the primary rhetorical device or serve as an alternative but parallel (rather than subordinate) rhetorical device.* (Jessop 2010: 283).

The broader issue that humanities scholars always focus on is the emphasis they place on written language and their apparent mistrust of images. This mistrust stems from a historical basis, William Ivins (1969) wrote about the limitations of images in scholarship arguing that it was impossible to disseminate ideas because of the difficulty of reproducing them accurately. Another part of the problem is also the relative 'newness' of digital visualization and it is primarily because of this that a context for digital visualization needs to be established within the scholarly method.

There are many ways in which to structure an analysis of the use of visualization in the humanities such as by discipline, type of information, platform etc. and delving into too much detail into any one of these aspects would be beyond the scope of this project. However an appropriate starting point and general overview is the one provided by Jessop who chooses to describe briefly the type of data that is being visualized, whilst bearing in mind (as we all should) that the boundaries of each data type are many, blurred and bear an importance beyond their immediate scope (Jessop 2010: 283). The types listed are, space, quantitative data, text, time and most relevant to this research, 3D visualization, which is what the following paragraphs will be detailing with below.

Jessop starts by looking at the study of spatial relationships, perhaps because it is an aspect that is studied in many disciplines. Leading this particular area is Geographical Information System software (GIS) originally developed for scientific information that displayed a large amounts of precise information but which was perhaps less appropriate to use with the more sparse and uncertain data used in the humanities (Jessop 2010: 283). Space is important not only because of the evident data applications of maps and GIS but because it forms the core of all visualizations. The spatialization of data adds a level of dimensionality that is absent from the written language and in doing so makes the display of simultaneous elements easier (Jessop 2010:283).

3d visualization has so far focused upon visualizations of the built environment. This remains of interest not just to historians and archaeologists but also to anyone interested in understanding the relationship between these buildings and the people who occupied them (Jessop 2010: 285). The emergence of digital 3D visualizations in the last two decades now allows for dynamic ways of investigating architecture and this is one of the most dramatic shifts brought about by visualization tools. The potential of experiencing architecture through digital reconstructions however raises a series of questions about the validity of the actual experience. Is a 3D reconstruction a valid method for increasing our understanding of real architecture, particularly those buildings that are either partially complete or no longer extant (Sirbu 2010: 61)?

In the first section of this chapter we have seen that, in order to understand architecture we must experience the way we move inside the building and how this experience is affected by scale, selection of colours, light texture and acoustics amongst other things (Holl 2006: 122). In the real world, we can observe and intuitively understand how the building has been designed and the function it was designed for. There is also a personal element to experiencing architecture that is linked to the memories that one associates with various spaces and these inevitably influence how architecture is perceived (Sirbu 2010: 62). This process, as Schultz's analysis has shown, is defined in architectural theory as place making (Norberg Schulz 2008: 11). Schulz makes a distinction between two fundamental components: space and character. Space is defined by the physical components of architecture and this acquires character through the memories that we project on the spaces we have lived in (Norberg Schulz 1980: 11-23).

Can these ideas be applied to the experience of digital architecture? Daniela Sirbu addresses this question by investigating the nature of space in digital reconstructions of architecture and the various ways in which this same digital space, like its real world counterparts acquires character through the memories that are formed through one's interactions with the digital environment (Sirbu 2010: 63).

Digital media distinguish themselves from other types of media because they are active and dynamic and one must therefore consider how these elements influence content and delivery. In short, the properties and the way architecture is understood through computer visualization are different from those of real architecture (Sirbu 2010: 63). So does the logic we use to navigate a 3D model differ from how we choose to navigate a real building, particularly when we have certain features available to us, such as interactivity and the non-linear navigation of space. The digital representation of an architectural building also takes on a different significance. It is no longer the primary source of experience as a real building would be, it becomes a 3D interface, a representation around which information is attached. With this approach, the 3D representation takes on a dual role; that of an interface and cultural content (Manovic 2001: 78). Moreover, the actions a user chooses within digital environments are connected with both the information and navigation, even if the navigation is conditioned and informed by our everyday experience of real architecture (Sirbu 2010: 64). Yet, at times one cannot help but feel awkward when navigating even the most advanced reconstructions. This happens because creators of 3D reconstructions equate the way we experience architecture in real life, such as walking from one point to the next, to the model but neglect to apply or adapt the interaction principles. Another cause for the ineffective 3D models is because there is little incorporation of the real architectural metaphor and the specifications of the digital environments (Sirbu 2010: 64).

Before proceeding to the conclusion of this section and thus the chapter, it is worth noting that the concept of place as described by Norberg Schulz acquires an entirely new meaning when referring to digital environments reproducing architecture. The digital space is now built around the representation of architecture but now it also holds new meaning as a place of information. Inhabiting and experiencing such spaces requires an adjustment of the original concept of space and place that reflects the specific nature of what has now become a digital space and digital place-making (Sirbu 2010: 65).

Digital archaeological visualisations differ in character and affordance from the traditional isometric and axonometric projections. One such difference is that the latter are parallel projections that are of particular importance in archaeology because accurate measurements can be taken directly from the image. There is however the possibility of a perceived distortion easily resulting in situations where depth and altitude are difficult to gauge. Moreover, once the image is created, even in CAD, the information one gleans from it is limited and immediate interaction with the drawing is not possible (for example, an isometric drawing cannot be rotated in CAD).

A three-dimensional digital visualisation on the other hand allows for constant manipulation and the changing of parameters that allow for more immediate answers to instinctive queries. These include rotation, zooming in and out, adding volume and changing perspectives. These differences however do not mean that a digital visualization is inherently more accurate than an isometric drawing and indeed the possibility of distortion within the model and even loss of data after tampering with the object also exists.

5.9.3 Examples of digital visualisation projects

Today there are many projects that make use of digital visualisations. To name but a few, the Rome Reborn Project by Bernard Frishcer, the Portus project by the University of Southampton and the Utopian Theatres by Rachel Hann are all examples of how digital visualisations have played a vital role in the understanding of complex datasets similar to those of Pozzuoli. The Rome Reborn and Portus Project both address large areas. *Portus* in particular addresses a port town that underwent many changes over time much like Pozzuoli.

The purpose of Rome Reborn model is to present information and theories about how the city looked at this moment in time, 21, 320 A.D. as well as to create the infrastructure whereby the model could be updated, corrected, and augmented. Whenever possible, the sources of archaeological information or speculative reasoning behind the digital reconstructions, as well as valuable online resources for understanding the sites of ancient Rome, have been made available to users. The model is thus a representation of the current state of knowledge about the urban topography of ancient Rome at various periods of time.

The digital model reflects the sources of knowledge about ancient Rome. These are mainly of two kinds: archaeological data about specific sites and features and quantitative data about the distribution of building types throughout the fourteen regions (or wards) of the city. Where, evidence is completely lacking, the following features have been omitted from the model: interiors of buildings; furniture; statues; small honorary monuments; inscriptions posted on buildings; polychromy of buildings and sculpture; decorative sculpture on buildings (http://romereborn.frischerconsulting.com/about.php).

The Portus Project has been producing computer graphic representations since 2007 for a variety of reasons. The representations have helped bring together all the many forms of digital data gathered on site, they have also allowed the researchers to develop interpretations of the archaeological datarecovered. It was also possible to perform formal analyses of different aspects of buildings at the site (http://www.portusproject.org/technology/2012/12/reconstructing-portus/).

Rachel Mann's project objective was to form new insights on these seldom examined theatres through the process of computer-based 3D visualization. Her three case studies draw upon a wide range of source material: including architectural plans, sketches, performance manifestos as well as significant productions and artistic trends that informed 1920s theatre practice. The case studies were implemented using the architectural 3D modelling software AutoDesk's 3D Studio MAX 2008. Conducted alongside a conventional historical review, this project has been designed in line with the principles and recommendations of the London Charter. This approach to historical analysis was framed by an assessment of the research qualities and conditions of computer-based 3D visualization (http://www.utopiantheatres.co.uk/guide.html).

Each project encounters the same challenges to that of Pozzuoli, primarily the vast amount of complex datasets available for the site or buildings and how these should be organised and selected in order to use in the digital reconstruction and each project then chooses to address these datasets in different ways. The Rome Reborn project has a database whereby the data for an individual monument can be sourced (http://romereborn.frischerconsulting.com/ge/TS-017.html). The Utopian Theatres project has a similar principle whereby a case study can be selected and the relevant information can be accessed. This type of approach to data collection would serve the Pozzuoli project well and a database for different elements of Pozzuoli's architecture could be created in order to combine the various sources that were used to reconstruct the monument. The Portus Project descriptions of how selective models wee built take a descriptive form much like that of Chapter 7 in this work. This has the benefit of clarifying the decision making process which led to final picture.

Where this project hopes to go further is in the detail. What this project has sought to avoid is the lack of description in both the assessment of the sources chosen or lack of detail in the decision making process. The Rome Reborn project for example gives a list of sources but does not detail the model making process, which would have complemented the database entry perfectly. Likewise a small summary of what led the creator of Building 5 (http://www.portusproject.org/fieldwork/buildings/building5/) to produce the model (visualised in the second photo) from the first photos of the excavation remains, even if hypothetical, would not have been lost.

5.10 Conclusion

The implications of this on the various aspects of this project are many. Each theoretical consideration was selected because they were elements that inevitably needed to be considered during this study of Pozzuoli. One may ask what the phenomenology of architecture may have to do with the understanding of the ancient port but as previously mentioned, looking at ancient architecture with the modern constructs we are accustomed to, we run the risk of imposing these on interpretations about the past. A quick glance at modern phenomenological approach to architecture is therefore not entirely futile. Neither is the overview of the theory about the development of Roman town planning and Roman monuments. These bear a more direct link to the study of Pozzuoli because there are many parallels and examples that can be identified in the development of the port and this greatly enhances our understanding of the area. The sections about the responding to monumental architecture, the Roman viewer and the theory on visualization are vital to the project, although they have less to do with the physical port itself and more to do with the methodology that was applied to the study of the port. Visualization, like our daily movements in and out of buildings is something we often do not stop and think about. The knowledge of the considerations described above not only impinge on the methodological process of the project but they ensure that the work is executed with a degree of awareness that allows the project to be as transparent as possible, with all the potential pitfalls this transparency and self-criticism entails.

It must be noted at this stage that this project will not make use of the term “Virtual Reality” to because the reconstructions carried out do not adhere to Frischer’s description of “the use of three-dimensional computer graphics (CG) in a system that is (at a minimum) real-time, immersive and interactive.” The only attribute that can be assigned to the models created is that they are interactive. They are not immersive or real-time. The term "digital visualisation" is perhaps more appropriate because the models here created are a means of representing visually complex archaeological data using a digital set up.

As already mentioned above, the sophistication of the imagery employed in digital visualizations has made the technique vulnerable to criticisms because of a lack of intellectual rigour and effective methodology (Jessop 2010: 285).

The knowledge representation strategy that emerged in this particular work is one of compromise. The models created have proven useful in summarising complex datasets. They have also highlighted lack of data as well as the quality of available data in certain cases. The models have also helped, through the interactive act of building them; create an understanding of individual elements within a building complex. The models vary in substance however when it comes to the more phenomenological approach to digital architecture, the perception of light and the emergence of patterns. The problems Sirbu mentions above such as the little incorporation of the real architectural metaphor and the specifications of the digital environments (Sirbu 2010: 64) are apparent in the models created here.

The digital visualisations used will not be immersive or real-time. Photorealistic rendering will not be implemented. This lack of visualisation elements has more to do with time-constraints, data availability and user know-how which in turn affected the methodological choices that followed,

There is however plenty of opportunity for future works to be carried out on the existing models. Digital visualisation offers ample means of representing changes over time. This aspect remained unexplored throughout the project due to lack of time and the number of elements that underwent change (Amphitheatre, Capitoleum, Macellum) but there is enough data available to explore this in the future especially as more data for Pozzuoli is collected.

To counter this ever-present scepticism a lot of work is being focused not only on the principles of best practice (Such as ICT Methods Network and the ADS guidelines) but also on the principles for maintaining the intellectual integrity of the work such as the London Charter. These points bring us to the introduction of the following chapter, which is a detailed description of the methodology that was employed throughout the various stages of the research project set within the context as defined by the guides to best practice and of the intellectual integrity as defined by the London Charter.

6 Methodology

6.1 Introduction

"Total order, like total chaos, is uninteresting. [...] It is complexity – the vast territory between total order and total chaos – that contains everything worth talking about."

(Norretranders, 1999 in Anderson and Woodall, 2004)

"Images are seductive and there is a natural tendency to instinctively believe whatever one sees with one's own eyes..."

(Martin Jessop: 2008)

Why model ancient cities to begin with? Physical modelling is an historic practice that started no later than the 14th century. Filippo Brunelleschi (1377-1446) used a physical model to show that his radical design for the cupola of the cathedral of Florence could work. In this case, the model was used as a means of persuasion (Piga 1996: 56, 60) but Leon Battista Alberti (1404 -1472) saw the physical model as a means to check the accuracy and correctness of the architectural design both in terms of aesthetics and structural soundness (Piga 1996: 68). In the 16th century physical models of fortified cities were built with the aim of acting as visualization tools in order to help commanders plan their defense or attack (Warmoes 1999: 13). Louis XIV was a master commissioner of city models and of the 144 built during his reign; thirty survive today (Warmoes 1999: 8).

In 2003, David Staley identified six types of representational and abstract visual sources that are used by historians but these can also be applied to the humanities. The categories are: Galleries of images, Museums and collections of objects, Film, television and other moving images, Dramatic re-creations, Maps and atlases, Pictures of data.

Jessop adds another category to this list, that of Single images (Jessop 286). David Staley argued that *galleries of images* in this context were not simply a collection of images but their spatial arrangement was such that it substituted the linguistic arrangement of any written sources associated with them (Staley 2003). In other words, careful arrangement of the images would allow the viewer to identify patterns and relationships. This is the opposite of what often happens in scholarly publications, where photographs are used as replacements for the primary sources and are usually accompanied by a written caption or description that identifies the source (Jessop 2008: 286). However, if there is a purposeful arrangement or a juxtaposition of images, it is possible for these images to carry scholarly communication and value as was demonstrated by John Berger's publication *Ways of Seeing* published in 1972.

This brief note about the context for digital visualization in the humanities is useful for two reasons; the first is to show that the approach is not as new as we think. Second of all, because visualization as an academic activity suffers from the mistrust held towards images in general, it is worth pointing out the more positive examples of the use of visual sources (Jessop 2008: 286). It also acts as a reminder that the principles behind digital visualizations are not new and that there are examples of the use of visual sources and tools in humanities scholarship[37]. Digital visualization can be placed in this context forming a continuation of the method rather than a complete upheaval of it. This is not to say that the method is without problems as was highlighted in the previous chapter, its most notable being the lack of historical background and the incomplete record as well as all the measures required to ensure transparency of method, selection process, intentional omissions and missing data.

[37] For a more detailed discussion on the context for digital visualization in the humanities see Jessop 2008.

The emergence of digital technology has created a new medium for these tools that provide us with extended functionalities and opportunities for development. As a result of this, there is further potential for new research methodologies that increase our cognition (Jessop 2008: 281). These serve two distinct purposes. The first is described in the platitude: 'A picture is worth ten thousand words'. Despite the basic truth in this phrase, what is being implied here is simply a matter of transmission and that is unidirectional. Of greater importance is the second purpose, which is the potential of these tools to allow visual perception to be used in the creation and discovery of new knowledge; a knowledge that is not transferred or revealed but created through a dynamic process (Jessop 2008: 282).

The following chapter aims to describe the rationale of the project as reflected by the computing methodology that was employed to answer the research's main question: What was the impact of the main monuments on the skyline of Pozzuoli when viewed from the sea and what can this impact tell us about the desire to assert imperial influence in the area? The chapter will also look at why this particular method was chosen over others, how it is going to be employed and the extent of its success. It will proceed to outline the process employed for the reconstructions and the processes that were implemented in order to carry out the analysis of the model.

6.2 Methodology for the reconstruction of the port of *Puteoli*

6.2.1 An overview of the techniques used (art-Humanities.net definitions)

In his article on the appraisal of 3d modelling techniques Hermon (2008) provides what is perhaps the best definition of what creating a virtual model involves:

"*A virtual representation of an archaeological entity is based on data originating from various sources, such as historical records of graphical nature (ancient maps, drawings, paintings, mosaics etc.), texts, archaeological field investigation (surveys, soundings or excavations), comparative studies, and, last but not least, the modeller's informed imagination [….] It should be stressed that these variables are in turn informed by further, usually unrelated to each other, variables (e.g. accuracy of measurements, reliability of historical texts, ancient maps etc.)*".

This project aims to follow as closely as possible the standards set by the above-mentioned description while adhering to the standards set out by the London Charter for the use of computer-based visualisation methods in relation to intellectual integrity, reliability, documentation, sustainability and access (London Charter 2009: 2). The description will also include how the ADS/JISC best practice guidelines were applied to each stage and how each stage could be improved where needed. Following this, a description of the impact each method had will also be described both in practical and conceptual terms.

To use a simple example of the above-mentioned impact would be to consider the simple process of saving a scanned image in either a JPEG or a TIFF format. The former is smaller in size and easier to load within the digitizing software, however the loss of data (from the saved image) will only allow the user a limited zoom before the lines become harder to define, thus presenting the user with choices on how best to digitize. TIFF images on the other hand are file formats with a higher degree of information thus allowing (whilst digitizing) the user more flexibility but drastically increasing the overall file size. In the digital humanities discussing file formats may seem nowadays to be a rather obvious, trivial element, yet it affects the decision process that is taking place from choosing what elements need to be digitized accurately to how to store and access the resulting files.

Together with this, a part of this chapter will also take a more in-depth look at the two-dimensional data representations and will proceed to outline why they are still considered an integral part of the reconstruction process. With so much focus on three-dimensional data, it is all too easy to forget the reasons why we use two-dimensional abstractions in the first place. It is important to re-evaluate how 2d data helps us (if it helps us) move towards a three-dimensional model. Even more important is to understand the degree of information that is lost during this process, the type of information that is lost and at what stage. Each consideration will be mapped out in chronological order according to the process described.

The first part of this methodological description seeks to outline the actual physical processes that were employed throughout the project, the second half seeks to address in more detail the London Charter and its pertinence to the methodology used throughout this research.

6.2.2 Data Capture

Data capture comes in numerous forms and those that were carried out for this project will be described below using the terminology as described by the arts-humnities.net webpage. Arts-humanities.net is a valuable resource and guide to digital humanities and the arts. It provides information on projects, on tools and methods for creating digital resources; a listing of expert centres and a library documenting case studies, briefing papers and bibliography. Project entries are also regularly updated.

6.2.2.1 2d Scanning

'Scanning' refers to the process of creating a digital image from a paper document. The term '2d Scanning' particularly refers to data captured by means of a two-dimensional scanner (e.g. flatbed scanner, film/slide scanner, drum scanner). For this project various elements were scanned, these included, images from texts, maps detailing the general landscape of Pozzuoli plans and sections of the larger monuments (these included the Amphitheatre, the *Macellum*, the Stadium, the Temple of Augustus on the Rione Terra) and where available of the smaller archaeological remains (these included cisterns, *Horrea* and fragments of buildings deemed relevant to scan). Scanning was also extended to visual documentation that was sourced from the archives of the *Soprintendenza Archeologica di Napoli e Caserta*. Detailed archaeological drawings such as the plans and sections of the Temple of Augustus and the underwater remains of the warehouses are examples of the large format scanning that was needed to collect as much of the visual documentation necessary in order to reference during the reconstruction process. Other elements that were scanned were historic maps and paintings, artists' impressions of both the landscape and of any monuments, architectural details and of any other material that was needed for comparison.

6.2.2.2 Heads up Digitising and Interactive Tracing

Heads-up digitisation, or on-screen digitisation, is perhaps now the most commonly used method of digitisation. The idea is to convert the digital image into a form usable in the GIS environment (i.e. in such a way that each feature on the map has a geographic co-ordinate associated with it).

This is often the second step after 2D scanning but is not always so. Whatever the stage of the data collection, when a scanner automatically captures map features as a raster image, this raster lacks any geographic information that has to be input manually. In order to achieve this, the digital image is displayed on the screen and zoomed to a comfortable level such that all the features on the image can be easily traced on the screen itself and in the process creates new layers or themes. This process is called 'interactive tracing'. These methods are not only limited to geographic maps but are now frequently being used for plans and sections of archaeological features and of individual buildings. In the case of this project both techniques were used for the wider geographic landscape of Pozzuoli as well as for its individual monuments. The data digitized for the landscape included geographic and spatial references, while the data for the individual monuments included volumetric measurements that would then be used as references for the eventual three-dimensional reconstructions.

6.2.2.3 Use of Existing Digital Data

This refers to the usage of data that already exists in digital form. This can include any type of digital media, such as text, images, sound or video. Digital data may be reused to gain new meaning, and presents it to a different audience. There are many different ways this data can be used, such as analysis, editing and publishing (arts-humnities.net). For the *Puteoli* project, the digital data that already existed was procured from work previously commissioned by the Naples Superintendence, namely CAD files with survey data of the entire region of Pozzuoli, and of the underwater remains and GIS and bathymetry data of an underwater survey that took place specifically in the area of the *Portus Iulius* (Ripa Puteolana). Other types of existing digital data included scanned images of Zevi's 1993 gazetteer that were stitched together to cover the area of Pozzuoli that was surveyed at the time.

6.2.2.4 Manual input and transcription (Appendix 2)

In the humaninites.net description the above terminology is described as follows:

"Transcription is the conversion of spoken into written words, or of handwriting or a photograph of text into pure text. Additionally, the term can apply to the conversion of a written source into another medium, such as scanning it to produce a digital version".
(arts-humnities.net)

This project had made extensive use of manual input that was more closely akin to the second half of the description in that a written source was converted into another medium for clarity. The primary example of this was the transcribing of Dubois, Somella's and Zevi's gazetteers of archaeological remains from their typed published format into an excel spreadsheet. Manual input forms quite a large part of the methodology as it was used to document various stages of the reconstructions from listing the images that were used for digitising the plans and sections of the monuments. The same process was repeated for the work that was carried out in GIS and during the three-dimensional reconstructions and the analysis that was subsequently carried out.

6.2.3 Data Structuring and Enhancement

6.2.3.1 Image Enhancement

The term ‘image enhancement’, or ‘image editing’, refers to the techniques used to improve the appearance of digital, as well as analogue, images. Raster and vector files can be manipulated using specialist software. Processes such as changes to colour, contrast, sharpness and brightness can be applied to the entire image, or to a selected portion, to obtain the desired effect. An important part of image enhancement is resizing an image to fit a particular space, enable it to be printed, or reduce the size of the file. Image size can also be reduced using the cropping tool, which cuts out the desired portion of the image and discards the surrounding area. Similarly, flipping or rotating it can change the orientation of an image (arts-humnities.net).

Throughout this research, a large portion of images required enhancement. For the most part many images simply had to be cropped and re-sized in order to import them for digitising. A number of images also had to be tidied up by increasing/decreasing contrast and brightness and in some instances the file format had to be changed such as in the case of bitmaps to tiff files in order to increase the editing options. More complex image enhancements included the stitching of various images, sometimes to create panoramic views or simply because as with the artists’ impressions in Golvin’s publication, one scene was spread over two pages. Taking and cropping screenshots, was also a part of the image enhancement process, an exercise that was carried out in order to capture and illustrate the various stages of the reconstructive process.

6.2.3.2 2d Modelling – Vector

2-dimensional modelling is the representation/reconstruction of objects or structures using a vector data model and specialized software. They can be used alone or as components of 3D models. Vector models use points, lines, curves and shapes (geometrical primitives), based on mathematical equations. These formulae build the best quality image possible, given the screen resolution, which is scalable to any size and detail, although the file size remains the same. There are occasions where it is better to use vector tools than raster tools, and vice versa (arts-humnities.net). The vector models that were created for the Pozzuoli architecture were a simple combination of the plans and referenced cross-sections, which could be viewed three-dimensionally and were then used as guidelines for the three-dimensional reconstructions, particularly where height data that needed to be extrapolated. The creation of the two-dimensional models was possible for the well-documented monuments such as the amphitheatre, the *Macellum* and the Temple of Augustus. For the stadium and the warehouses, where section data was not available as part of the original documentation, comparative material was digitised instead.

6.2.3.3 Overlaying

This term refers to the techniques used to produce a geometric intersection between two sets of data to highlight features of interest. Overlaying is often used when studying or displaying maps. Specifically, the term ‘overlaying’ refers to the use of vector data. A similar method called ‘data extraction’ is performed using raster data. The process of overlaying consists of putting two maps of the same region (the input data) to produce an effect similar to a Venn diagram, as used in statistics (the output data). This can be achieved in several different ways but this project makes use of Union overlay where the inputs are combined into a single new output (arts-humnities.net).

Overlays can be used to designate particular points on a map. These points specifically relate to a set of coordinates that match those on the ground, which means that they continue to point to the exact place even when the map is resized. Points can be joined to form lines or polygons, to highlight specific areas of interest. Overlaying was carried out primarily with the various digitized maps representing the area of Pozzuoli including the combining of the land and bathymetry data into one AutoCAD file as well as the data that was digitized in order to represent the location of the archaeological features. These were then referenced on to the modern survey data (arts-humnities.net).

6.2.3.4 3d Modelling – Vector

The arts-humanities.net website gives a similar description for three-dimensional modelling as it does for the two-dimensional (see above) but it adds a series of components, two of which are relevant to the methodology used here.

The first is surface data, which is used in 3D modelling techniques to analyse and represent the surface of an object or material. In this instance the surface data that is being created is made up of contour and point data of the landscape (rather that of an object or material) that can be displayed three-dimensionally in specialist software such as ArcScene. GIS software is also able to produce three-dimensional raster data in the form of Digital Elevation Models (DEM) that are formed of grids (pixels) with elevation and/or contour data attached (arts-humnities.net).

The second relevant technique is wireframe data, which is the visual presentation of a three-dimensional object that is then projected onto a computer screen by drawing lines at the location of each edge. Working with three-dimensional models is an integral part of this project, all the more because of all the data generated, as it is precisely these models that will be analyzed.

6.2.3.5 Graphical Rendering

The term ‘rendering’, in this context, refers to the process of generating an image from a digital model, by computing its surface qualities, such as colour, shading, smoothness and texture. Rendering can achieve both photorealistic and non-photorealistic results. A large proportion of the features that are edited during the rendering process relate to the way in which the digital model should interact with light and shade. Techniques that are used to achieve this include *radiosity*, an algorithm that simulates all reflections of light from objects in a scene, *ray casting*, the calculation of intersections between a ray and a surface, *ray tracing*, an algorithm that simulates all reflections of light from objects in a scene, and shading, a technique that produces realistic images by projecting imaginary light rays to determine which parts of an object should be illuminated. Other important techniques in graphical rendering include rasterisation, texture mapping, volume rendering and particle systems. Often, more than one technique is used on the same project.

This project makes use of rendering in two stages. During the data structuring it uses what is known as pre-rendering. This is when the rendering process occurs in full prior to the animation being shown, a process that is becoming ever more time consuming and computationally intensive. During the project’s modelling of the individual buildings, the results were rendered in order to view the results. The second stage of the rendering will take place during the final analysis as it will be part of the animation processes that are being employed in order to view the outcome of the various theories that will be tested on the final stages of the model.

6.2.4 Data Presentation

6.2.4.1 Visualisation

Refers to techniques used to summarize and present data visually, in a form that enables people to understand and analyze the information. Formats can include images, maps, timelines, graphs and tables. Visualisation often uses computer graphics software, including virtual reality and 2D or 3D animation, as well as static images (arts-humnities.net). The visualisation techniques employed for data analysis are mainly two: There will be the generation of static images that will be compared to the various historical representations including the images of the glass flasks. There will also be the generation of animated images such as those created in order to understand the sequence of how the monuments came into view as described below.

6.2.4.2 Animation

In 3D computer animation (computer-generated animation / imagery, or CGI), three-dimensional digital models are created, in this case, using specialist software. As well as using key framing techniques, the movement of models is controlled by giving them a digital ‘skeleton’, or ‘wireframe’, which can be programmed to move and react in a particular way (arts-humnities.net).

6.2.4.3 Image feature measurement

Image feature measurement is a term used to describe techniques employed to acquire, measure, and analyze the parameters of digital images, such as size, shape, relative locations, textures, grey tones and colours. These parameters are also known as ‘perception attributes’ (arts.humanities.net). This project will not use measurements in the strict sense of the word, it will however work with the context of the

"Perception attributes" relative to Pozzuoli's modern landscape taking into account elements that have been captured by the images such as weather conditions, time of day and skylines.

6.2.4.4 Interactive games engines and the use of the 3dsMax interface

A variety of visualization systems and external hardware devices are used to enable interactions with digital worlds. The level of 'immersion' within a world is dependent upon the devices that are used, and the interactivity that is designed into the world. There exist various systems for viewing digital (virtual) worlds but suffice to say that the current work will make sole use of Desktop interaction. What this means is the virtual world is projected onto the screen of a standard computer monitor. This approach relies on interactive features built into the world to provide a degree of immersion for users (ADS guides to good practice). While the current research does not make use of a strictly virtual world but rather of digital data-sets, it can still be safely assumed that this interaction, between the user and the digital model takes place within a desktop interaction and as a user, one still relies on the interactive features built into the 3d modelling software (in this case 3dsMax) in order to engage with the models being built.

6.2.4.5 GIS and the Use of a Digital Elevation Model

Today, the use of GIS in archaeology is widespread and it constitutes a vast area of research that underwent many dynamic changes since it started being applied in the 1990s. This project makes a very limited use of GIS and it would be therefore beyond the scope of this section to go into too much detail about the origins and the many practical and theoretical aspects of GIS. However an element of the project did make use of a Digital Elevation Model and a short description on how best utilize this tool is thus appropriate.

Digital Elevation Models, also known as Digital Terrain Models (DTM) or Digital Surface Models (DSM) record a raster representation of ground surface elevation; almost invariably the raster cell is square. Unlike contours, DEMs deliver an elevation measurement for every cell in the raster image, so there are no intermediate points for which interpolation is necessary. DEMs are used for a wide variety of purposes, such as studying visibility and inter-visibility, exposure, hydrology, ease of access and, using high resolution data, minor surface variations that may highlight the presence of buried features (Gillings and Wise:2011). The DEM in this case was used to create the terrain features of the Bay of Naples and was considered a vital element in the understanding of such a complex landscape.

The nature of DEM data is such that it is necessary to employ a GIS or Remote Sensing package in order to use these data. Although similar to image data, DEM data contain values from the lowest elevation, which may be below sea level and thus negative, to the highest and, as a result, are not suited to processing with general purpose image processing packages such as Photoshop. Most GIS packages, including Open Source products, include at least some basic tools for computing hill-shade and visibility, direction and angle of slope and to be able to associate specified locations with the elevation at those points. These basic tools combined enable a wide range of study opportunities. One very relevant point highlighted by the authors of the Guides to Good practice in GIS is that in archaeological terms, such tools are there to *support* an interpretive analysis: they are not deterministic in themselves (Gillings and Wise: 2011)

Whilst the ADS guide gives a very thorough description about how to obtain spatial data from providers such as the Ordnance Survey of Great Britain as well as from other parts of the world. The DEM generated in this product was created using a detailed contour map supplied by the Naples Superintendence and its use was by far simpler. The data extracted through the creation of the DEM was then used to create a terrain model for the bay of Naples, which would act as the basis upon which the singular models could be placed. Such a basic understanding of the landscape even via the computer screen was of primary importance not simply for its intrinsic value but also because it affected a series of subsequent decisions taken throughout the reconstruction process.

6.3 Standards and Best Practice (ADS Guides) Data Generated by the Project (Appendix 3)

6.3.1 Raster Images

Now that the more technical methods used for data capture of have been described, it is possible to link these with the data the project generated. As seen in the previous section of this chapter, the first process that was undertaken was 2d scanning. When using document scanners, it was important to choose an appropriate resolution and bit-depth for the dataset being created. A good place to start therefore, is describing the project's largest dataset: raster images.

Raster Images are perhaps one of the most common and easily generated datasets in archaeological archives that can be created from a wide variety of processes as outlined above. In this case the data ranges from original data capture such as digital photographs, scans and drawings through to outputs or 'products' such as plotted geophysical survey data and images from GIS layouts. Even though raster images are the product or component of the above-mentioned processes, these images consist of the same basic elements i.e. an image composed of a matrix of pixels with a fixed size/resolution. As technology is forever changing, one of the concerns with digital raster images is the number of formats in which images can be created and stored that are now available to us. Raster image formats may vary considerably in terms of the file's individual features and capabilities. Some file formats are software specific whist others are based on open standards. An important element of these file types is the wide range of individual features each format possesses - such as compression (lossless or lossy)[38], colour depth, support for transparency and embedded metadata[39], amongst other things. It is therefore important that an appropriate file format is chosen for the image being created both at the data creation stage and when thinking about the strategy for long-term storage. Moreover, in certain project workflows, images often change formats at different points throughout the project depending on how they're used. In these instances it is also important to be aware of what range of functionality each format supports and the potential loss of information during format migration.

Despite the variety of formats and use, a number of features remain constant that should be considered when creating and using raster image files, even though is very difficult to specify a precise setting for these elements. One can however consider these settings in the context of the wider project and the level deemed fit for the project's purpose,

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[38] Lossy compression is when in order to compress a file some of the information is discarded.
Lossless compression reduces the file size but lets you recreate the original file information exactly.
[39] See relevant section for a detailed description of Metadata

as we shall see. The two that will be considered here with relevance to this methodology are resolution and compression.

Image “resolution” is the level of detail within an image that is expressed as a pixel count (e.g. pixels per inch (*ppi*) but also dots or samples per inch (*ddi/spi*). In short, the higher the resolution, the more detail is captured in an image. Image resolution is an important consideration for all raster images and an appropriate resolution should be chosen for the task at hand. An increase in resolution increases the file size so it is important to balance the level of details required from an image with the use of files created (Montague 2009). The second element that will be described briefly here in relation to this project is compression. In relation to images, compression falls into either lossless type formats (GIF and PNG) or lossy formats (JPG) in which data is discarded. Formats, such as TIFF and PNG, also allow data to be stored without any compression. When a file is being compressed and data is being generated, one should be aware of what compression is being used (e.g. within a camera when capturing a JPG image) and the level at which this occurs (Brown 2009).

With the above considerations and examples in mind, it is worth evaluating what the intended uses of the raster images for this project are. To begin with we have data extraction. That is using a raster image in order to create a vector image (which will be discussed in the following section). Then there are the images that will be used in order to make simple visual evaluations (that is, comparing two photographs or a photograph and a screenshot). Finally, the vast majority of these images will be viewed in print form. Therefore, this project selected a resolution size 300 dpi or above for document scans. It was felt that this size was an acceptable compromise that would work well both on a computer screen and when delivering the print versions (none of which would be too large as they were destined to be in-text). Even when images were extracted from public domains (websites), such as the views of modern Pozzuoli from the sea, the files selected were those with a resolution of at least 300 dpi, anything less was not used.

One has to also bear in mind that with many scanned files a later conversion is often undertaken - e.g. conversion to PDF files - which often sees the data down-sampled (i.e. the resolution is reduced). In such cases it is important that the original files are both of a suitable resolution to allow such down sampling and that where believed to be significant, the original files are maintained as the definitive versions.

This project makes use of both JPG (lossy) and TIFF (lossless) raster image files. Each file type was used according to the image's use at various stages of the project. A lot of the primary data, such as that obtained through the 2d scanning of archival data was first saved as a TIFF file but when used as base maps for the digitization process and the creation of vector images, a JPG copy was created. The TIFF file however remained the definitive version, especially when these images were needed in order to extract details. This was a decision made for precisely the reasons outlined above, one of which was a reduction in file size that allowed for enough information to be extracted whilst making the file manageable within the software. Even so this didn't always work as well as was expected. At times the project's workflow was interrupted by the fact that some of the JPG files used during the digitization process did not contain enough information to extract data accurately and it meant that the TIFF version had to be used instead. The downside to this was that the file became more and more unwieldy as more information was being added.

6.3.2 Vector Images (AutoCAD and GIS)

Unlike raster images, vector graphics represent objects as geometric entities rather than as an arranged grid of pixels. These vector objects include lines, circles, rectangles and curves, all connected by points and paths and are created by co-ordinates and mathematical formulae that make them scalable without having to worry about the loss of quality. Vector graphics can contain two- or three-dimensional geometry and many files often contain both vector and raster data. Perhaps the most useful features of using a vector format is that you can transform each vector object independently within the image, making it an extremely versatile format. One can make an unlimited number of changes and transformations at any time while the image is in a vector format (it only becomes locked for editing once you have converted it into a raster format).

Vector images can be created in a number of contexts, from technical drawings and creative illustrations to animated and interactive web graphics, they are often the more popular choice in the area of modern design. In computer-aided design for example, the vector format is perhaps the only available choice. In archaeology, the most common examples are 2D images/illustrations, usually produced for publication purposes, often derived from CAD (e.g. archaeological feature or building illustration) or GIS (site plans or distributions) datasets. The same can be said for the vector data generated by this project, whereby as a result of the Heads up digitizing and Interactive tracing processes, numerous vector images were created primarily in CAD and GIS files, which will be discussed in more detail below.

6.3.3 CAD (Computer Aided Design)

The use of CAD has become widespread within the discipline of archaeology and is no longer the domain of architecture and surveying.

Apart from archaeological building and site recording, CAD is being used to undertake archaeological surveys, interpretative modelling, visualization and reconstructions, an example of which is the use of CAD for the purposes of this project.

Hand in hand with the use of vector images mentioned above, there are several reasons to consider using CAD for a project: First of all, the use of layers in a CAD model makes it possible to record and organize complex datasets in a way that allows the information to be presented visually in multiple ways. The use of layering and the possibility of isolating specific features of a landscape or site by period or type enable the data to be presented in isolation from a mass of an otherwise visually complex dataset. Secondly, CAD models can be manipulated in order to view a structure, object or site from different angles and perspectives. Three-dimensional CAD models allow the viewer to explore the model from viewpoints, which may not normally be experienced *in situ*. This manipulation has to be exercised with caution particularly during an interpretative process. Also, the dimensions of objects and coordinates of data points can be extracted from a CAD model with the same precision that was used in the original measurement, whereas in a scaled drawing a recalculation of the original measurements would need to take place. Measurements stored in digital form may also be projected into alternative coordinate systems or site grids with ease. Of great importance is the fact that CAD models allow us to attach data to them and this combination (CAD and textual data) is by far more powerful than either one of these elements individually. One last important aspect that will come into play even within this project itself if that CAD files are easily migrated and by used by other program types such as GIS and 3d modelling software packages and, as is the case with the data from Pozzuoli, provide the core data for other applications.

At this point it is best to pause and take a look at the principles of best practice and conventions for working with CAD files and data. As yet, there remains no standard open format for exchanging CAD data between different software packages and the best advice on the subject comes from Lyman and Besser (1998) who suggest that CAD users should “save in the most common file formats” (Lyman and Besser 1998). At present the most commonly used CAD software is AutoCAD, made by AutoDesk and as a result it is recommended that CAD files best be saved in both .dwg and .dxf formats.

The most widely used CAD file format is .dwg, which is the proprietary format issued by AutoCAD. It is in this format that all the CAD files related to the *Puteoli* project will be found in. Due to AutoCAD's market dominance, the use of the .dwg format is now so widespread that other software manufacturers have chosen to implement Autodesk software in order to permit their users to read and/or write .dwg files. The drawing exchange format (.dxf) is another proprietary standard that belongs to Autodesk©. This format allows users to exchange and transfer AutoCAD data into other drawing programs. The .dxf format is also widely used but a standards body does not control it and Autodesk can still alter the format at will. As with most proprietary software, there will always be the issue of incompatibility. This is mainly due to the fact that some software packages do not support particular versions of the .dxf format. These files may still appear to have imported the data but they often do so incompletely. This is something the user has to be vigilant about.

Given the problems of incompatibilities not only between different file formats, but also between the same file format from the same manufacturer, ADS has recommended that CAD files should be saved in the latest possible version of .dwg and .dxf formats, and that this is fully documented. A relevant preservation issue is that CAD files will always require active curation involving the regular migration to new versions of dwf/dwg as they come into use. After every migration each file will need to be checked to ensure that there was no loss of information during the migration process.

If raster images have been embedded into CAD files, such as those used in this project, then ADS recommends that these files are stored separately from the CAD file and are documented and archived following the recommendations found in the Raster Images guide. These guidelines have been followed throughout this research project.

6.3.3.1 CAD conventions: Layers

In the introduction to CAD, the incredible flexibility of this format was highlighted thanks to the use of layers. However as with all things, the more highly developed the software package, the greater is its flexibility, the greater the flexibility of the software, the more complicated to use it becomes. Many have experienced the horror of opening the CAD file of a contour map expecting to extract useful data, only to find that every feature is one layer and it is all in one colour. It is small wonder that as digital techniques have developed throughout archaeology, fortunately so have the guidelines.

The ADS suggests that when one is constructing a CAD model, various parts of the model should be recorded on different layers. In theory, these should be designed to distinguish material in the model according to important criteria, for example, building part, building phase, depending on the user's needs. Each layer should really only hold a portion of the model as putting too much on a single layer may result in problems particularly if the model is going to be used for analysis. Objects can be moved from layer to layer, but the more objects one has on a layer, the harder to handle they become.

Using multiple layers requires not only a system for assigning parts of the model to different layers but also a naming convention for the layers created. All models can theoretically be segmented in any number of ways depending on the use of the CAD model but the chosen scheme should make it possible to find material according to multiple criteria and in this way the layering scheme allows users to access the layers in the same way they might access parts of a database.

An example of a CAD file from this project will help highlight the extent to which the above-mentioned practices have been adhered. Taking as an example the file entitled RioneTerra_1.dwg, which is the digitization of the *Rione Terra* promontory. It is by far not the most detailed CAD file this project possesses, mainly because the data captured here is of a secondary nature. However, the layering conventions as put forward by the ADS were still adhered to, albeit in relation to the needs of the research. This CAD file has many layers and because this information in based on raster images the first layers that were created were those that held the imported raster images (in this case, plans). Each raster was assigned its own layer and all were assigned a shade of blue, this colour choice for raster image layers was adhered to throughout the entire project. Next, each feature considered relevant was included in a new layer, for example, buildings of a residential nature were put on one layer, buildings interpreted as bathing complexes were placed on another, the perimeter of the town within which these buildings were found was placed on another and so on. Roads were placed on separate layers as was text as and any additional information such as legends and symbols.

In a more detailed part of the same CAD drawing however, each building was placed on a single layer. This again was a reflection of the change in needs with regards to parts of the data in the same file. In this case, therefore, because each building was assigned a number on the original raster plan, it was then replicated by being placed on a separate layer with that same original number.

6.3.3.2 CAD Conventions: Layer names

The ADS also stresses the importance of adopting a systematic approach to naming layers in CAD models. CAD systems enable searches based on layer names and some systems even allow the user to search using 'wild-cards' that enable the retrieval of sets of layers with structured names. In complex CAD models or models that include cross-referenced files, it is important to search and find layers without causing confusion because of inappropriate layer names. Most users often begin with layer names that are simple enough but as the model grows, these names inevitably grow longer, more complicated and harder to remember. As a result they cannot be easily selected resulting in the user having to remember all of the layer names when trying to select specific portions of a model and even then, one is never quite sure that all the relevant layers were correctly located.

Some organizations have defined their own layer-naming conventions designed to meet specific and practical needs. For example architects might define conventions to be used by different professionals working on a development. The same has been done for this project. The layer names have been designed to meet this projects needs but they have been standardized across the whole project. Fortunately the CAD files generated by this research are manageable when compared to files generated by an excavation.

6.3.3.3 Conventions for selecting drawing colours

It may seem that colours should be used like layers, in order to highlight aspects of a model. A specific colour might be assigned to a given structure, or a given stratum in an archaeological site. While this can be done, ADS however suggest that it is best not to assign different colours to objects on the same layer of a drawing. Objects should be placed on appropriate layers first and then a colour should be assigned to each layer. All the elements on that layer will then be the same colour. The visual result may be the same, but the process is different because it is with the layers, not the colours, that the analytical distinctions are made.

There are two reasons to avoid the use of colours, rather than layers, to hold meaning, First of all it is easier to change colours than to change layers and inadvertent colour changes could result in a significant loss of meaning. Secondly, the print process generally uses the colours or line weights in the model to determine what will be printed on paper. This means that the colours in the model may need to be changed every time a paper drawing is produced. This could result in increased confusion when needing to make even the smallest of changes. Since, the danger of losing important distinctions is so great if colours are changed, and any distinctions between sections of the model should be made using layers.

The above ADS recommendation was strictly adhered to throughout the current project and there are no two colours within the same layer (See CAD screenshots). It is also why many of the project's CAD files, despite not being particularly complicated in content, have numerous layers. This was done precisely for the reasons outlined above, especially the selection of data and the importance of the analytical distinctions.

6.3.3.4 A note on precision versus accuracy of the CAD drawings

At the project design stage it is important to consider the appropriate level(s) of precision to be used. The ADS describes the *precision* of a measurement as "…*how exactly that measurement was made and not the correctness of the measurement*". For example, a measurement made to the nearest millimetre is more precise than a measurement made to the nearest centimetre. Given the choice, the highest precision offered by modern instruments should always be used, as data can always be degraded but cannot subsequently be improved in precision.

The *accuracy* of a measurement as described by ADS refers to "*how correctly it was taken and not how precise that measurement is*". In short, accuracy relates to the correctness of a result while precision essentially relates to the size of the smallest unit of measurement.

Different levels of precision and accuracy are appropriate for different projects, depending on the purposes of the data produced. Modern survey methods make it easy to obtain very high levels of precision and there may be the temptation to seek the precision that is possible rather than that which is appropriate. For example, survey instruments like total stations automatically take measurements with high levels of precision but these can sometimes give yield some misleading results.

For paper drawings a more practical approach is to match the appropriate precision to the drawing scale so that the most precise measurements can be expressed in a drawing at the scale to be used. Therefore measurements are taken with the scale of the final drawings in mind, to the level of precision that would be useful in those drawings. (2005: 2) suggest that the scale at which surveyors expect drawings to be produced affects the survey precision.

6.3.4 Three-dimensional modelling of data

This was a particularly interesting issue to address when sifting through the archiving guidelines. The ADS Virtual Reality guidelines are currently being revisited as a lot of the content is now out of date. In fact the 3D models produced for this project did not appear to fit in any of the categories set out by the guidelines as the only mention of the proprietary software that was used for this project (3dsMax) was buried in a subsection of the Virtual Reality guidelines under the heading of "Authoring tools" and further described as 3D authoring software. There was also not much information about how to address the output file format (.3ds/.max). Following direct contact with ADS staff it was decided that the digital models should be treated using the CAD guidelines instead. The metadata produced for the 3d models of this project will also therefore use the CAD template. This is not ideal as there are a variety of different elements within the 3d model that are not available in the CAD files, such as the use of light and textures. It is not all bad however. Similarities in the use of layers and naming conventions should go some way in preparing this data as best possible given the circumstances and since the ADS is an evolving archive, this problem may one day be of value for the reassessment of future guidelines.

6.3.4 Documents and Spreadsheets

While most people today take the creation of a document for granted, it is important to mention that there are indeed issues to bear in mind, particularly as it is indeed easy to create a document compared to other datasets and so many documents are generated over the course of even the simplest projects. There are two main concerns when archiving documents. The first is the vast number of file formats that are now available which often leads to incompatibility issues. The second is the embedding of content within text documents. The most common type of content is images but more complex content can also be stored, such as videos and spreadsheets (ADS). The ADS recommend that together with the original embedding, this external content should also stored separately.

The following project will submit one text document, in thesis form, including appendices. No images will be embedded in the main text but will be created and organized separately using image processing software, the final output of which will be in PDF (portable document format).

At their simplest level, spreadsheets contain tabular data with values organized in columns and rows. The data stored on the sheet can be used to generate more data but more importantly it is often used to convey meaning or highlight specific elements. The spreadsheets in this project had an even simpler function: To organize and view a relatively large quantity of the data in the simplest way possible. No data extraction or manipulation was carried out, with the exception of some simple ordering of the data based on the column fields. The spreadsheets submitted will be in the .xslx format with the long-term accessibility considerations as recommended by the ADS.

6.3.6 Metadata

The word "metadata" means "data about data".[40]

Metadata is the term given to the descriptive information about documents, datasets, images, and other material. When a project provides metadata it enables the user to discover, access, and use the files that have contributed towards an archive. Documenting metadata is done using standardized fields and terms designed to describe the files. Moreover, metadata provides information for non-textual materials such as datasets and images that may not be useful or even usable without this extra information. Metadata therefore refers to a standardized set of information that can be used to document different aspects of data archiving at various levels, in a structured way. Metadata may be of a general or specific nature depending on the type of project, resource, or file, but the ADS suggests that a:

> *[...] minimum should provide the "who, what, when, where and how" information relating to a file or project [...]* [41]

The information supplied should be detailed enough to enable others to evaluate whether they need the file or project. Common types of metadata include: A general descriptive information about the contents of a file or project, information that places the project or file in its broader context, administrative information tracking submission, access, and rights; and technical or file metadata identifying how the file was created, the program used, file size, and other detailed information.

The process and reasons for creating metadata are well documented in a number of existing guidelines and by numerous organizations and repositories (NISO 2004 ; Day 2005; Ballegooie and Duff 2006) but, in

[40] http://dublincore.org/documents/usageguide/#whatismetadata
[41] http://dublincore.org/documents/usageguide/#whatismetadata

short, the aim of metadata is to make digital resources easily identifiable, retrievable and usable through the storage of descriptive and contextual information.

6.3.7 Types of Metadata

For the purposes of a brief overview, the ADS groups metadata into a few categories: Project-Level Metadata, Resource-Level Metadata, File-Level Metadata and more broadly Administrative Metadata. For the most part, these types of metadata are collected at a certain level (e.g. project or individual resource) but particular elements may easily be recorded for data from the general down to the specific file level. In addition, certain metadata standards may record elements of metadata that function at a number of levels (e.g. 'Author' may aid resource discovery as well as provide administrative information). The two categories relevant to the current research project are Project-level metadata and File-level metadata. The project makes use of the ADS templates for recording Metadata and the schema adopted by the ADS is the "simple" standard of the Dublin Core. It was chosen because it can provide a detailed overview of the project as a whole, including geographical coverage, temporal dates, methodology, monument and evidence types.

6.3.7.1 Project-Level Metadata (See Appendix 3)

This is the data that is at the broadest level of an entire project regardless of the techniques used. It covers elements such as period terms or dates, site and artefact keywords, project details, site codes and geographic location. Much of this information is often included within documents in the archive (e.g. site reports). *Descriptive or Resource Discovery Metadata* is designed to give the comprehensive description and easy retrieval of datasets or documents, and is more about the project than its results. The Dublin Core standard is a good example of a metadata standard which incorporates a number of descriptive and resource discovery focused elements.

6.3.7.2 File-Level Metadata (See Appendix 3)

This (incorporating “Technical” and “Preservation”) metadata is usually very specific and applied, as the name implies, at the level of the individual file. File-level metadata incorporates information on hardware and software. In many cases, if the data is to be deposited in a digital archive, it is the archive itself that will generate much of this metadata. However, the data creator must often supply a number of elements, often during the process of data creation. This project will provide the metadata of the files that have been specifically created as a result of the research; these are the CAD and GIS files.

This project follows the ADS guidelines for Project Metadata and using the ADS templates undertook to provide as much information about this research as possible. To consult the metadata of this research see Appendix 3. Even though the first edition of the ADS *Digital Archives from Excavation and Fieldwork: Guide to Good Practice*[42] recommended that each file in a digital archive should have an associated metadata record, experience demonstrated that this level of documentation was largely unnecessary. Depending on the nature of the data, groups of files of the same format or sharing other characteristics can be documented by a single metadata record. However, given the size and nature of this study, using file level metadata is not without scope and it has consequently been included. File Level Metadata for this project will also be documented as follows: This will include metadata for the CAD files, the digital model files, the GIS file and the raster image files. To consult these see Appendix 3.

[42] http://archaeologydataservice.ac.uk/advice/g2gp

6.4 The London Charter

6.4.1 Introduction to the London Charter

In the past when using visualisations was still a novel approach, there was little regard for any coherent methodology. A noteworthy example of how issues of accuracy, authentication and scholarly input into the modelling process were urgently needed, came in the form of the Pompeii CVR project of the now defunct Simlab of Carnegie Mellon University. Despite the project's financial backing no Pompeianists were consulted and as a result, archaeologists and art historians were hardly impressed with the results, a feeling that was summarized in the comments made by Bringham in 1996:

" [...] In particular, a number of scholars observed that the design team had fashioned their temple complex out of mural vignettes excised from several different archaeological sites and contexts. Painted panels along the periphery of the reconstructed sanctuary were unsettling to many precisely because they had been filched from other Roman cities. Thus, the reconstruction took form as a pastiched continuum, a collage of recombinant parts. Not the kind of thing scholars of Antiquity are bound to love." (Bringham in Frischer *et al.* 2002: 5).

The London Charter was established in 2006 in response to the increased use of computer visualisation techniques for cultural heritage. As has already been mentioned in section 5.9.1, despite initial knee-jerk reactions towards visualization in archaeological research there were many scholars who immediately recognized the urgent need to establish a more coherent set of guidelines to help tackle not only the complexities of three-dimensional/virtual/digital reconstructions in archaeology but also the need more honest about issues such as uncertainty and reliability. It was felt that the use of these digital techniques needed to be carried out with the same intellectual and technical precision as the more established research techniques while at the same time maintaining the distinctive properties unique to digital visualization. The creation of the Charter was a means of ensuring this. (Denard 2012: 57). Works such as those by Nick Ryan who discusses the documentation and validation of "virtual" projects via the use of carefully constructed metadata (Ryan 2001), by Nicolucci and Hermon who tackle reliability by using numerical values (Niccolucci and Hermon 2004) and Earl who in his thesis addresses the methodologies available at the time with the intention of critiquing them in order to pave the way for a new combined and more theorized approach (Earl 2002) are all examples of scholars who realised there was this need. Organisations and research groups such as the ADHS[43], VASIG[44] and CVRO[45] have long stressed the importance of setting and maintaining standards and that the outcome of these standards was that the visualization should accurately convey to the user the state of the knowledge it represents, including elements such as distinctions between evidence and hypothesis and different levels of probability (The London Charter Various 2009: 2). These examples are just a few of the precursors that led to the many joint collaborations and that eventually culminated in the February 2006 Symposium entitled "Making 3d Visual research outcomes transparent".

The aim of the London Charter was to collect and build a consensus on these related issues so that they could be widely recognized and adhered to within the relevant disciplines. The charter's main principles with regards to visualization are related to intellectual integrity, documentation, reliability, sustainability and access (The London Charter 2009: 2). It has thus far enjoyed a lot of success by acting as a catalyst for establishing international consensus across various disciplines and it is now widely recognized as the benchmark to which

[43] Arts and Humanities Data Service
[44] Virtual Archaeology Special Interest Group
[45] Cultural Virtual Reality Organisation

heritage visualization processes should be held accountable (Denard 2012: 58).

This section is dedicated to describing the salient points of the London Charter in relation to the methodology being employed throughout this project and to understand to what degree it helped with the model creation. More importantly, it aims to highlight how using this methodology helps others extract information as well as understand the decisions that were taken during the model building.

6.4.2 The Principles of the London Charter

The charter is based on six principles, the first of which is *Principle 1: Implementation*. This principle states:

> *"The principles of the London Charter are valid wherever computer-based visualisation is applied to the research or dissemination of cultural heritage."*

A corollary of this principle that is applicable to the current project is that which states that every practicing community, be it academic, commercial or educational should develop London Charter implementation guidelines that can be merge with its own aims, objectives and methods (The London Charter 2009: 5).

The second principle falls under the heading entitled *Principle 2: Aims and Methods* and states:

> *"A computer-based visualisation method should normally be used only when it is the most appropriate available method for that purpose."*

This is perhaps the one principle that almost all projects undertaken needed to adhere to whether they were aware of the existence of the London Charter or not. Such was the criticism of computing visual techniques in the past that many have become acutely aware of the need to justify the use of computing as a method for understanding an archaeological question. The visual impact and appeal of this method means that “it looks great” is no longer a justification for choosing this method. However neither is it a reason for the complete dismissal of a visualisation. If we are able to discern where archaeology ends and art begins and if we are open about both the nature of our visualization and its documentation process then the final result would have a strong visual impact that is able to inform as well as excite. This is true not only of visual techniques in archaeology but goes right down to the level of producing a graph with such a small amount of data that a table would have been more appropriate (Jessop 2008: 290).

How does this principle apply to this project? The port of Pozzuoli was once a rich, bustling city, today however only a few scattered monuments attest to its affluent past. It did not suffer the same fate at the hands of the Vesuvius as the neighbouring cities of Pompeii and Herculaneum and as a result continued to be inhabited uninterruptedly to the present day and what were once imposing public monuments are now engulfed in the city’s dense urban fabric. The subsequent studies of Pozzuoli often focused on one monument at a time and when more exhaustive surveys were carried out, the results were summarized on a series of maps that often included both the ancient and modern buildings. One can safely state that imagining what port may have looked like during the Roman Empire is extremely difficult, even more so if one is trying to imagine what the port may have looked like from the sea.

As more research on Pozzuoli takes place it is increasingly clear that even the gazetteers and detailed surveys are still not able to recreate (even if just schematically) what the port in its entirety may have looked like and when an artists' reconstruction was undertaken, detailed as it is, fails to capture a view from the sea. From the inception of the research idea all throughout its progress it became quite apparent that a computer visualisation was the most appropriate technique to answer the various research questions that were being asked. It is with a well-founded degree of confidence that one can safely state that the Pozzuoli project sits comfortably within the second principle of the London Charter.

The charter's third principle *Principle 3: Research Sources* states that:

In order to ensure the intellectual integrity of computer-based visualization methods and outcomes, relevant research sources should be identified and evaluated in a structured and documented way.

This is an important point that is now becoming even more integral to the success of any visualization project undertaken in the humanities. The example of the CVR Pompeian fiasco is very much related to this principle. The sources used for a 3D visualization should be evaluated rigorously and the rationale for their use, interpretation and dissemination as part of the final visual outcome should be carefully considered (The London Charter 2009: 7).

There is a wealth of resources for Pozzuoli and these come in many forms. This project works with archival data, digital map coverage, photographs, academic research and artist's reconstructions (both modern and historical), physical reconstructions (*plastico models*) as well as images depicting ancient representations. Each source has been carefully considered and evaluated; some have even been discarded based on issues of relevance and revision. Consideration of these sources will be further described in the following chapter but a conscious effort has been made throughout the project to evaluate each and every source not only of its intrinsic value but also of the effect these sources had on the decision making that took place throughout the project.

The resources that were considered the most reliable throughout the project were based on how often the source was reproduced in subsequent publications dealing with the same monument such as De Ruyt's plan of the Macellum and on the ease of extraction of data from the sources. For example, Zevi's plan of the amphitheatre is a more recent publication that Golvin's but the published image was harder to scan and more blurred in some places so Golvin's was chosen instead as digitising it would be easier. For some of the models only one available source was available and in others two perhaps conflicting ones. These were then both used and the alternative interpretations represented.

The next principle *Principle 4: Documentation* of the London Charter tackles the issue of documentation. It states that:

"Sufficient information should be documented and disseminated to allow computer-based visualisation methods and outcomes to be understood and evaluated in relation to the contexts and purposes for which they are deployed."

The charter goes into a lot more detail with regards this point but its overall aims are to make sure the methodology is as transparent as possible by using explicit statements as to what one is using and why. It also ensures that the transparent use of resources and in doing so, help with the understanding and distribution of knowledge that can be derived from the project. More importantly, this principle aims to further the debate on methodological and theoretical issues that are well developed in many other fields but are quite new in the digital humanities (Jessop 2008: 291).

The detailed description of the documentation process (paradata) highlights that this project has aimed to follow as much of this principle and as closely as possible. The correct and systematic documentation of sources leads to the charter's fifth and sixth principles; that related to sustainability and access. *Principle 5: Sustainability* states that:

"Strategies should be planned and implemented to ensure the long-term sustainability of cultural heritage related computer-based visualization outcomes and documentation, in order to avoid loss of this growing part of human intellectual, social, economic and cultural heritage."

This principle draws attention to the fact that strategies should be put in place to ensure the long-term sustainability of heritage-related computer visualizations and avoid their potential loss over time (Denard 2012: 69). This however was not no so easy to implement during this project and not without its problems. While a large part of the original data collected can easily be converted for use with non-propriety software (such as jpegs, xls files, tiff dxf files and word documents) the creation of the three-dimensional digital models was carried out using very specific propriety software and versions. This will affect the long-term sustainability of the 3D model files of this project but a conversion to non-proprietary software was made to resolve this. All the .3ds files created were converted into the open format .fbx using Autodesk's online converter. Coupled with this problem is the fact that many digital repositories are still working on developing data models that will integrate 3D content (Denard 2012: 69). Even though ADS still do not have a detailed set of guidelines dealing specifically with the creation of three-dimensional models and models created using specifically 3dsMax (with the exception of models produced via laser scanning) (Michael Charno: pers.comm), it is still possible to preserve the data created in a meaningful way. The open formats created will still be deposited with the ADS archive and coupled with this a copy of the dataset will also be deposited on the servers of Archaeology Department at the University of

Southampton. The digital files and the relevant Metadata (therefore the project in its entirety) will also be preserved on the online repository “Dropbox”. This repository can then be shared with anyone wishing to access any part of the dataset when needed.

Given the resources available this is what it was possible to achieve in order to preserve the digital assets created over the course of this project. Ideally in the future it would be of huge benefit for repositories to better cater the myriad of data types available. Most recently, ADS have started an ADS easy online uploading of small to medium sized project data that can be done directly via the user. This is a significant step in the right direction (http://archaeologydataservice.ac.uk/easy/)

In the future access to these datasets can be established in a variety of ways. The creation of online, interactive real-time versions could be uploaded onto a blog-site I had created (a small one of which had already been created at the start of the project but which was then abandoned due to time-constraints). A description and links to the ADS archived project could then also be posted on online archaeology forums such as those of the Council for British Archaeology and the Institute of Field archaeologists, to name but a couple. Once the datasets is properly archived and organised it would then be possible to ensure that links to it appear in relevant web searches thus making the data readily available to those who wish to further query and study it.

The sixth and final principle of the London Charter labelled *Access* states that:

“The creation and dissemination of computer-based visualisation should be planned in such a way as to ensure that maximum possible benefits are achieved for the study, understanding, interpretation, preservation and management of cultural heritage.”

This is a principle the project strongly believes in, as there would be no point in undertaking a study that cannot be shared. A lot of the documentation of the resources, the files produced, the description of the rationale behind the various processes and the detailed description of the decision-making that took place throughout the project are all a part of the idea that the data produced can not only be understood but can also be accessed and expanded upon when needed. The latter would be considered a great success for the methodology.

6.5 The principle of Paradata: The youngest of the data triplets[46]

At this point, we are well aware of how active the debate on the transparency of visualization-based research is, especially with the considerable emphasis in the principles of the revised London charter.

Paradata is described by the London charter in the following way:

Information about human processes of understanding and interpretation of data objects. Examples of paradata include descriptions stored within a structured dataset of how evidence was used to interpret an artefact, or a comment on methodological premises within a research publication. It is closely related, but somewhat different in emphasis, to "contextual metadata", which tend to communicate interpretations of an artefact or collection, rather than the process through which one or more artefacts were processed or interpreted.[47]

How is this different from the Metadata that was described earlier? In short, metadata is text that describes the raw data or the contents of datasets while paradata describes the decisions and the interpretations

[46] http://researchaccess.com/2011/11/meet-the-data-triplets-data-metadata-and-paradata/
[47] http://www.londoncharter.org/glossary.html

that took place during the various stages of project rather than simply the process one went through[48]. Metadata also tend to describe the more static and measurable properties of data objects, many of which are fixed (such as height, weight, location etc) while paradata describes the more ephemeral processes (Baker 2012: 170). This is still a relatively new area of the documentation process when compared to others such as the ADS guidelines and by contrast, the properties of the decisions taken during the visualization process are fluid, often non-linear and therefore quite difficult to define using a conventional metadata schema (Baker 2012: 170). It does however have a large role to play in ensuring that scholarly visualization work is taken seriously by scholars and other more established disciplines (Beacham 2011: 10).

The prefix *para* is used to describe a parallel stream of data that is created every time data is transformed. Paradata aims to capture the decisions, the selection process and the reasoning behind the interaction of different data artefacts particularly when these are removed and/or discarded from the original dataset. This data then becomes an extension of the original dataset that should sit alongside the project's metadata (Baker 2012: 173).

In heritage visualization therefore the metadata needs to be kept objective while the subjective process of combining and transforming data can be captured in the paradata documentation. This includes the selection and evaluation of the data, of ideas, cultural and technical knowledge, inference, possibilities and probabilities. The recording of this data then makes it possible to track the reasoning and construction of the hypothesis in its visual form and the output of this process becomes more than simply a "pretty picture". The creation and documentation of paradata helps the scholar (both the creator and the

[48] See also Rachel Hann’s work on the use of paradata in http://www.utopiantheatres.co.uk/guide.html. Work based on her doctoral dissertation: HANN, R. (2010) 'Computer-based 3D Visualization for Theatre Research' PhD Thesis, University of Leeds

end viewer) to document the complex journey of the visualization process, with all its uncertainties and complexities transparent and intact (Baker 2012: 173).

This may mean sacrificing visually stunning results for more humble visual outputs, as is the case of this project. The following chapter is entitled “The biography of a Monument” and it is this project’s attempt at documenting paradata, which yields some interesting results not only on the initial research question but also on the concept of paradata itself.

7 The Biography of a Monument

7.1 Introduction

One of the more fascinating aspects of any research process is looking at the evolution of the project from a methodological and conceptual point of view. Every research question starts out simple enough but once the journey of discovery in underway the corners and turns that it takes may not always be the ones originally conceived, particularly during the collection and elaboration of the data. It must be remembered at this point that the knowledge one needs in order to fully understand the ancient phenomena being explored is indeed limited and as it shall be seen even the most thorough data collection is riddled with gaps and unanswered questions. This does not mean nothing existed and we know that for Pozzuoli at least, something was indeed there. Faced with these "gaps" in the collective knowledge and the lack of direct connections and meaning, scholars often find themselves making a somewhat creative leap in the dark but as Beacham rightly points out *"… always as securely as possible and with the safety nets in place (qualifications, an indication where fact ends and hypothesis begins, etc)."* (Beacham 2012: 11). It may well be that at the end of this journey some new insights will emerge.

This chapter serves two purposes; first of all, it is a reflective description of this so called "journey" and secondly, it is an exercise in the use of paradata that will help highlight the strengths as well as the potential pitfalls of such a documentation process. The following text will proceed to describe the individual monuments that were included in the reconstruction process. This will be in the form of a ranking system that will look at the degree of certainty associated with each building based on the history of research (see section 1.2 on pages 5-8 and chapter 4 section 4.4), previous visualizations and on my own familiarity and the degree of certainty based on the available data. The ranking will provide a framework for the assessment of my own state of knowledge within the confines of the London Charter and will be summarized in a table as part of the appendices (see Appendix 2).

7.2 Biography of the individual monuments

7.2.1 The Amphitheatre

The overall dimensions: Length: 149m, Width: 116m, Height: Unknown
Arena dimensions: Length74.8m, Width 42m
Area of cavea: 11.107m^2
Estimated perimetre: 832.5m
Percentage devoted to seating: 82%
Estimated seating capacity: 35700
(All dimensions based on Bomgardner 2000)

There is little doubt that the remains of the Flavian amphitheatre in Pozzuoli should be the first on this list. Not only is the monument still visible and largely preserved both above and below ground, it has also long been studied. Moreover, even before it was studied formally, we know from the previous chapters that it was very much observed and that it featured in many historical paintings (See Chapter 3).

7.2.1.1 The data sourced

As already mentioned, the first person to record the remains systematically was Charles Dubois in 1907, who provides three plans of the levels of the amphitheatre as well as an isometric reconstruction of the seating tiers (Figure 36). Amadeo Maiuri, undertook an even more thorough study of the amphitheatre (Figure 37) in 1955, producing a work that was rich in photos and drawings, including the more detailed elements of the building such as elements of the amphitheatre's external portico (See Figure 38). The plan of the amphitheatre drawn by the Naples superintendence is widely published and the clearest examples where it was found were in Sommella (1978), Golvin (1988) and Fausto Zevi's (1993) publications amongst others (See figures 39 and 15, 16).

For the initial process of digitization, this project chose to scan the plans and section that were those found in Golvin's 1988 publication as they were deemed to be the clearest examples to digitise compared to those found in Zevi's publications. For the elements that formed the portico, Maiuri's drawings were scanned and later digitized, as there was no other publication that represented these elements in such detail; these included architectural elements such as column bases and block carvings (Figure 40). In fact what we see in Maiuri's drawings are hypothesised reconstructions based on the remains of three pilasters. Fortunately, the diagram differentiates quite clearly between the existing remains and Maiuri's hypothesis (Maiuri 1955: 73, publication figure. 28). Similarly, Golvin's reconstructions of the profile for the *cavea* (1988: 182) are also hypothetical but the structures found beneath are well known and these can therefore be used with relative ease.

As the monument in Pozzuoli was dated to the Flavian period, it was possible hypothesise that the architectural style would be very similar to the Flavian amphitheatre in Rome. This enabled the gathering of even more elements that could be used for the reconstruction. Thanks to a detailed isometric interpretive reconstruction found in Katherine Welch's publication (Welch 2007: 137) as well as those published by Ward Perkins and reproduced in Bombgardner (Bomgardner 2000: 7 and 14) (See publication figs 3.4 and 3.5) one could get an idea of what the what the *vomitaria* and the stairs that led to the respective *Cavea* may have looked like.

7.2.1.2 How the model was built

The stages of the 3d modelling began as follows. To begin with the plans and section of the amphitheatre were digitized into AutoCAD (Amphitheatre screenshots 1and 2). The portico as hypothesised by Maiuri and the architectural elements he recorded were also digitized. The plan section and portico CAD drawings were then incorporated into one file so that the section and portico stood at the correct intersection of the plan (Amphitheatre screenshot 3).

This file was now ready to be imported into 3DStudioMax. As this reconstruction also served to familiarize myself with the software, the 3d model of the amphitheatre was built in its entirety. This included the inner elements of the building that were not really needed for the overall final visual assessment. To begin with the modelling started by creating the outermost vaulting system of the theatre (Amphitheatre screenshot 4). In order to simplify the process as much as possible, only a quarter of the entire building was initially created. Once all the elements were successfully in place, these could be reproduced within the software for the other three-quarters of the ellipse.

The portico was built “block by block” so to speak using Maiuri’s drawing and extracting the depths and width from the digitized plans (Amphitheatre screenshot 5). These were then reproduced in order to make two rows of porticoes that sat in front of the modelled arches. The whole arrangement gave the reconstruction a sense of depth. No further work was carried out on the interior of the amphitheatre, as ultimately it was the exterior that was going to be used.

The uppermost tier of the building’s exterior (the balcony) was modelled following the assumption that this building was constructed in a similar vein to the Flavian amphitheatre so a simplified version of the portico was created by using the section of the balcony that had been hypothesized and drawn by Maiuri (See figure 38 and corresponding screenshot 5). As the drawing was done to scale it was possible the extrapolate smaller details such as the windows on the balcony that were hypothesized using the section drawings by Golvin and Maiuri (Figure 16 and 37) and cross-referenced with other drawings of the Flavian amphitheatre in Rome (Claridge, A. *et al.* 1998: 279, 281) (See publication figs. 133 and 135 reproduced here, fig. 41). Finally, the conjectural elements of the awning system were added in the same way and the reason that in the more advanced stages of the model, these elements are coloured red is because there is still an open debate. In fact, this colouring system is not consistent within the other models and neither within the model itself. The red was used initially for the sole purpose of highlighting the hypothetical layer to be turned on and off. The colour then came to represent how uncertain these elements were whereas in other models where there is more certainty about a hypothetical element, white is then later used. We don't know whether these "poles" were in fact used, as it seems physically impossible that these would have held the weight of the *velum* that covered the seating (see Bomgardner 2000). In the final rendered model they have been included but have been placed on a layer that can be turned on or off depending on the viewers preferred interpretation.

7.2.1.3 A note about colour

The colours and light applied to the reconstruction have been deliberately simplified because this is a particularly complex area of digital reconstructions that a whole separate area of research would have been required in order to justify applying any impartial textures on the reconstructions. While these would have helped the overall visualization in some respects, it would have, to me at least, produced some very awkward results, especially as there are large gaps in the overall town plan, so producing a visually accurate amphitheatre set on a questionable background would have been counter-intuitive. Worthy information can still be extrapolated using simple neutral textures (Amphitheatre screenshot 6) coupled with the available architectural information that we have become familiar with. The model is left open and accessible even for future architectural and texture enhancements.

7.2.1.4 Unresolved issues

Considering the wealth of research that amphitheatre all over the empire enjoyed, there was little information that could not be extrapolated with ease aside from the colour and texture and the awning system described above. One element of uncertainty that was difficult to resolve were the balcony columns. Despite using the section drawing by Maiuri there was no real way of calculating the width of the columns not even from the isometric reconstructions in Bomgardner and Golvin. As a result the columns appear disproportionately thin (Amphitheatre screenshot 7) when compared to the rest of the architectural elements and given that there is no record of the upper tier of Pozzuoli's Flavian amphitheatre any changing of the width would so far, be purely conjectural.

7.2.2 The *Capitolium* on the Rione Terra

The overall dimensions:
Length: 26m
Width: 15m
Height: 20m (approx.)

7.2.2.1 The data sourced

Fortunately for this project this monument was recorded in extensive detail in a survey carried out by the SANC (Figures 42 to 46). This survey did not only include the plan and section of the building but also architectural details and decorations such as the column fluting and the marble fragments that were re-used during the expansion of the church

(See Gialanella 2000: 22). The data used for the reconstruction of the temple were the plan (Figure 42), the section (Figure 43), the cross-section of the columns and lintels (Figure 44) and the drawings of the column elements (Figure 45). The drawings of the marble fragments that very likely belonged to the roof decorations were not used (Figure 46), given their fragmentary nature. If the reconstruction had been solely of the *Capitolium* then including these elements would have been imperative but because the role of the individual model was secondary within that of the landscape, then including such detail would have been of little use. For the volumetric reconstruction of the roof, drawings from Pierre Gros were used to understand the basic elements that formed the roofs of Roman temples (Figure 47) as well as for parts of the podium (Figure 48 and 49) as these could not be interpreted from the original survey plans (Gros 1996).

7.2.2.2 How the model was built

The plan, section and column details were digitized in AutoCAD (*Capitolium* screenshot 1 and 2) and these files were then imported into 3dsMax. It was possible to glean the majority of the principal architectural elements of the *capitolium*, from the survey plans. These elements included; the position of the columns and the inner chamber. The height and the top part of the podium directly in front of the entrance were also easily reproduced. Minor elements such as the stairs going down the side of the podium as well as the column details were also reproduced from the SANC survey and cross-referenced with Gros' drawings (Figures 43 and 47) data. Although the roof of the temple was represented in the section profile, there was no way of telling the exact angle of the triangular roof, so a representation by Pierre Gros was digitized and used to reference the roof based on the assumption that this was one architectural element that did not vary much within the Roman repertoire. Each element of the columns was built using the SANC survey drawings, these included the base, the fluting and the capital (Figures 43 and 44). These three elements were then grouped together and then using the appropriate command in 3dsMAX were multiplied and placed in their correct positions according to the temple plan.

7.2.2.3 Unresolved issues

Despite the detailed drawings by the SANC, there are still elements that remain somewhat uncertain. One of the first things that is apparent when viewing the monument is that a lot of the temple's decoration, particularly that of the roof's frieze has been left out. The work of Filippo Demma (2007) and Valeri (2005) may go a long way in understanding what the original decoration may have looked liked but for the purposes of this project, was considered to be too complex and there was not enough data to justify such detailed reconstruction. The part of the roof where the frieze would have been, was therefore left empty. Still related to the issue of decorations are the column capitals. The SANC survey drawings give us enough information to recreate these from scratch, however given the limited time available for execution, this project instead chose to use pre-defined capitals. These were chosen based on the close resemblance to the surveyed material.

Since parts of the *capitolium's* portico remain unclear in the SANC plans, mainly due to lack of physical evidence, this project made use of a portico interpretation by Gros (1996). This publication was chosen based on the vast number of temples the author surveyed. As this again was a conjectural addition to the model the simplest portico structure that closest matched the plan (based on the SANC survey) was chosen and no additional decorative detail was included

The inner chamber of the temple was created using in part the SANC survey plan that depicts part of an inner wall running parallel to three of the four walls of the building (Figures 42 and 43). To further help with the reconstruction a generic temple plan with clear lines marking this room was selected from Gros's survey (Figure 47). No additional architectural details were added to this element with the exception of an opening, the height of which was also extracted from Gros's survey data. As with all the other elements, the model was left open with clear layering conventions that allow for future enhancements.

7.2.2.4 Colours

The colours used were simple terracotta red for the upper-most part of the roof and simple white colour for the remaining elements. In some renders, all the elements of the building were coloured white (*Capitolium* screenshot 3 and 4).

7.2.3 The *Macellum* (Market)

The overall dimensions:
Length: 58m,
Width: 75m,
Height: 22.45 (Based on De Ruyt 1983).

7.2.3.1 The data sourced

There is little doubt about the role this particular monument played in the history of Pozzuoli. To this day the most authoritative research belongs to Claire De Ruyt whose work *Macellum: marche alimentaire des Romains* is a detailed survey of the surviving *Macella* around the world. Again this is not to say that De Ruyt is the only person who documented the *Macellum* of Pozzuoli (See Dubois 1907, Sommella 1978, Zevi 1993 and De Caro 2002) but the plan published in her work was considered the to be the most reliable as it is was further reproduced in subsequent publications dealing with the Macellum (Figure 50). In addition to De Ruyt's work is an interesting study carried by Filippo Demma (2007) who also produces a section and some simple volumetric reconstructions that were used to create the height of the market (Figures 52, 55). Another source that was used, with a little bit more caution were the watercolour paintings by Christie, a French Architect who produced some magnificent watercolours of the monument but for this project only some architectural details have been used. His interpretations of some of the more elaborate features of the market, such as the circular *tholos* and the decorations of the building are conjectural (Figure 53). Despite these conjectures, a *plastico* model exists at the archaeological museum of Baia that reproduces Christie's work to in every possible detail (Plate 32-34). An alternative reconstruction to the *tholos* can also be found in Golvin's (Golvin in Reddé 2008) illustrations (Figure 54) but these two were used as alternative hypothesis rather than for the basic reconstruction.

7.2.3.2 How the model was built

The main architectural forms of the model were built using the same system as the amphitheatre. Therefore De Ruyt's plan (deemed to be the most reliable and detailed) was used for the digitizing process in AutoCAD (*Macellum* screenshot 1). The section drawing that was used was that produced by Filippo Demma. Demma's section was then aligned to the plan and it was possible to start reconstructing the various elements (*Macellum* screenshot 2). The large interior elements of the building such as the walls were built using simple extrusions on the plan and the height of the building was extracted from the section as published by Demma whose work was the most recent at the time of the model building.

Details such as the column bases, the balcony elements and the central *tholos* were built using Christie's watercolours as reference, as they are extremely detailed if slightly embellished. This choice of source, albeit debatable from a reliability point of view has got more to do with the representation of detail. Knowing full well that some elements of the drawings were interpretive as well as embellished, there was no other publication that sought to record so many architectural details. So much so that the SANC deemed the publication appropriate enough to base the construction of a *plastico* model that is now on display in the archaeological museum of Pozzuoli.

Once the individual elements were built, De Ruyt's plan was used in order to place them correctly within the structure.

7.2.3.3 Unresolved issues

Unlike the amphitheatre, there are a number of architectural elements that were unclear during reconstruction. To begin with, there is a degree of uncertainty about what the central *tholos* may have looked like. Christie depicts it without a roof and simply with a circular decoration while Golvin covers it instead. In this case both options (equally plausible) were reconstructed, placed on separate layers that could be turned on or off accordingly. The same was done for the back of the central vestibule (Figure 55). Demma and Golvin use simple shapes to reconstruct the back of this structure at least when compared to Christie's interpretation (Figure 56), so both interpretations were recreated (*Macellum* screenshot 3 and 5). There is also no real knowing what the upper floors may have looked like and while it appears that there may have been rooms with doors leading onto the upper balcony, there is little way of knowing this for certain so a simple wall with conjectural entrances was used. Lastly, and perhaps the most problematic of the uncertainties of this model were the doors and windows of the exterior. De Ruyt's plan tells us about the shop doors that looked inside the building and those that looked outside and these have been reproduced based on De Ruyt's plan. However we have no information on the windows on the ground or upper floor. Therefore, the three interpretations suggested here are purely conjectural despite Christie's suggestions, which were not used, as they too are an informed guess. All three interpretative layers can be turned on or off depending on the preferred hypothesis (*Macellum* screenshot 6 and 7).

7.2.3.4 Colours

The colours used were simple terracotta red for the roof elements and simple white for the walls. Christie's watercolours suggest that this might have been a lavishly decorated building despite its commercial nature (See figure 56 and plate 32). Alternatively an all white colour was used in some of the renderings to see the effect this had on the buildings visibility (*Macellum* screenshot 8 and 9).

7.2.4 The Porto Julio Warehouses

The overall dimensions: Unknown

7.2.4.1 The data sourced

For this particular building the only direct source available were the plans of the underwater survey carried out by the SANC (Figure 57). This plan shows a series of rooms all of similar dimensions aligned in a row and in front of which is another smaller structure that looks like the base of an exterior wall or portico. There was more than one plan available, each one depicting various parts of what must have been a rather complex series of warehouses in its day. The plan chosen for the reconstruction was the plan with the largest number of buildings represented (Figure 57).

The data sourced for the conjectural portico and balcony elements was taken from Gros' section representations of the Horrea Agrippiana Gros 1996) as they are, to my knowledge, the most detailed hypothetical section drawings currently available of a warehouse (Figures 58 and 59).

7.2.4.2 How the model was built and the issues raised:

Unlike the descriptions of the other monuments, because the whole exercise was largely conjectural and so little of the actual building is known, these two sub-headings are placed together. According to Rickman, the only evidence for the *Horrea* of *Puteoli* is found in an image by Picard but is a very questionable data source, (Rickman 1980:132). We do not know how high the Puteolean warehouses were or what the exterior looked like. The only certainty about these structures is that they were simple vaulted rooms (Gialanella pers. Comm.).

Rickman tells us that as far as ground plans are concerned the warehouses of other major ports such as Ostia seem to have imitated those of Rome and that these were predominantly constructed around a courtyard. There is however uncertainty as to the date of the original construction of these building types (Rickman 1980: 121). Perhaps, as with Ostia, because of the tremendous development of these sites under the Empire there is no reason to believe that the construction of warehouses developed differently. In fact, the plan of the Horrea at Portus, another major port, also shows a number of similarities with that of *Puteoli* (see Rickman 1980: 125 and Gros 1996: 469).

If it was in keeping with the architectural tradition in Rome, it was therefore quite likely that these large warehouses had a portico. The plan of the warehouses of *Puteoli* is very similar to the *Horrea* of Portus and this is therefore the main reason why the elevation of the Horrea Aggrippiana was chosen. It is also quite likely that the complex was square in plan set around a central courtyard (in fact this can probably be denoted by the L-shape form of the plan).

Therefore, the digitized plan of the warehouses was used and the conjectural height of the individual vaulted rooms was created using the hypothesized section of the Horrea Aggrippiana (Figures 58, 59) drawn by H. Bauer and reproduced in Gros (1996: 467). Simple vaulted rooms with entrances were created and multiplied along the plan lines (Figure 57). This was done in order to give depth to the reconstruction especially when looking beyond and behind the façade. Two levels of rooms were created (*Porto Julio* screenshot 1). These two were based on the interpretation of Bauer's section drawing. Other architectural elements such as the balcony or parts of the façade including the columns and doorways were based using dimensions of Bauer's drawing, as were the roofs (*Porto Julio* screenshot 2). In the final stages of the reconstruction another secondary source was used. This was the watercolour reconstruction by Golvin of the port of *Puteoli*. Golvin's (2008) reconstruction of the warehouses was found to be similar to the one of this project and he too includes an inner portico (Figure 80). For part of the uppermost roof elements, where no other data was available, Golvin's reconstruction was copied. This part of the roof was placed on a separate layer that can be turned on or off accordingly.

Since the L-Shape plan is likely to have represented only half of the square shaped warehouses, the reconstructed area was mirrored and coloured using a single white colour to highlight the conjectural nature of it (*Porto Julio* screenshot 3) and because so little is known about the *horrea* of *Puteoli*, the façade represented in the model is a mere hypothesis and each element of the façade can be switched on or off accordingly.

7.2.5 The Stadium

The overall dimensions:
(Dubois: Length - 370m, Width – 50m)
(De Jorio: Length - 318m, Width – 47m)
(SANC: Length – 260m, Width – 73)

7.2.5.1 The data sourced

The highly debated dimensions of Pozzuoli's stadium remain somewhat approximate, even today. The building lies west of the town and is more precisely located near and parallel to, the *Via Domitiana* (Humphrey 1986: 571). The exterior of the building that faces the *Via Domitiana* was made out of *opus laterizia* and decorated with partial columns that supported the arches of the *vomitaria,* of which today only scant traces remain. Humphrey suggests that the monument's location in relation to the town is plausible enough for a circus but the dimensions however, do not settle the issue. Dubois' plan shows the arena as being approximately 370m in length and a little over 50m wide (1907), although it is not clear in his drawing, which was the circular end and there is no trace of any central barrier. The plan by Andrea de Jorio (1817) suggests a structure that had two rounded ends and certainly one existed on the west side but the east side may well have been treated like Domitian's stadium with arena dimensions of c. 318m x 47m. The width of the structure in Pozzuoli would denote a stadium but the reported length however would better suit a circus, since Domitian's stadium was only 275m in length (Humphrey 1986: 572). The building was constructed of brick reticulate-faced concrete that was still visible during Dubois 's time (1907).

7.2.5.2 How the model was built

In order to reconstruct this particular monument, the most recent plan of the Stadium used was that found in the SANC archives. Given the many interpretations, this was considered to be the most accurate as it was reproduced both in Zevi (1999) and again in Gialanella (2009) (Figures 61 and 62). Zevis' publication for all intents and purposes can be considered to be the most accurate for a lot of the maps and plans as all the images reproduced are based on archaeological surveys carried out by the SANC. Unfortunately there was little else to go on particularly with regards to the elevation and seating arrangement of the Stadium. In fact, when the digital model was being created, there was no section drawing available, this was because at the time the survey was carried out, the vertical elements of the stadium were largely underground.

As a result, a large part of this monument is also conjectural. In order to create the seating area, the section drawing of the seating in the *circus maximus* in Rome (Figure 63) was used. It must be noted that a more accurate section does exist now (Figure 64) but remains incomplete so the hypothesized section was used instead. Both the plan and section were digitised in AutoCAD and then used as guidelines for the model building in 3dsMax. The steps were traced and extruded following a path (Stadium screenshot 1) and once all the elements were built they were copied and mirrored for the second half of the monument (Stadium screenshot 2).

7.2.5.3 Unresolved issues

As already mentioned there are many elements of the Stadium that are open to debate. First of all, despite the most recent section drawing by the SANC, we are unsure of what the completed seating may have looked like. Moreover, even with Humphrey's description of the remains and their dimensions there was still no secure way of knowing how they could be best reproduced. His descriptions are purely textual. There is also great uncertainty about the entrance of the stadium and even using Domitian's stadium as an example the measurements simply do not match and creating these would have been not only conjectural but their dimensions approximate.

While we also know through Humphrey that the Stadium had a vaulted portico, for which he gives us the measurements, he says nothing of the upper parts of the exterior. The model therefore puts forward some interpretations. The lower portico is vaulted and the upper part of the exterior is represented also with a portico as suggested by Domitian's Stadium and also represented without (Stadium screenshot 2 and 3). Other details not included due to lack of evidence were the exits on the seating and the underground structures beneath the seating. There are however some more recent studies that go some way in understanding them (See Gialanella 2008).

The site of the stadium today is inaccessible and cannot be visited. Following the excavation works undertaken in 2008, the site is once again overgrown and abandoned.

7.2.6 The Harbour Mole

The overall dimensions: Unknown

7.2.6.1 The data sourced

The remains of the ancient pillars were still visible in Dubois' day and his plan and section were digitised and used to create the digital model (Harbour mole screenshot 1and 2). The remains now lie underneath the modern breakwater and although plans of the latter are available, the length and style are considerably different to that of the ancient structure (Figure 65). For the architectural details such as the triumphal arch and column, Golvin's watercolour reconstructions were used (see Figure 60). Again, it must be noted, as in previous sections that Golvin's hypothesis are conjectural and based on the interpretation of the images found on the glass flasks. As a result, only a small part of the ancient mole is built using primary data (Figures 66 and 67).

7.2.6.2 How the model was built

The width of the mole pillars was used as recorded by Dubois. Simple arches were created and their height was also established using Dubois's section drawing (Figure 67). The number of arches created was based on Golvin's hypothesized length, as were the triumphal arch and monumental column. These were created using arbitrary heights (as there are no measurements in Golvin's reconstructions) and placed in approximate positions along the mole. A decision was made to follow Govlin's hypothetical reconstruction in this case because in an article written by him in 2008 he proceeds to explain how he was able to compare the archaeological data (based on Sommella's Gazetteer) with the various representations of the mole on the glass flasks and the Bellori drawing (See Golvin 2008: 164-173).

7.2.6.3 Issues raised

Golvin hypothesizes that the mole was slightly curved towards the front part of the mole but there is no way of knowing this for certain because the remains surveyed by Dubois are not only a fraction of the potential length of the original building it also indicates a curvature that would have been earlier on in the length of the mole. Moreover all the representations available for the mole depict it as straight. Another issue is that the heights as recorded by Dubois of the moles' arches or *pilae* are not uniform (Figure 67) and there is as yet no secure way of selecting the correct height. The model was therefore left as simple as possible with all the various features on different layers that could all be turned on or off and as with all the other digital models, can be enhanced should further data come to light.

7.2.7 The Thermal Complex (*Tempio di Nettuno*)

The overall dimensions: Unknown

This is perhaps the least known monument of the group and as a result, while it was originally thought possible to reconstruct, it was soon discovered that the material available was not enough for a digital reconstruction, not even a conjectural one. We find a plan and an image in Sommella's gazetter and the most detailed recording following his work, comes from a plan and isometric drawing by SANC (Figure 68). However, little else is known and there was certainly no attempt at a reconstruction.

The most recent description of this monument is a short article by Filippo Demma who describes the results of an emergency excavation that took place in 1998 by the SANC. The excavation allowed for a re-assessment of the building phases of the complex, the first phase of which is dated to the first half of the 1st C AD and the last phase dates to between the 4th and 5th C AD (Demma 2006: 469-482). This monument posed a particularly difficult problem because as seen in the Chapter 4, bath complexes did not follow a rigid architectural style. Although we know that the Puteolan bathing complex followed the Imperial *frigidarium, tepidarium* and *caldarium* room sequence but there is no information about the original height of the building and although we know how rooms were distributed within the overall complex, there is little information about any other architectural feature. The size of this bathing establishment is also particular. The width of the extant remains falls short of being of 'Imperial' size yet it is most certainly bigger than the baths that were considered 'local'.

Due to the complexity and in this case, lack of understanding from the researcher's part of the SANC plans, the reconstruction of this monument was thus not undertaken. This in no way implies that the available plans themselves are inaccurate or insufficient. It was my inability to interpret these drawings that hindered the reconstruction process. The difficulty in interpreting this plan is that it only represents the upper floors of the bathing complex. The rest of the building is still underground. Without a floor plan for guidance, an element in the reconstruction process I became heavily dependant on throughout the research, I personally, was unable to visualise the building process in three dimensions.

The following section will look at the more complex part of the reconstruction process: that of the so-called "Gap-Filling" which was needed in order to understand the remainder of the landscape of *Puteoli*. It is described in the same manner as the above-mentioned monuments but it is a more complex process with many more factors that need to be considered. Moreover, the data being considered in this case comes in the form of archaeological studies as well as primary sources such as maps and plans, thus compounding the complexity.

7.3 The Biography of the Model's Gap-Filling

7.3.1 The Data Sourced

The so-called "gap filling" of the project took place in two stages. Principally, the reconstruction of the surrounding landscape followed by the addition of all the known and recorded archaeological remains in the town of Pozzuoli. The accurate reconstruction of the landscape was relatively simple in that the data obtained was a digital contour map (Landscape screenshot 1 and 2) of Pozzuoli and its surroundings. Underwater contour data was also used, as were a series of cartographic maps. The latter however were mainly for reference (see Figures 69 and 70).

For the remains that pepper the town of Pozzuoli, the two main sources were consulted; the archaeological gazetteer compiled by Paolo Sommella (1978) and its update published by Fausto Zevi (1993). For the area of Rione Terra, the plan published by Crimaco, Gialanella and Zevi (eds) in 2001 was used together with those published in De Caro (2002) and more recently in Valeri (2005) (see Figures 71 and 72).

7.3.2 How the landscape and remaining archaeology were reconstructed.

7.3.2.1 The Landscape

The creation of a digital terrain model was created using a GIS in order to understand the main features of the landscape, although it soon became clear, upon closer inspection that while features were visible on the macro level of the monument, upon zooming in, that certain details in the landscape were missing (Landscape screenshot 3 and 4). These areas included the stretch of coastline by the sea and more importantly the promontory of Rione Terra. This was understandable since these areas are densely inhabited. To counter this, some older plans were consulted and as a result, a series of sections of Pozzuoli's hinterland drawn by Paolo Sommella (Figure 73) were digitised, as was a drawing of a cross-section of Rione Terra recorded by the SANC (Figure 74).

The digital contours were not only placed within a GIS but also within the 3d modelling software in order to create the "base" upon which all the archaeological elements could be placed upon. Due to the polygon count generated by the terrain in 3dsMax, the model was rescaled according the to the software's settings. It may see like a rather arbitrary decision but it was the only way the file could be manipulated. Any bigger and not only would it have become unwieldy and unstable, it would have made the process of adding the remaining archaeology, particularly slow. Furthermore, the whole file was rescaled once more, as there were large discrepancies between various elements of the file.

To do this the units of the whole file to metres were first reset, then a block that was 200m in width was created after which everything was then scaled up.

Once the landscape was in place, the missing terrain was added manually using Sommella's cross-sections as guidelines (Landscape screenshot 5) focusing primarily on the promontory of the Rione Terra the area immediately surrounding it. It has to be noted at this stage that despite the use of Sommella's cross-sections, the manual recreation of the terrain should not be considered an accurate indication of the heights above sea level or the morphology of the land. This part of the landscape needed to be elevated (even if simply arbitrarily) (Landscape screenshot 6) because we can still see Rione Terra as a promontory today and leaving it flat would have affected the overall viewing experience considerably. Once the terrain was considered "complete" it was then possible to start adding the additional archaeological elements (aside from the main monuments) to the overall landscape.

7.3.2.2 How the known archaeological elements were incorporated into the landscape.

This process can also be divided into two instances. The first step was the modelling of the known archaeological remains. The second step then proceeded to address the modelling of the remaining "gaps". The process of the first step was as follows: To begin with the Zevi gazetteer was to be digitized in AutoCAD as it is considered to be the most updated published work. Even before the digitization began however, an excel sheet was created that formalized or rather "broke down" all the data in Zevi's gazetteer into smaller units of information (See Excel sheet in Appendix 2). This proved to be an extremely useful tool during the digitization process because it was then possible search the numbers on the plan find out what their description was and put them in the appropriate layer in AutoCAD. All remains belonging to the same group, for example "Other baths", "Tabernae", etc. were placed on a separate layer with a unique colour. The same was done with all the other archaeological elements in the gazetteer (Landscape screenshot 7). At this stage anything that did not have a plan outline was not digitized, even though they are marked in the gazzetter by a dot or a star (Figure 75). Moreover, buildings whose function was unclear were put in on a separate layer entitled “Misc”.

The same process was used to digitize the plan of the remains on the Rione Terra (Landscape screenshot 8). As the published plan of the excavations of Rione Terra was in a different publication, it had to be included in the AutoCAD file containing Zevi’s gazetteer. Using the scales provided on the original datasets, all these additional maps including those of Rione Terra and Somella’s studies were all added to the file, all on a separate layer that could be turned on or off but all with the same colour as they were all external scans (see Chapter 5 for AutoCAD best practice). Once the Rione Terra plan was scaled and rotated accordingly all the features of the excavation were digitised and in this case, every single feature was placed on its own layer and its feature name and number (as described on the published plan) was given such as “Decumanus of Via Duomo”, etc.

It was not just archaeological elements that were digitized, elements such as the modern buildings on Rione Terra were included or the hypothesised ancient roads in Zevi’s gazetteer were also added on their designated layer. Other significant additions to the plan were of a more interpretive nature, most notably, Sommella’s interpretation of the various areas (Commercial, Residential, Public) of the town (Figure 76) all of which were based on his research at the time. The various areas he designates were digitized and also placed on separately coloured layers (Landscape screenshot 9) that could be manipulated and consulted during the reconstruction and analytical process. The same can be said for the ancient divisions of the town as marked in a number of publications including Zevi’s and Sommella’s.

Once it was felt that all the possible and useful information had been digitized, the AutoCAD plan was then imported into the 3ds file and the uncertainty modelling could now be attempted.

7.3.2.3 How the uncertainty was modelled

Once all the features from the AutoCAD file had been imported the, layers were tidied up and organized once more. It was made sure that there was a layer for every type of “gap” building clearly labelled and all the subsets, also clearly labelled (Landscape screenshot 10). This included the importing of the individual main monuments into the file. These were scaled accordingly and placed within the overall landscape scene (Landscape screenshot 11).

The next step involved the simple conceptual extrusion of the imported AutoCAD lines (Landscape screenshot 12 and 13) exactly as they were originally digitized and arbitrary relative heights were assigned to them depending on function. The knowledge of the said function comes from Zevi’s gazetteer (see Appendix 2) but it is very limited. The heights remained arbitrary throughout because there is little concrete knowledge of the original dimensions of these remains. Therefore every CAD line kept its original imported colour and was simply extruded. This already began to give a sense of volume to the scattered remains, abstract as they were.

The following step, which progressed in a similar vein, was to then create simple solids based on the outlines of the buildings using the same arbitrary heights as the extrusions (see above). These were then placed according to their function on the appropriate layer and assigned a new colour (i.e. one colour per layer, one layer per function) (Landscape screenshot 14 and 15) and by clicking on the line the name of the remains came up as identifier.

Lastly, as part of this simple volumetric exercise, simple blocks were created with the same arbitrary heights but this time also with an arbitrary square or rectangular shape that covered the building's original outline. These were also placed, on relevant separate layers, with their own colours (Landscape screenshot 16).

With these three types of volumetric geometry, it was possible to switch on and off the various layers as well as change the colours or the heights of the buildings when necessary. This way it was possible to experiment with different conceptual visual scenarios on both a large scale, incorporating the overall landscape and on more area-specific locations, such as that surrounding the Rione Terra.

The next part of the gap filling process is perhaps the project's most difficult, putting many aspects of this chosen methodology to the test and producing mixed results.

The secondary elements of gap filling: i.e. where there is no evidence marked not even in the gazetteers was carried out using the following data: One of the indicators of the potential archaeology of Pozzuoli is a detailed article by Giuesspe Camodeca on *Vici* and *Regiones (*the ancient town's administrative divisions) (Camodeca 1977). While it may be a bit outdated with regards some aspects, his overall hypothesis is still considered valid today (See Gialanella 1993 and Valeri 2005). Moreover, the work by Ostrow (1977, 1979) also provides some details about the Puteolean landscape, which may help in the recreation of the some of the unknown buildings, as is the work by Sommella whose plans have already been used extensively. To a lesser extent, Govin's watercolour reconstructions were also consulted, despite the scepticism that surrounds his work. It is quite clear that Golvin used similar sources for the positioning of the main buildings and for the hypothesized ones (namely the Sommella Gazetteer and the Glass flask drawings).

Moreover, it remains a visual reconstruction that with the right considerations in mind, can indeed be a useful reference.

It is best to start with the information that was gleaned from Camodeca's article describing *Puteoli*'s administrative divisions. Most of Camodeca's hypotheses are formed based on inscriptions discovered on statue bases (Camodeca 1977) and it was therefore worth looking at what information he was able to surmise and whether this could be used in the reconstruction process of any elements that were not recorded in the archaeological gazetteers.

Regio Ara Lucilliane: The source of this name was found on the base of a statue during the building of the *educanato femminile* in Via C. Rosini (see Figure 77)(Camodeca 1977: 63). The base was found *in-situ* precisely near the slope that delimits the southern natural terrace towards the sea. We also know from the wax tablets that in the town's forum there also existed an ARA AUGUSTI HORDIONIANA also erected by a wealthy family the *Hordeoni* that were very generous towards the city and who probably had various private and commercial properties around *Puteoli* (Camodeca: 1977: 63).

Regio Clivi Vitrari sive Vici Turari: The name of this *regio* was also found on the base of a statue, also *in-situ* apparently at the bottom of the hill of via Ragnisco (Figure 77). This Regio included also a clivus (covered road) were all the glassmaker shops were found as well as the clivus for the perfume shops (Camodeca 1977:65). The remains of this clivus are likely those that are still visible on the right of Via Ragnisco in the garden of Villa Avellino, this then became Via Tecta in the late empire (Camodeca 1977: 66).

Regio Decatriae: This area is known from a dedicatory inscription in a reutilised stone that formed part of the *duomo* of Pozzuoli and therefore not *in-situ* and tells us nothing about geographic location of the region.

What we do know is that the word “Decatria” appears on the Prague flask and Ostia fragment. Camodeca believes that this *regio* was situated close to the *collegium decastressium* (this building known based on the identification of two statue bases dating to 337 and 342 AD). These bases were found in their original position therefore denoting the location of the *Collegium* and consequently that of the *Regio* (Camodeca 1977: 68). Camodeca further hypothesizes that since the words “STRATA POS FORV” appear on top of the word DECATRIA on both the Prague flask and Ostia Fragment, the word “FORV” stands for the *Forum* of the city and even though the limit is not known, excavations have uncovered remains that may have been part of this public space. Consequently, Camodeca assumes that since the name of the forum and the name *decatria* appear close to one another on the flasks, that this was the relative location of the *Regio Deactriae*. On a map, this would be on the sloping seaward terrace immediately behind the promontory of Rione Terra (see Figure 77) (Camodeca 1977: 69).

Regio Hortensiana: This area is known from an inscription (*CIL*.X 521 = ILS. 6325) whose Puteolean origins seem to be confirmed by the text on the Prague Flask: [H]orte[n]siana rip[a]. Camodeca even goes as far as to say that the flask may give the approximate location of this area (Camodeca 1977: 70). The name is derived from a family who owned lucrative properties around the town that were even documented by Cicero himself (Camodeca 1977: 70). What the exact location on a modern map is, we do not know.

Regio Porta Triumphalis: This administrative region was mentioned on a dedicatory inscription dating between 337 and 343 that was found in what is now the Villa Cardito, placing it in the location of the hypothesized forum and even though the statue base was reused a couple of times, Camodeca still thinks it plausible that the name given to this particular *Regio* is reminiscent of the name given to the areas in Rome and that it is likely that this name was derived from the four sided triumphal arches (similar to those found in Rome) found in the forum of *Puteoli* that may also have been depicted on the Odemira flask (see Figure 32) (Camodeca 1977: 73).

Camodeca tackles other hypothesised administrative areas and regions of ancient *Puteoli* (see pages 73 – 98) but less and less evidence for their topographic location is described and it is therefore from the above mentioned areas that we must extract the relevant information. What can Camodeca's study tell us about other buildings around *Puteoli*? First of all, a couple of issues need to be tackled that relate to the contents of article and the available data. Camodeca himself does not know what the exact number of *Regiones* and *Vici* were in *Puteoli* and more importantly, the use of the glass flasks as a geographic indicator is somewhat hazardous. The best indicator of where some of the buildings lay is the area labelled *Regio Clivi Vitrari sive Vici Turari* (glass and perfume shops) and we can hazard a guess that there may have been a series of *Tabernae* in the area hypothesized by Camodeca (see Figure 77). The area of the forum as described by him has also become an accepted hypothesis even if the evidence is fragmentary at best. With regards to his other description about the areas, the best that can be said is that we know the approximate location of the area itself but not of the buildings that populated it. Still it is a good enough start and coupled with the data may provide some interesting results.

One of the plans at the end of Somella's gazetteer shows the town of Pozzuoli (specifically that related to the Rione Terra) with a series of shaded areas each representing the type of architecture that may have dominated these zones based on his research (Figure 78). These are "Commercial areas", "Infrastructures connected with commercial areas" "Urban residential areas" "Sub-Urban residential areas" "Area of largely public buildings" "Modern additions that have resulted in a complete loss of archaeological data". With this information it was possible to hypothesize a few simple volumetric shapes that could be placed where no data was available. Simple shapes were created to represent, *Horrea* and *Tabernae* (warehouses and shops) cisterns and simple residential buildings.

The basic shape for the baths was based on the best-documented bath structure there is. That of what is commonly known as the *Tempio di Nettuno* (See Section 7.3.7). This is particularly problematic structure as it is of considerable height and is much larger than town baths yet smaller than imperial ones. It is somewhere in between and the original height remains therefore unknown. Because the remains of the “baths” are even more fragmentary than the *Tempio di Nettuno*, for the sake of “filling”, the same simple structure has been used. It must be stressed that none of these shapes bear any resemblance to what the structures may have really looked like and they are being used purely for illustrative purposes.

For the buildings labelled “Misc” by the archaeologists because they were unsure of their function, a simple box and roof structure was used to merely highlight that there was a building there.

Using the area delimitations that were previously digitized and imported, some buildings were added to the landscape. In the area marked by Sommella as “Commercial” a series of *Horrea* for storage were included as were *Tabernae* for the exchange of goods and cistern buildings based on the assumption that fresh water supply was important and needed to be readily available. The back-to-back orientation of the generic *horrea* in this project (Landscape screenshot 15) is based on a description by Rickman (1980: 148).

For the areas marked as “Residential”, it was the areas in blue that were not covered by the green-hatched pattern areas that were chosen. This was done because the green-hatched areas represented a complete loss of data as stated by Sommella (Figure 78). In the small blue area a generic Domus shape was used, that was reproduced many times, to cover the area marked by Somella.

In the areas Sommella marked as related to commerce, some of them coincided with the Zevi Gazetter such as the *tabernae* so more cistern shapes were included and the line of the road was used to orient them facing one another. A series of *horrea* and tabernae were also included as part of the commercial building set (Landscape screenshot 15).

The areas marked as “public buildings” were already taken up by the amphitheatres the baths and there is an area also marked for the Forum. However, the part of the forum is also covered by the area marking complete loss of data even though there are some traces and many, such as Camodeca, Sommella andDubois have assigned the forum in this location but given the lack of data even Golvin’s reconstruction is a very generic hypothesis of what the structure may have looked like. There is also a section in the middle of the area where there is loss of data that appears to designate the area of the theatre (there seems no reason to believe that *Puteoli* did not possess a theatre and it is also marked on the glass flasks but no archaeological evidence remains) (Figures 31 and 32).

We can see that a lot of the data can be correlated. For example, Sommella’s placing of some of the commercial area spots corresponds with Camodeca’s area designated for the glass and perfume shops (see Figure 78). The same can be said about the forum, where Sommella, Golvin and Zevi all place in the area as described by Camodeca (Figure 79) and upon closer examination one can see that Golvin’s watercolour reconstruction is also based on Sommella’s area hypothesis as well as on the interpretations of the glass flasks (Figure 80).

This kind of educated guessing was not without its problems. To begin with, while it was possible to include some generic volumetric shapes to fill in the gaps, the orientation of the buildings, with the exception of the main ones, was not known. So all the orientations are conjectural. In some cases it was possible to deduce the orientation in detailed plans like that of the Rione Terra where the buildings would have had the entrances facing the roads.

Throughout the whole process simple shades were used for the volumetric representations. Like the individual monuments, using colour at this stage would have been of no value because there was so little information about the archaeological remains themselves and because of the rather sparse distribution. Colour would only have added an unnecessary and rather confusing element to the overall landscape, skewing an already selective interpretation of it. More importantly, where there was no data either by Sommella or by any of the gazetteers, the spaces were ultimately left blank. It was tempting to simply look at Golvin's reconstructions and copy the buildings and the generic shapes that he used but this would have been counter-productive and against the whole purpose of uncertainty modelling given that in the methodology principle stated at the beginning of this project, it was stated that the work will use both textual and visual reconstructions that would be both self critical and transparent where there were gaps in the knowledge. While this may seem to go against the idea that by leaving a gap one might produce a distorted image of what we know, it is here that the textual reconstruction is important. A 'visual' gap may represent lack of archaeological data needed for a detailed reconstruction but other data may be available (such as Camodeca's detailed study) to supplement this gap until new data becomes available.

In the future perhaps a more distinctive approach could be adopted for the modelling of the unknown. Instead of using a similar modelling technique to that used for the creation of the main monuments, one could use 2D elements such as stylised images or adapted cartographic symbols as these would help create an aesthetic distance between the viewer and the visualisations and as a consequence reflect more accurately and honestly the degree of uncertainty encountered. Alternatively, ideas could be borrowed from Hoefnagel's engravings and combine topographical views with perspective projections of the landscape and the buildings within it.

It was at this point that the line was drawn with regards to how conjectural the conjectured buildings were going to be as there was simply nothing to go on and any other building placed in these areas with no data, would have been pulled out of thin air and it was at this juncture that it became clear that it was no longer possible to justify the gap-filling process and the placing of any more buildings.

7.4 Conclusion: Some considerations about paradata

Those who were expecting a visually accurate and impressive photorealistic reconstruction of the port of Pozzuoli may be somewhat disappointed. In my mind, the original project did include photorealistic and incredibly beautiful representations, which says something about the pre-conceived ideas one has about the site, the nature of the dataset, the current available techniques and one's own capabilities. By "visually accurate" I intend colours and materials that would have been present on the monument and the landscape as well as the accurate lighting (such as that generated by procedural lighting). By "Photorealistic" I intend the final image looking very similar to that of a photo. This work may be considered accurate in many other terms such as the positions of some of the major buildings or the level of documentation but visually and photorealistic, it is not. That however doesn't mean that these images don't have a story to tell.

As both Denard (2012: 67) and Baker noted in their separate contributions while the theory of the acquisition of paradata is valuable to research, the practical implementation is not without its problems (Baker 2012: 174; Denard 2012: 67). The first issue which is mentioned by Denard (2012: 68) and which became increasingly challenging as this project's complexity grew, was the documentation of the moment-by-moment decisions that can be said to have started well before the visualization process. It is true that as a researcher working with a digital visualization, a lot of decisions were made as Denard aptly puts it "on instinct" (2012: 68) and it is clear that the latter is affected by a series of factors such as the subject's background research and technical knowledge (2012: 68). It was very difficult to remain aware of these "instinctive" decisions in order to monitor their validity (Denard 2012: 68). Of course, one always started every visualisation with a high level of awareness but realistically and honestly, it was not always possible to maintain. This problem can be attributed to the fact that the decisions taken when creating visualizations are non-linear in nature, making them quite complex to document consistently.

This led to the second challenge, duly highlighted by Denard and Baker. That of choosing realistic levels of detail about the interpretive process that was possible and appropriate to document (2012: 68, 174-175). Major data elements such as the evidence and the decisions based on it were included. The decisions about the “granularity” of the paradata highlighted by Baker were more difficult to implement (2012: 175). This was partly due to the fact that each building visualized contained different levels of datasets (see for example the difference between the Amphitheatre and the Warehouses). Moreover the decisions as to the value and sustainability of the paradata documented were difficult to make. Baker gives the example of the granularity of the columns’ components (2012: 175). In this project, for example the individual column elements were not documented in great detail. Decisions about ‘granularity’ are ultimately based on the scope of the visualization. It is one thing to discuss column elements when studying a single architectural monument or construction, it is quite another when creating a townscape that will be viewed from certain distances (see principle 4 in Denard 2012: 66).

In sum, working with paradata was not easy as is evidenced by the above chapter. Parts of the methodology and its related processes were subject to change also because of issues outside one’s control such as lack of primary data, software updates, logistics, and so on. Even the most thorough methodology designed at the outset of a project is subject to change and as a result so would the documentation of its process. An exercise worth carrying out as part of the paradata documentation process would be to list the expectations and perceived potential of the dataset at the beginning of the project and compare these to the descriptions of final outcome. These would prove particularly interesting in identifying, as this project did, what the methodological glitches encountered along the way were and how they could be solved in the future. Another elements that would have helped in the collection of paradata would have been to document all the processes using a video camera or a video blog that would record in real-time all the work the user was undertaking. This could then have been revisited and would have acted as a reminder of the steps “instinctive” or otherwise that were carried out. It would also have helped to evaluate the various stages of the reconstruction processes and see whether it was possible to make any useful changes.

The reconstruction of the port town as presented in the following chapter as part of the analysis can be considered an honest attempt at working with the data (and lack of it) using an open and self-aware approach that will still yield some interesting results and some even more interesting questions to debate.

8 Analysis

8.1 Introduction

This chapter is designed to draw together all the strands that have been unraveled throughout the research. Using all the information that has been gathered in every chapter from the general understanding of the landscape to the minutiae and implications of the reconstruction process. It is here that an analysis of the images and animations created can now be carried out. The following chapter is divided into three sections. The first section looks at the hypothesized positions of the viewer by Ostrow and Golvin as related to the images on the glass flasks. Camera positions were reproduced to match the descriptions and the views were then compared with images of the views depicted on the glass flasks, the Bellori drawing and the visual interpretation as represented in Govin's pictorial reconstructions.

The second part of this chapter will then compare a second series of camera views that were created to replicate the likely positions of the modern photographers whose images were commented in on in chapter 2. This will not only include a comparison of the original photograph and the reconstruction but will also look at elements such as different lighting conditions, times of day and camera distances. The final section of the chapter is composed of the concluding remarks that are based on a re-examination of the analysis undertaken together with elements that were described in the previous chapters.

8.2 Analysis

The analysis of the Pozzuoli reconstruction takes place in several stages based on a series of aspects related to the monuments' visibility from static points on the water.

8.2.1 Analysis 1

THE GLASS FLASKS AND THE *BELLORI* DRAWING: CREATING THE OBSERVER

In his thesis on the topography of Pozzuoli as depicted by the glass flasks, Ostrow makes a series of interesting observations, particularly one that describes where the observer might have been situated in order to be able to see the various buildings that are represented on the flasks. Examples of these descriptions include the following text:

> *[…] a fairly consistent view of the observer can be established […] lies somewhere offshore in the midst of the city's harbour, perhaps north of the western extremity of the great harbour mole […]*
>
> *[…] the mole designated as* PILAS *or* PILAE *on the three intact vases thus lies to the right of the observers' visual field […]as the southernmost feature that he sees, while his viewing field is closed at the north western end, with views either of the stadium or of the cities two amphitheatres […]*
> (Ostrow 1977: 75)

To match these descriptions, a camera was created within the 3d model of the landscape to match each of the above descriptions. A rendered view was then created that could be analyzed. Placed on a separate and appropriately named layer these cameras were labelled as follows:

"OSTROW_1" (Figure 81) is a view that incorporates the mole and the amphitheatres. The camera labelled "Ostrow_2" includes a view of the Stadium (Figure 82).

Ostrow also describes the observer in another instance, this time related to the forum of Pozzuoli, which no longer exists but its location is known through various textual sources and from the depictions on the flasks which he believes correspond to the position of the remains (Ostrow 1977:182). The camera related to the following description is labelled "Ostrow_3" (Figure 83).

> *[...] To the eyes of the spectator situated mid harbour between the breakwater and the* Cantiere Armstrong *the proposed forum lying on the plateau of the upper town and somewhat south of the flavian amphitheatre - just to the left of the long harbour mole and towards the right-hand limit of his visual scan of the city's other major monuments [...]* (Ostrow 1977: 181-2)

If for the time being we discount the surrounding landscape and the scale issues and if we focus on just the positions of the various buildings as depicted on the glass flasks a number of relevant observations can be made. The reconstructed camera can confirm the prominence of the mole to the right of the observer regardless of the fact that, as has been highlighted before, the position of the mole and the other monuments does not correspond to where they have been depicted on the flask (Figures 81 and 83).

Also as Ostrow pointed out, the observer is likely to have included elements that may not have all been visible unless he was situated at a particular distance from the coastline but this cannot be known for certain. An example of this issue is in the rendered view of the camera "Ostrow Camera_2" (Figure 82) which incorporates the stadium. With this position of the camera the stadium and the part of the amphitheatre can be seem at either end of the view but the mole in this instance has been excluded. However it can also be confirmed that the columns that appear to adorn the ancient mole are quite a striking feature as can be seen in both the reconstructed view and on the glass flask engraving.

The representation of the divinity that sparked much debate (see chapter 4) brings about an interesting notion. Perhaps this figure and the building related to it may have been of a symbolic and cultural importance rather than a purely visual one. The statue itself would have had to be colossal if it was going to compete for visibility with similar elements such as the mole, the mole's decorations or even just the amphitheatres. We know from chapter 4 that the statue discovered was of no such size (Dubois 1907: 149, Ostrow 1977:107).

Ostrow's description of the location of the forum as dictated by his hypothesized observer in this case can also be confirmed by the conceptual view created. It seems that the hypothesis of this is related more to where the forum was located on the Bellori drawing rather than on the glass flasks and like in the Bellori drawing, the location of the forum may have been visible just behind the Rione Terra and the mole. Of particular interest to the conceptual view and the Bellori drawing is the view of the *Horrea*. Even with the limitations of the conceptual reconstruction there is no reason not to believe that there would have been many of these buildings in and around the town of Pozzuoli and that they were immediately visible. The camera labelled Ostrow_3 and the Bellori drawing set side by side suggests that this may well have been possible (Figure 84). The fact that remains is that the artist of the Bellori image took considerable liberties with regards to which buildings to represent. The most striking example of this is the lack of any of the more "popular" buildings such as the amphitheatres or the stadium.

In his article describing his own visual reconstructions, Golvin (2008) hypothesizes the angles of the observer as well as the possible position of the Temple of Serapis (Figure 85). His diagram shows us the plan of the centre of *Puteoli* with the axes and the angles of the observer of the glass flasks. For the analytical purposes of this project, three cameras were created replicating Golvin's suggested views. The camera labelled "Golvin_1" is a camera looking directly at port (using a 20mm lens). The camera "Golvin_2" is a camera looking towards mole (with 35mm lens) and lastly, "Golvin_3" is a camera looking towards stadium (35mm lens). The Lens mm has been noted here because it is conjectural as it is unlikely that we will know the viewers' exact field of vision given that glass flasks representations are schematic and positions by Golvin, Ostrow and Sommella are also hypothesized.

If we look at Golvin's first line (Figure 85) and compare it to the rendered reconstruction (Figure 86) we see that this camera looks towards the part of *Puteoli* that expands westwards towards the stadium and the *Portus Iulius* even though this area is not represented in his diagram. The second line and its respective camera is perhaps that view that most closely resembles Ostrow's hypothesized viewer (Figure 81 vs Figure 87). The reconstructed view incorporates part of the mole and the amphitheatres but not the stadium and the third view as hypothesized by Golvin is perhaps the most unrelated to the glass flasks as it looks at the entirety of the mole and parts of the Rione Terra (Figure 88) but none of the other main monuments represented on the glass flasks are included. These comparisons of the hypothesized viewers are particularly interesting because they highlight certain issues that perhaps only surface during the digital modelling of an area. The first as has already been mentioned is the viewer's range of vision. Assuming that the scale of the digital model is correct (there are known issues as has already been pointed out) it seems difficult that a person would have been able to encompass the whole bay and still be able to identify all the architectural elements within it in just one view. Golvin has also suggested a location for the temple of Serapis (Figure 85) but unless is was the size of the amphitheatre or the stadium it is unlikely to have been as prominent as it appears to be on the glass flasks. Unfortunately, the views of the reconstruction cannot be compared with the position of Golvin's hypothesized viewer as his reconstructions adopt more aerial views looking out towards the sea rather than from sea level looking inland.

So to sum up, considerable caution has to be exercised when describing the position of the viewer in relation to what was depicted on the glass flasks. Not so much because of the monuments represented. Indeed the mole and the amphitheatres can be identified on a simple conceptual model at considerable distance so yes, it is likely that were truly impressive whether viewed from the sea or from a land based position. However these representations may also have been based on the 'rule' of Roman art for this period. This being that the depicted size of the monument didn't reflect the actual size of the building but rather its importance at the time. The prominence of the Amphitheatre and the Mole on the glass flasks and their distorted scale could perhaps be interpreted as being visually, architecturally and socially important to Pozzuoli according to the priorities set out at the time.

It is however the issue of scale that raises questions. Even by using a wider lens, it was particularly tricky to include all the major elements depicted on the Prague flask, where we find the stadium and the mole that are realistically very far apart in the bay of Pozzuoli. In this respect, Ostrow's hypothesized viewer positions are more reliable than Golvin's.

8.2.2 Analysis 2

The second part of the analytical process looks at the comparison between the modern panoramic photos selected in Chapter 2 and a conceptual view based on the hypothesized position of the modern viewers, which were again replicated by cameras in the 3dsMax file. Although a camera for each modern photo was created not all views yielded the desired results. As the model is conceptual, the analysis will therefore consider the images that were best matched. It will look at some key features in the skyline of both the real and conceptual landscapes and see whether any information can be gleaned. Just like the process of paradata, where the description moved from the most known monument to the least, so too do these comparisons start with the best comparison to the worst.

The first comparison that can be made is that in Figure 89. The camera was placed on the right hand extremity of the mole and while the real picture was taken at a slightly closer distance we can see that some features do indeed draw the eye. First and foremost we have the landscape that frames the buildings in both images and despite the density of the modern town they still appear just as dwarfed by the surrounding landscape as the sparse volumetric models. Next we can see the Rione Terra promontory on the right hand side of both images while in the centre the focus is on the harbour mole (both ancient and modern) that completes the framing of the port town.

The next comparison looks at the port of Pozzuoli from a distance with the mole at the furthermost left of both images (Figure 90). In this case the buildings in the modern photo occupy a larger percentage of the view than the landscape and it can be assumed that if the volumetric model had been populated with the same density as the modern buildings then a similar view might be expected of the reconstructed model.

The third analytical comparison looks at a head on view of the centre of the port (Figure 91). As described before, it is the buildings that feature most prominently however the landscape backdrop is never too far away. One can imagine that the coastline in ancient *Puteoli* would be lined with the more functional buildings such as the warehouses and shops (some of which have already been placed on the digital model).

The following comparison looks at the promontory of the Rione Terra with the viewer looking NW (Figure 92). Once again in the modern photo we see the dominant architecture and in the volumetric model we see just parts of what could have been dominant architectural elements such as the Capitolium and the buildings surrounding it. We must also imagine that here there would also have been the buildings related to the forum that would have also created a denser digital view.

The last of this set of comparisons looks at a view that appears to have been taken directly in front of the mole (Figure 93). An assessment of the visible features in this case is problematic due to the differences in viewing distance and density of architecture. In the modern photo it is possible to see that there is an equal amount of visible architecture and landscape and an equal amount of sea and sky but the same cannot be said about the reconstructed view.

The next sets of rendered images were created independently from their modern equivalents. The following renders include a series of settings/elements that are believed to impact on the viewing experience. These are the distance of the camera (camera lens) (Figures 94, 95, 96) and the time of day. The last sets of renders were created using a camera looking outwards towards the sea.

There is no doubt that the natural lighting conditions would have greatly affected the viewer's experience of *Puteoli*'s overall landscape. Four renders were created with the natural light of 07.00am, 08.00am, 14.00pm, 19.00pm and 20.00pm[49] respectively (Figures 97 to 101). Even with a simple conceptual model and not taking into account the

[49] The software sets the time of day automatically by giving it the relevant geographical settings.

factor of artificial light, it is quite clear from the series of images that depending on the time of day, the view of the port is likely to have been different. In Golvin's visual reconstruction we have a clear bright day but what if the vessel entered the port early in the morning (Figure 98) or just after sunset (Figure 100)? The renders of the landscape at 07.00am and 08.00am show considerable shadow interplay created by both the landscape and the volumetric models. By 14.00pm the buildings, despite their simple shadings, are quite clearly defined (Figure 99). The last two renders of the set depict the same view with 19.00pm and 20.00pm and it is interesting to see how the buildings are still quite clearly seen in this render but an hour later the render is quite dark and the most striking feature becomes the landscape, set as a dark backdrop in the middle of the image (Figure 101).

These renders are not without their issues. Artificial lighting also greatly impacts the overall view of a skyline often highlighting aspects that may not be visible during the day. The photo of Pozzuoli taken at night is such an example. A road can be seen leading up from the water's edge to towards the town that was not very visible during the day (Photo of camparison1/Plate 1). These renders must therefore be viewed with caution and with the understanding that there is likely to have been light around the town that although different to modern lighting in terms of its strength, would have affected the way the port looked from the sea. One could imagine the town rendered at 20.00pm dotted with subtler flame lights.

The last group of renders was created in the attempt to give a sense of a more land-based view. The first camera for this view was placed next to the amphitheatre thus giving a sense of whether any of the landscape could be seen from above the buildings. This cannot be confirmed with any certainty because of the height of the camera, which appears to be slightly elevated if compared to the amphitheatre. It is unlikely that in a densely populated town one would have been able to see the landscape from above the rooftops. A slightly more plausible camera position is that placed behind the columns of the *Capitolium* of the Rione Terra. Even though there are only a handful of buildings in front of the *Capitolium,* when in fact there are likely to have been more. It may be possible that one could see out to sea (Figure 102). If on the other hand a portico surrounded the *Capitolium* as interpreted by Golvin, then this may have not been possible.

9 Conclusion

This project started out with a simple enough question. Were *Puteoli*'s main monuments visually dominating when viewed from the sea? The answer may not be quite what was originally expected but before attempting an answer, it is best to review the various strands that have been explored and that have brought us this far.

It is best to trace our steps back to Chapters 2, 3 and 4 where we are reminded of the overall Campanian landscape and its impact that still resonates today. It was described and documented by the ancients and all those who followed them, not only for its geological phenomena but also because of its fertile lands and striking beauty. A simple comparison between the digital elevation model and the textual reconstruction of the landscape may appear somewhat redundant, given the simplicity of the digital model but if coupled with the textual reconstruction of the landscape as described at the end of chapter two (see section 2.4.7), it is possible to start understanding just how pivotal the whole area was to the towns that developed in and around it.

The same can be said about the archaeology of the town. The textual reconstruction of chapter 4 suggests that the port town of *Puteoli* was a bustling, densely built port with a combination of commercial and public buildings that sat very comfortably side by side because in the case of *Puteoli*, as with other port towns, it was its commercial activities that defined its immense wealth and status. The conceptual model that was created as a result of this research admittedly does not really do the port town's reputation much justice but this was due to the data available and the methodology chosen rather than the absence of evidence. Coupled with the simple volumetric reconstructions we must add colour, different building heights, streets and minor port facilities such as winches and loading bays. It was not possible to represent these elements in this instance but it is hoped that in the future this simple volumetric model may be augmented to include all these elements. What the digital model did give us was a sense of how the buildings sat within the overall landscape.

Much of the considerations that were described in the theoretical chapter of this research served to understand Roman monumental architecture as a singular element. That is, as a monument, why it was built and the purpose it served those who frequented it. The second part of the theoretical considerations that dealt with computer visualisation served to keep the methodology as transparent as possible with the knowledge of the various limitations of the both the data and of the individual manipulating it. These considerations were brought together during the modelling of the landscape and the individual buildings, a lot of which was affected by scale.

To begin with there was the scale of the whole Campanian area, which is still today, nothing short of, immense. This realisation came to the fore quite quickly after having viewed a video of a sailing boat moving around the bay of Naples (see attached video file). In fact, the digital interaction between the individual and the data being processed greatly reduced the sense of such an enormous scale. This was slightly improved when 'zooming into' the Bay of Pozzuoli itself even though at this stage there were gaps in the data particularly in the areas that have been developed. It was the reconstruction of the individual monuments and their respective available datasets that perhaps provided the best idea of scale. It was from here that one could begin to understand the size of the buildings and in some cases their complexity (see amphitheatre).

This issue of scale in fact was to prove more complex than anticipated at the start of the project. There was not simply the physical scale that needed to be understood but also the scale of the data available, ranging from the contour map of the Campanian region to the individual columns capitals and marble fragments of the *Capitolium* recorded by the SANC and how to fit these within the methodological process. The scale of the tools available also played a role in this complexity. Software such as GIS packages were used but only to produce the simplest of results and other types of available technologies were not used such as procedural modelling, which, in hindsight could have yielded some interesting results.

Unfortunately as a result of all this, it was not possible to handle the sheer scale of the Campanian landscape or of the entire town of Pozzuoli as is evidenced by the problems with the "gap filling" process. It was only the scale of the individual monuments that could be addressed at this stage. Depending on the available data it was relatively simple to switch back and forth between the macro-level reconstructions (such as creating a simple shape based on the plan of the building such as the Baths) to the micro-level modelling (creating the portico of the amphitheatre block by block based on Maiuri's elevations).

The second consideration that came about during the reconstruction process was the selection of the available data. At the beginning of the project the idea was to create a realistic reconstruction of the town using all the available data from ancient paintings to historical documentation to modern interpretations. It soon became clear that not all the data available could be used. An example of this was the historical paintings. Upon careful consideration and a more in-depth understanding of how they produced and reproduced, it was evident that apart from a select few, many of these paintings were reproduced by artists who had never been to visit the Phlegraean fields, throw in the instances when the paintings were used to train students, add a pinch of artistic license and the painting, beautiful as it may be, became an unreliable source. And what about modern interpretations such as

Govin's watercolour reconstructions? Golvin too uses computers to reconstruct ancient architecture but feels that it is precisely computer models that are cold and give no sense of authenticity (Reddè and Golvin 2008). I would agree to this sentiment in as far as trying to understand the whole port. His use of nuanced colours and textures does indeed help the eye digest certain key aspects of the town such as the location of the key monuments. The lack of authenticity that was experienced during the consultation of these images was the viewing angle that these images were set to (see Figure 80). A bird's eye view is something we now take for granted in order to understand large areas (Haraway 1991: 189; Pollard and Gillings 1998: 145). While we know the sources that were used for some of the main reconstructions in his visualization, a lot about all those buildings in-between has not been described. This most certainly does not imply that these buildings were drawn on a whim, on the contrary, there is most certainly a thorough study behind his visualizations (Golvin 2008). It is just unfortunate that they were not included alongside the visualization, or broken up into stages, as it would have resulted in an incredible resource.

At this point it is perhaps best to return to the original question set out at the beginning of this section. Were *Puteoli*'s main monuments visually dominating when viewed from the sea? To this question we can add a series of other questions such as: What has been learnt about architecture and town as a consequence? How has the landscape informed the understanding of the port? Did the use of less visually impressive models affect the data interpretation and how? Were there any unexpected results? Having undertaken the process, was a visual reconstruction still the right approach and why?

If we presume that the Romans deliberately organized monumental architecture and their town plans, then in the case of *Puteoli* they must have had a thorough knowledge of the overall landscape and that the locations of certain monuments such as the amphitheatres were chosen based on the natural settings of the surrounding area rather than on the need to assert Imperial influence in the area. That would have been taken as a given in any event, the port's status being what it was. This hypothesis has been hazarded because of what is perhaps an unexpected result. It is likely that where it was originally thought that the monuments were going to be particularly visible, upon reconstruction of the landscape and inclusion of the main monuments within it, it become evident that this may not be quite the case even if the buildings were viewed from the sea. As the surrounding landscape is so imposing so it may mean that in comparison, even these public buildings including the amphitheatres and the *Macellum* were ultimately only visible at certain close quarters and at very specific angles (the Stadium and the *Macellum* especially). If the mole was indeed the hypothesised length and size we assume it to be, then it is likely to have been the most prominent monumental feature, with the two amphitheatres coming in second. The *Capitolium* of Rione Terra may well have been visible on the promontory but again this would only have been so once the ship entered the harbour itself. It may well be possible that the most prominent feature of the port of *Puteoli* was the surrounding landscape itself. Simplifying the colours to match the volumetric modelling did little to reduce its hilltops looming over the volumetric blocks and it was further confirmed by the comparison with the modern photographs and the video.

This project has experienced many challenges. Each that needed to be addressed, particularly with regards the non-linear visualization process coupled with the uncertainty of the data and the tools employed to counter this. Some aspects of *Puteoli*'s townscape were impossible to understand purely because of lack of data. The visualizations produced may not be complex but the process of visualization was still considered to be the most effective tool and it brought to light some interesting aspects of the town such as the town's development in relation to the landscape, which is likely to have been more complex than was imagined.

The visualisations were therefore necessarily selective because as it was soon to become clear, to meaningfully model a whole town is both impossible and too extensive a task to for a single person to undertake. However the project explored a number of interesting case studies and more broadly acted as a demonstration of a methodology, which could be widely extended both for Pozzuoli and sites of similar nature.

So in some respects the answer to whether a visualisation approach was needed in order to understand the viewer's experience from the sea, then the answer to this would be no - it was not. The landscape was far too vast and the data far too fragmented to qualify this study and base it purely on this question.

If we were to ask whether this project contributed to the creation of new data and constituted original research then the answer would be yes. Over the course of the data collection it becomes evident that Pozzuoli was visually "reconstructed" in many ways using various techniques. These ranged from the representations of the glass flasks, the cartographic maps of the 17 and 1800s, Somella and Zevi's Gazetteers to Golvin's watercolours. The monuments visually reconstructed here using the available current technology (like all the previous visualisations) sit along all these studies with the added advantage that they can be accessed, queried and manipulated in the future in order to glean information. The process of digital modelling could act as a way to better understand different datasets and the relationship between them that may have not been previously evident or highlight conflict between different hypothesis. Furthermore the attention which this project gives to the history of representations of Pozzuoli, can be further developed could provide a compelling basis for the identification and interrogation of the implications of digital visualisation thus nudging the work towards a more interdisciplinary position.

The textual reconstructions this project has collected do the same thing, with the added difference is that being at the end of the scale of the many years of research, this project has gathered all the possible visual and textual data available on Pozzuoli that was currently available at the time of the project's realisation.

Despite the challenges, what this project has hoped to achieve is first of all an exercise in the use of a transparent methodological process where all the decisions, even the questionable ones have been documented. More importantly, it hopes to have raised some interesting points about the ancient port of Pozzuoli and its landscape and has brought together enough material to set the basis for future debates additions to the knowledge about what was and still is, one of the most fascinating areas of the Tyrrhenian coast.

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