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FACULTY OF HUMANITIES

Archaeology

Volume 1

The exploration of lived experience in medieval buildings through the use of digital technologies.

by

Catriona Elizabeth Cooper

Thesis for the degree of Doctor of Philosophy

December 2014

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

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THE EXPLORATION OF LIVED EXPERIENCE IN LATE MEDIEVAL BUILDINGS THROUGH THE USE OF DIGITAL TECHNOLOGIES

Catriona Elizabeth Cooper

For the last twenty years phenomenology has been an intensely discussed topic in prehistoric archaeology. The phenomenological way of thinking has taken steps to embrace an understanding of the past based on bodily experience in the world. However, this process has been rarely applied to medieval studies despite a much richer dataset. Phenomenology has initiated a number of discussions concerning how we can think about human experience in the past (the lived experience of the past).

The phenomenological approach has been criticised for a lack of methodological robustness and for being overly subjective. In the same period archaeological computing has developed alternative frameworks for sensory interaction with the material evidence of the past, and with its varied interpretations. Its underlying methodologies have been similarly critiqued, and also interconnected with phenomenological and other models for experience. Critiques of archaeological computing have been asking the same questions as those of phenomenology: namely how do we deal with uncertainty and subjectivity when interpreting the archaeological record.

In this thesis I suggest digital techniques in archaeological computing that can offer new routes to approaching human experience in the medieval past. I present two case studies that demonstrate alternative and complementary techniques to explore the notion and implementation of a digital "lived experience" of late medieval buildings.

My first case study based at Bodiam Castle uses visualisation techniques to explore the lived experience of the private apartments. I propose a mixed media approach for the presentation of visualisations. In my second case study I move away from visual experience of medieval sites. I present an assessment of a series of auralizations of Ightham Mote. The conclusions demonstrate that digital techniques that work across senses can provide a robust mechanism for exploring the concept of lived experience, and for exploring the lived experience of specific medieval buildings.

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DECLARATION OF AUTHORSHIP

I, Catriona Elizabeth Cooper

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

THE EXPLORATION OF LIVED EXPERIENCE IN LATE MEDIEVAL BUILDINGS THROUGH THE USE OF DIGITAL TECHNOLOGIES

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. [Delete as appropriate] None of this work has been published before submission [or] Parts of this work have been published as: [please list references below]:

Signed:...

Date:...

Acknowledgements

The creation of this thesis would not have possible without the help and support of so many people. Firstly I must thank both of my supervisors who have been with me from the start. Prof. Matthew Johnson for firstly envisioning the project, supporting my application for the studentship and then acting as my supervisor when he was based at Southampton and unofficial supervisor when at Northwestern. Dr. Graeme Earl for encouraging me as undergraduate and master's student, then in my application for the studentship. Also for his continual support supervising me throughout this project. They have worked tirelessly to help make this project happen and I am eternally grateful. I would also like to thank Dr. Alison Gascoigne for taking over as my second supervisor. I promise I will learn to use comma's appropriately soon.

Working in collaboration with the National Trust over such a period of change has been eye opening and my supervisors at the National Trust: Dr. David Thackrey, Caroline Thackrey and Nathalie Cohen have made a huge difference in making this possible. As have a number of onsite staff: George Bailey, Bernadette Gillow, Lynne Antwis and Lance Woodman in particular.

My collaborators at the Institute of Sound and Vibration: Dr. Fillipo Fazi and Diego Murrilo Gomez have taught me so much and made this project possible. This thesis also would not have been possible without the advice and support of a number of members of staff throughout the faculty. Prof. David Hinton, Prof. Chris Woolgar, Prof. Anne Curry, Prof. Mark Everist and Dr. Maria Hayward have been generous with their time and their advice. As has Eleanor Quince, Andrea Reiter and the Graduate School of Humanities for helping me navigate the AHRC and University administration.

The department of Archaeology at Southampton has been the best place to work over the last few years. So many people have helped in many different areas: Penny Copeland, Kris Strutt, Tim Sly, Dominic Barker and James Cole for fieldwork training, help and support during the Elite Landscapes project. David Wheatley for his advice about the dreaded statistics. Members of the Archaeological Computing Research Group for advice and help in times of need Matthew Harrison, Paul Reilly, Matt Tyler-Jones, Sara Perry, Grant Cox, Gareth Beale, James Miles, Alice Watterson and Nicole Beale. The Medievalists Eleanor Williams and Jude Jones. My cohort Sarah Coxon and Rachel Bynoe, without

your support and the help of Mr Alexander Gordon and Mr Johann Schweppe I would not have survived. And the rest of the postgraduate community at Southampton (particularly Lucie Bolton, Kristen Heasley and Lizzie Richley).

Finally this would have been possible without the never-ending help, love and support of my family, my partner Sam Griffiths and personal cheerleader Camilla Rowe.

Glossary

My thesis is multidisciplinary, as such I have found it useful to create a glossary discussing specific words associated with the study of buildings archaeology, acoustics, visualisation and medieval studies that may not be clear if one is not an expert in that field.

Visualisation terminology

Cartesian Space

A way of thinking about geometry of space. Cartesian is a modern rectangular coordinate system. In terms of space it refers to mapping of points according to numerical coordinates on a plane (x, y).

Digital Media

Digital Media in this context refers to the digital simulation of aspects of the past, not all applications of multimedia.

Euclidian space

Euclidian space is considered the mathematical properties of space in geometry and is a physical description of space according to rules of angles and lines in three dimensions (x, y, z).

Experience

I use experience in two ways in this thesis. Firstly to mean knowledge gathered from past events, either actively through learning or through subconscious existence. The second I take to mean the state of consciousness or being where one embraces the things happening to us. For example "I am going for the experience".

Lived Experience

Lived experience has its origins in Phenomenological discourse. For this thesis it is taken to mean how people understand the world around them, not based on some preconceived scheme but through experience: how they move, their activities, everyday paths and places and memory. This means that the documentary and physical evidence are not enough, because the past is subjective, memory: both personal and inherited are important.

Ocularcentrism

The privileging of the visual over the other senses (Thomas & Jorge 2008). The reality of the present is not understood through just one sense but by all in combination and the same is true in the past. Considering the past in a primarily visual way the human understanding of the past is bring lost.

Perceived Reality

The perception of reality is about how people understand and think about what is real. In the context of this thesis it refers to how people understand and relate to visualisations. In film studies Prince (1996) discussed how people react to the use of CGI in films how they evaluate it and consider how "realistic" or how close to believable it is. The same ideas can be applied in virtual realities how the use of computer graphics is perceived in archaeology is important in how we represent the past and how people engage with it. The perception of reality is different to some extent in this context, unlike in film studies, having a complete belief in the images before one is not always considered a good response. As what is displayed is an interpretation of the past it is often considered helpful for a more doubtful view of the image or at least an understanding that what is being shown is not "real" but is the perceived real of the past that has been created.

Real, Reality, Realism etc.

Realism is a complicated word with many meanings based on the context it is used in. It is one of the "Keywords" that has been unpicked and explored by Raymond Williams (1983). He suggests that although these words (in this study) are intrinsically linked move beyond each of their origins in linguistic history.

At a base level what is real is described as the opposite as to that which is imagined or something that has existed, but it is more than this. These definitions fail to confirm exactly what makes something "real" or what the "reality" of something is.

For the purposes of this thesis the real world is considered the world we exist in today. Realism is how close to appearing like the real of today a visualisation

is, so the move towards photorealism is concerned with trying to create a visualisation resembling a photo or appearing "real".

Reconstruction

The word "reconstruction" will not be used in this thesis. Although frequently the visualisation or simulation process is referred to as digital reconstruction (Chalmers 2002; Bakker et al. 2003; Sundstedt et al. 2004; Hermon & Fabian 2000; Kantner 2000; Galindo et al. 2009; Eiteljorg 2000; Dawson et al. 2007; Malpas 2008 to name just a few), in fact the past can never be reconstructed. As Clark states one "cannot 'reconstruct' the past; one can only construct models or simulations of the past" (Clark 2010). It is in the creation of our models we forget that what we are doing is interpreting the evidence or material remains that are available to us and our results are just one perceived reality (see below) of the past. As such, visualisations, simulations, models and virtual reality are used to discuss the method of creating interpretations of the past.

Spatio-temporal

Spatio-temporal means belonging to both space and time. Data in this respect means that it has elements both of space and time information. A common example is data associated with moment as an object can only occupy one position at an instance in time so to represent it or understand it one has to consider the space the object is moving in as well as the way the object is moving over time.

Subjectivity

Subjectivity is particularly difficult word to discuss especially in a medieval context. The word has changed meaning to almost the reverse from its original Latin root. Its original meaning was considered as things are in themselves. Objective has its origins in the verb to object, to present the opposing argument.

In the 17th century a change of meaning began to be observed, where objective view was considered as something true in itself whereas subjective where we (the subject) are certain of it. It is at this time the shift in meaning begins to occur. I think this change has its origins in the changing standing of the upper

classes, no longer was their word law. Subject became the active and/ or thinking agent existing in the mind of he who judges, based on impressions not facts. Object that which is other than the active mind or thinking agent, the external object. Objective began to solidify as a term for factual and fair-minded and neutral (Williams 1983).

Today it means to present a personal opinion based on one's own experiences. In this thesis subjective is taken to mean a personal point of view or opinion.

Virtual Realities

A computer simulated environment that aims to immerse the participant and simulate their presence in that space. The aim of many of these multimedia's is to replicate full sensory experiences.

Buildings Archaeology

Bay

The spaces between posts or trusses in the length of the building (as opposed to aisles dividing the width of the building).

Chamfer

An architectural decorative feature created by the removal of the connecting corner of two surfaces.

Cranked (tie beam)

A tie beam with a bend up in the centre: meeting the Crown post at its highest point.

Crown post

A post which stands on the tie beam and supports a collar plate.

Enfilade

A succession of rooms which are entered through doors which align along a single axis.

Machilations

Work in the same way as murder holes but are built into the battlements of the building and have larger gaps between the wall and their extent.

Racking

Slant and final collapse of the roof along its length.

Tie Beam

The horizontal beam forming the base of a triangular truss for a pitched roof.

Truss

A structural framework of timbers designed to provide support for the roof. They occur at regular intervals along the length of the room: the gap between them is known as a bay.

Wall Plate

Horizonal beams which run along the length of a room not across it like a beam. Wall plate refers to the upper plate running along the base of the roof. Collar plate refers to a horizontal beam in the pitch of the roof, it is usually supported by a crown post.

Wealden

A type of vernacular timber framed building found in the Weald in south east England. It typically consists of screens end, hall and solar and is usually formed of four bays. It displays the typical medieval plan I discuss in Chapter 1 where two bays form the hall itself, a bay forming the low end of the hall containing the services and a bay at the high end of the hall housing the solar.

Acoustical Terminology

Auralization

Auralization is the technique of creating audible the acoustical parameters of a specific environment (Kleiner et al. 1993). In acoustical studies auralization has more than one definition. I am choosing to define it as the process of producing audio from numerical data. It can refer to only the final step of making numerical data audible (Kleiner et al. 1993). However, as with visualisation I consider the process beginning from the outset of the project

and not just the final modelling process I consider the same auralization that it should include the research, sound propagation and survey leading up to this point).

Clarity (c):

Can be measured from impulse response using a phase analysis. It is the balance between early and late arriving energy and can be measured as either c50 or c80

Intelligibility

A measure of how easy it is to comprehend speech.

Reverberation time (t):

the duration required for the space-averaged sound energy density in an enclosure to decrease by 60dB after the source emission has stopped. This can be obtained by recording the impulse response of a room and integrating this result. It can also be obtained by recording the sound pressure after exciting a room with a noise. It is often not possible to generate the level of noise needed to record t (often referred to as t_{60}) instead a smaller decay is recorded and the sound then extrapolated, these are usually done in levels of 20dB or 30dB and are referred to as T_{20} and T_{30} respectively. See

Chart 11: page 368 for a graphical representation (the decay curve). This value is used to characterise a room's acoustics allowing it to be compared to other spaces. Shorter reverberation times are spaces with high levels of absorption whereas more reverberant spaces have longer reverberation times.

Room Impulse Response (RIR):

A method of obtaining decay curves to calculate reverberation time. The reverberation time is discussed below and can be measured in a set space. However, it can be calculated more accurately by measuring the Impulse Response. Impulse Response is required for the creation of auralizations, the RIR can be recorded in a space and then used to assess the success of the modelling software, when the recorded RIR is the same as the modelled RIR one can believe it has been successful.

Introduction

Scholarly enquiry in the last twenty years has questioned the ability to access the lived experience of those in the past. From the publication and following critique of Tilley's (1994) *Phenomenology of Landscape* the study of prehistory has focussed on exploring everyday life and experience in the past. Medievalists have traditionally held back from the lived experience/ phenomenological way of thinking; instead accessing the study of the day to day through historical sources and traditional remains (see Woolgar (2006)). However, the medieval dataset is rich in remains and resources which would be well suited to an exploration of this type, an area of research led by Gilchrist (2012).

The use of digital images and computer graphics to visualise scenes is not something new to the study of the past. Digital images in this context have been biased towards aesthetic appraisal, although analytical approaches have also been championed to a fairly limited degree. Multisensory perspectives and experiences of the past only exist to date in a limited sense (See chapter 2) and again they focus on prehistoric settings. However, the creation of these scenes can be used as a methodology for looking at the experience of life in the past.

My thesis uses the theoretical approach of phenomenology and proposes using digital techniques as a methodology for exploring the lived experience of two late medieval buildings (Bodiam Castle and Ightham Mote). I present two case studies showing how different methodologies can further our understanding of medieval life in a 14th century secular building.

The relationship with the National Trust

This thesis is the result of a successful application to the Arts and Humanities Research Council for two Collaborative Doctoral Awards (CDAs) by Prof. Matthew Johnson in collaboration with the National Trust (the Trust). The project: Lived Experience of Bodiam, Scotney and Ightham in the Later Middle Ages, was designed to approach questions on the study of Late Medieval domestic buildings. The partnership with the Trust allowed for a formal relationship to be formed. This provided access to the properties, access to the knowledge of both staff and volunteers, accommodation at the Scotney

basecamp and a forum for the dissemination of our research. Putting this relationship in place at the start has made it easier to research in collaboration with the Trust. As the title for the project suggests the original concept for this thesis was to include Scotney Castle (Figure 4), I chose not to work at this site as the data available about the site is limited (there are few historical records), and the standing remains are heavily ruined and have been greatly developed overtime.

The relationship with the National Trust meant that this thesis could have been approached in a number of ways. Their involvement has been considered in the development of the project theoretically (as discussed in Chapter 2) and explicitly in how the Trust could make use of the outputs (Chapter 4). The nature of this research is collaborative and therefore they have been informed of the developments of each case study and access to the results throughout. These will input into the interpretation of both sites and hopefully the wider interpretation of medieval sites by the Trust. However, their involvement was not as prescriptive as has been the case in other CDA theses. In this case due to internal changes at the Trust during my candidature and my own interests this thesis has taken a step back from the heritage agenda. Instead the focus has been on the academic questions of studying experience in the past not how the past is consumed at these sites.

Background

The subject of living in the middle ages has to some extent been avoided in the past. Medieval archaeologists have tended to focus on the abundant material culture and documentary evidence without addressing, at least in any considerable depth, questions on the experience of living (exceptions include Gilchrist (2012) Gies & Gies (2010) Giles (2007) and Johnson (2012b)). While historians, although appearing to approach questions on the experience of living, rarely provide answers or directions to take their studies. Lived experience has been discussed in prehistory in the recent emergence of phenomenology as a way of thinking about the past. It provides a way to think about life through the lost or decontextualized material culture from a novel, personalised perspective. Lived experience is how people understand the world around them on a multisensory level, not based on some preconceived scheme but through experience: how they move, their activities, everyday paths and

places and memory. Documentary and physical evidence are not enough, because the past is subjective, memory: both personal and inherited are important (Johnson 2012a; Hamilakis 2014).

Phenomenology emerged as a theoretical approach to address issues of subjectivity and meaning in landscape studies (Johnson 2012a; Hodder 1987; Hodder et al. 1995; Hodder & Hutson 2003; Tilley 1990). Research (Cummings 2002; Cosgrove 2006; Ingold 1993; Tilley 1994; Bender 1998; Gosden 1994) began and have explored the subjective (see glossary) understanding of landscape moving away from the Cartesian (see glossary) or "objective" way of thinking about space, which when carefully analysed is not really objective at all (Johnson 2012b; Massey 1994; Rose 1993; Cosgrove 2006a; Cosgrove 1984; Cosgrove 1993; Cosgrove 2006b; Cosgrove & Daniels 1988). Instead the "experience" of the places and how they can be explored from more than a plan or section viewpoint was suggested as a starting point for discussion. Experience in this context comes from a combination of meanings: knowledge gained from past events and an involvement of consciousness (Williams, 1983: 126).

The phenomenological approach has been critiqued at length due to the lack of empirical data often associated with its reflections. Particularly where it has been applied to prehistory: prehistoric landscapes and monuments of Wessex were among the earliest sites to be approached in this way (Ingold 2005; Tilley 2004; Bender 1998; Jones 2007; Pollard & Gillings 1998; Gosden 1994). Stephen Murray has approached buildings in a similar way he stated that [we need to be] "*reconciling our experiential responses with the task of dealing with buildings as entities that can go beyond the written document in providing vital access to the past.*" (Murray 2008: 383). Murray's ideas have rarely been applied to medieval sites or buildings. However, Murray's work also highlights the link between phenomenology and lived experience. The phenomenological approach has been described as the interrogation of lived experience (Johnson 2012a) it is however just one in several ways to approach th experience of living in the past. By taking the approaches suggested in phenomenology we can begin to move towards lived experience by taking these ideas and supporting them with the quantity and quality of data available from the medieval period. This will be discussed in more detail in Section 1.3.

There is an underlying assumption that houses from the late 14th and early 15th century straddle the gap between the austere castle keeps of the medieval period and the comforts of Tudor palaces (Curzon 1925: 10-11; Tipping 1921; Platt 1982: 118; Brown 1970: 144). In subscribing to this assumption, buildings of this period are presented as simple. They form a divide between two groups of buildings which lacks the understanding of these changes and the reasons for them (Johnson 2002: 133-4). To approach questions focused on living in these buildings I have chosen to explore the social interpretations of Bodiam (a castle) and Ightham (a moated manor house) alongside the physical buildings of Bodiam Castle (Figure 1) and Ightham Mote (Figure 2), as Johnson suggests, using digital methods to realise these aims.

Figure 1: Bodiam Castle, East Sussex viewed from the north.

Figure 2: Ightham Mote, Kent viewed from the north-west

Map 1 shows the location of both buildings in south east England. They form a focussed research area in which to explore questions about the social, regional and landscape context of late medieval residences. Their owners, Sir Edward Dallingridge (Saul 2010) and Thomas Couen (Minihan 2012), were not of the highest social status and the buildings were not in the first class of building. Bodiam Castle is well known for its composed landscape with manmade water

courses or bodies dominating the immediate surroundings. Ightham is also set in the centre of a manufactured environment, with a number of ascending ponds and stream systems. Both buildings were constructed with moats. Bodiam also holds a licence to crenellate (which in its most basic meaning was a grant that gave permission for a building to be fortified) and therefore it is considered to be a castle. Ightham Mote is a house which has been developed from a mill building into a domestic house. Both the surviving Bodiam and Ightham of today exhibit a courtyard plan; Bodiam was built to this design while Ightham's courtyard was the result of later development.

Bodiam and Ightham both date from the 14th century. Construction works across England mostly consisted of the building of houses during this period (Emery 2006a: 3). Bodiam was built by Edward Dallingridge, a knight climbing the social ladder. During the construction of this building Dallingridge was making a move from local politics to becoming a member of parliament. His rise was the result of a series of strategic marriages which are discussed in Chapter 3. Ightham Mote was the residence of Thomas Couen and, unlike Bodiam, was not a new build. Therefore it is a very different building. However, Couen and Dallingridge moved in the same circles in local politics and therefore we could question whether they had similar aspirations and would display these through their choices in home. Possibly the lack of major developments at Ightham are the result of Couen's death at an earlier stage in his life course than Dallingridge.

As well as the differences in the style of the buildings they offer different challenges in terms of the evidence available (both documentary and physical). Physically Bodiam appears the most straightforward building to discuss: it has not been greatly developed since its construction, but it is largely ruined (Figure 3) internally and documentary evidence is lacking. Ightham, although complete, has been greatly altered since its original construction. Unlike Bodiam it is now displayed to the public as a furnished residence, offering different advantages and problems to its study. The archival evidence for Ightham is much more complete and features a considerable amount of information about the household itself including the wills of its owners (Appendix F & Appendix G).

Map 1: Location map for Bodiam, Scotney and Ightham
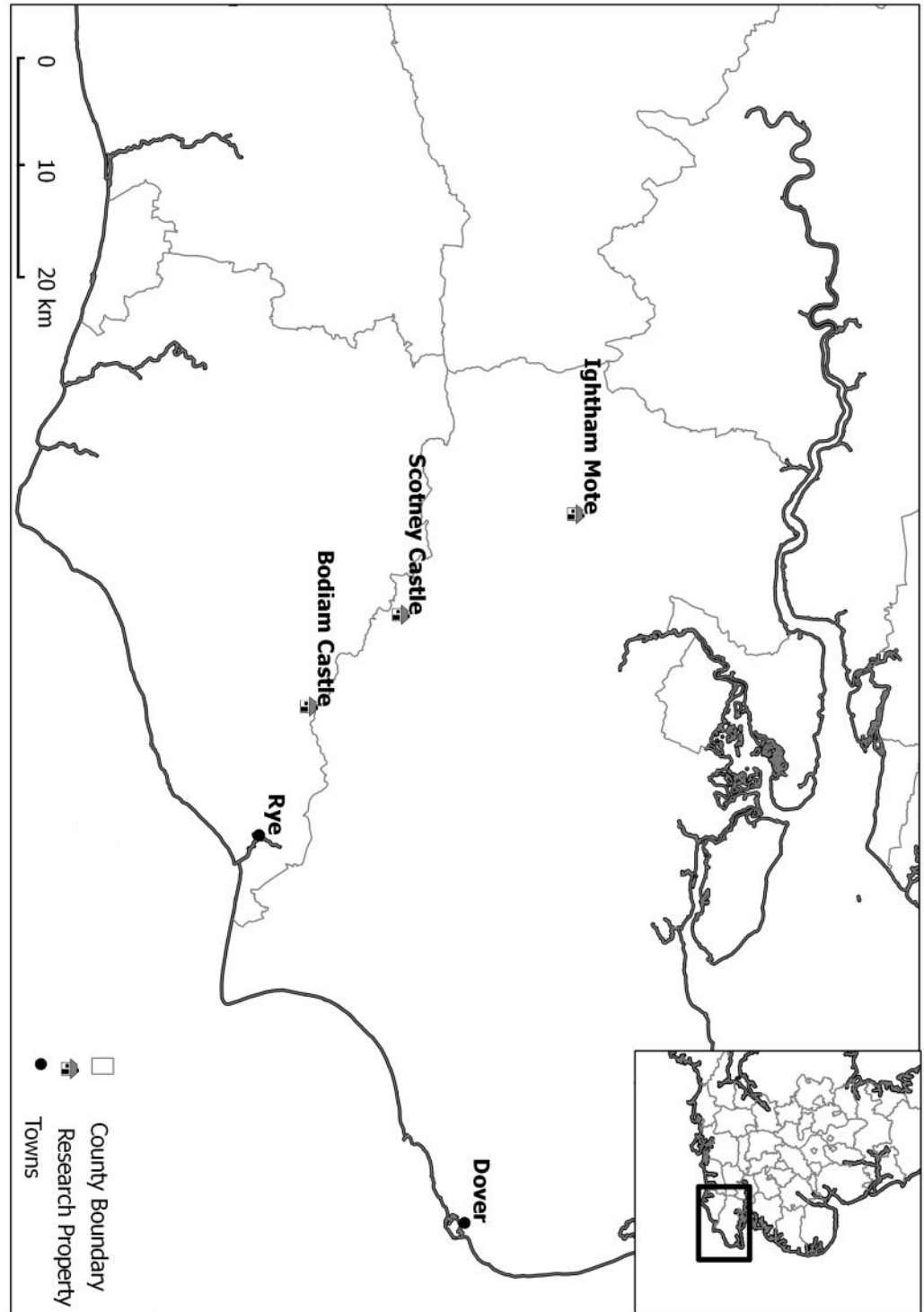
Figure 3: Internal appearance of Bodiam Castle. As you can see if is much more ruinous than the exterior (Figure 1) suggests. Viewed from the north-east

Figure 4: Scotney Castle, East Sussex viewed from the south

The experience of living as discussed in this context moves beyond just the visual experience. It examines how all the senses and perception influenced encountering, working and living in these buildings. Digital media techniques can allow ideas about the experience of the buildings to be challenged in a number of ways. The atmosphere of the building; how it was decorated and furnished, and how it 'felt' can be explored. Material culture of different varieties can be brought together, such as pottery, furniture, metalwork etc with an aim of understanding a completed space. This can be used to understand how the structure of the buildings affected how space was used and how this affected social interaction. Or a full sensory understanding can be explored beyond just a Cartesian understanding to discuss the experience of encountering or entering the building.

These questions lead into further discussion of the methodology involved in the creation of digital simulations and how the results can be represented. The nature of the past is subjective and uncertain (which is discussed in chapter 2 in more detail). The use of digital media in the study of the past can highlight this ambiguity and provide means to explore possibilities, but it can also hide the realities of the available information. The two buildings at the heart of this study have very different external and internal appearances and pose very different problems in terms of their digital simulation. By focussing on the interiors different questions can be asked in each case study allowing the exploration of the use of space at each building to be compared. The question of uncertainty can then be examined through two different methodologies.

Structure

This thesis starts by giving an overview of the study of late medieval buildings. Chapter 1 defines what a late medieval secular building is, then discusses how buildings have been approached theoretically. This details the nature of late medieval domestic buildings leading up to the 14th century in their most basic elements. It then discusses the changes which have led to the development of those elements in what we now call the late medieval domestic plan (Gardiner 2000) and the development of the decorative style. It introduces the nature of building in the study area of south east England detailing similar sites and patterns in building. The second section of this chapter discusses different

theoretical approaches on how medieval buildings have been studied following the work of archaeologists (Johnson 2002; Airs & Barnwell 2011; A. Richardson 2003; Emery 2006b), historians (Woolgar 2006) and architectural historians (Goodall 2011). The chapter concludes by suggesting that phenomenological approaches are challenging our understanding of the experience of living in the past but lack rigorous methododology (as discussed by Johnson (2012b). I suggest that digital techniques provide a possible way forward.

Chapter 2 looks at how digital media can address late medieval buildings and questions of meaning. The debate phenomenologists have been engaged with is the same debate ongoing within digital representation but with slightly different terms of reference and terminology. While phenomenologists are questioning how archaeologists can secure knowledge of lived experience, digital specialists are asking how uncertainty or certainty can be represented. These are actually the same or similar questions. The intention in this chapter is to introduce the background of simulation and how it has been applied to the study of archaeology detailing not only other work in the field but also the theoretical implications and issues relating to it. It firstly considers the background to archaeological computing, then the work undertaken in visualisation with particular reference to intended audience and the population of image. The discipline of acoustics is then introduced and a literature review of archaeoacoustics. Archaeoacoustics is a very small field and as such this reviews all work undertaken in the area, not just the digital. Finally the chapter discusses uncertainty and how this can be approached in visualisation and acoustics touching on realism, metadata and multiple interpretations of the past.

I then turn to two case studies through which I use digital technologies to ask questions of lived experience in practice.

Case study 1 (chapters 3 and 4): visualisation at Bodiam. The background to Bodiam castle is introduced and a literature review of the state of research associated with the site is presented. This moves into a discussion on the study of space at that site and how it has been approached at other sites in recent years. The chapter concludes by outlining the visualisation project and the questions it means to address before leading into chapter 4 (the digital project). Here I am producing a digital model envisioning the private suites of

apartments at Bodiam (Figure 5). The project itself is also concerned with the concept of an interpretative methodology. Creating visualisations is the method for interpretation of the site. A narrative is produced from the observation of the archaeological record through to how the "real" of the simulated past is perceived. Through the recording of the entire process of creation an understanding of how the uncertainty and assumption inherent in the simulation process is important: it can therefore be highlighted and can be critiqued. Choices made during the recording of Bodiam, research into decoration of medieval chambers, furniture and social uses of space are all included as part of the creation process. Making these decisions informs the creation of the final image; therefore they are inherent in the appearance of the final image and are an important part of the interpretation. The success of the modelling is evaluated through human responses.

One recent study (Frankland 2012) has suggested that visualisations are not considered as compelling to the public as their creators like to think. It is understood that the final image is an interpretation and viewers are interested in the creation process. Mood boards (a popular example of which is the social media platform *pinterest*) bring together multiple media to present a single concept or idea. I present the final CGI images which intend to show a particular concept or theme alongside the images that went into creating it (furniture and fittings, illustrations from medieval manuscripts and paintings from the 14th century) using mood boards. Participants were then requested to select the responses they felt most fitting, or the images they feel most represent their ideas. The study demonstrates that mood boards can be used to access the lived experience or response to the creation of the final images.

Figure 5: Internal eastern elevation of Bodiam Castle viewed from the west

Case study 2 (chapters 5 and 6) is focused on auralization at Ightham. Chapters 5 and 6 are structured in a similar manner to chapters 3 and 4, but tailored for Ightham Mote and the acoustical survey. Chapter 5 introduces Ightham Mote and the state of research at the site. Then chapter 6 discusses the application of an acoustical survey and analysis and how this has been undertaken in the Great Hall at Ightham (Figure 6) to explore how space is experienced on a level beyond the visual. In the same way as at Bodiam where a series of visualisations and mood boards are produced, here a series of auralizations are generated and then evaluated. In this case I assess the results subjectively and numerically. These allow me to discuss the use of the medieval gentry hall through the acoustical experience of them, allowing me to question the potential tasks that are undertaken in this space, the access to the hall and also how sounds were experienced throughout the household and how they would have been affected by different types of furnishings. As with the Bodiam case study I will discuss the narrative of creating the auralizations and how this informs the results.

The two case studies allow me to demonstrate two digital media applications for exploring experience in the late medieval period. I show how our understandings of these buildings can be changed through such an analysis. In

selecting both acoustical and visualisation case studies I am able to discuss not just each individual application but discuss the nature of experience of the past in comparison and in combination. Taking both together highlights the application of these techniques to archaeological questions. The two projects both create simulations of the spaces which can be compared to the buildings as they stand today. They are both analysed qualitatively which allows the two methods to be compared and discussed through the methodology and results. The visualisation project demonstrates the advantages of using digital media approaches to medieval studies, while the acoustics project highlights how the experience of the past is multisensory. The two methodologies allow me to question tasks that are undertaken in different spaces and how the spaces are experienced.

Finally a third exploratory study brings together both digital techniques: visualisation and auralization by pairing the auralizations of Ightham Mote with images of the Great Hall. This project demonstrates how experience is determined by a combination of different sense and cannot be explored entirely as a single sense on its own to understand the lived experience of space.

The conclusion brings all the work together to overall aim of this thesis is to answer the question "How can digital media be used to explore lived experience at later Medieval buildings?". The explicitly multisensory approach advanced highlights the importance of the senses beyond the visual. It also engages with how these techniques can be applied to the analysis of the use of space in late medieval buildings comparing the two techniques applied and how they can be used towards an understanding of the lived experience of late medieval buildings.

Figure 6: The Great Hall at Ightham Mote, the hall dates from the earliest construction on the site, however the wood panelling was installed in the Victorian period

Chapter 1:   Late Medieval Buildings

Medieval buildings have been a subject of interest for many disciplines. Research has focussed on the built environment's place in history, buildings' architectural style, artistic appeal and how they fill the archaeological record. As a result the literature is vast and difficult to master.

In the broadest sense this chapter asks "what is a late medieval secular building" and "how have we explored lived experience in late medieval buildings". A traditional literature review of late medieval secular buildings opens the chapter before an overview of different theoretical approaches which have been implemented for their study.

I begin by discussing what a late medieval secular building is. Individual elements (Great Hall, Solar etc.) which make up a typical medieval manor house are examined. Architectural developments are then introduced in terms of stylistic patterns of the 14th century. I finally discuss how buildings in south-east England differ from the rest of England. Here I examine not just localised architectural types but political and economic factors that affected the nature of these buildings. I discuss the people who chose to build in this region, their careers and social status.

Following this traditional literature review I then discuss the theoretical approaches taken by different disciplines, finally concluding with how we can approach lived experience in the context of this thesis.

I focus on rural dwellings, which form a very different category to town houses. The construction of buildings in towns is dictated by the space available. Therefore buildings do not always conform to the medieval ideal but towards the best layout that can be created (Pearson 1994: 4). They cannot inform the discussion of lived experience of rural buildings as patterns of commonality do not exist in the same way. However, they can be used in for comparison when considering contents of rooms. Equally I do not touch on ecclesiastical sites in great depth since again the use of the space is not always comparable. The nature of living and the life course of those living at ecclesiastical sites are different. Gendered relationships are different. The reasons for the space are in essence different. Although the construction of cathedrals is designed as a

house (for God) the use of space and engagement is changed. Also the study of ecclesiastical buildings has been at the centre of many studies concerning the use of space (A. Richardson 2003; Gilchrist 1988; Coldstream 2002) whereas secular structures have largely been put to one side. I return to the subject of ecclesiastical buildings in the conclusion.

1.1 What is a medieval building?

There is an assumption in the study of buildings that they must be considered differently to other artefacts (Hillier & Hanson 1989; Parker Pearson & Richards 1994; Steane 2001). Buildings both define the nature of the space they create, which is socially constructed, but at the same time is created (like any artefact), according to some previously conceived plan by the builder according to socially conceived ideas about the use of space. Therefore it is argued that there is a connection between the social and space which can be seen through the study of buildings. Buildings both mediate the space they create as well as being designed according to social concepts about how domestic, ecclesiastical or working space should be ordered: see Figure 7.
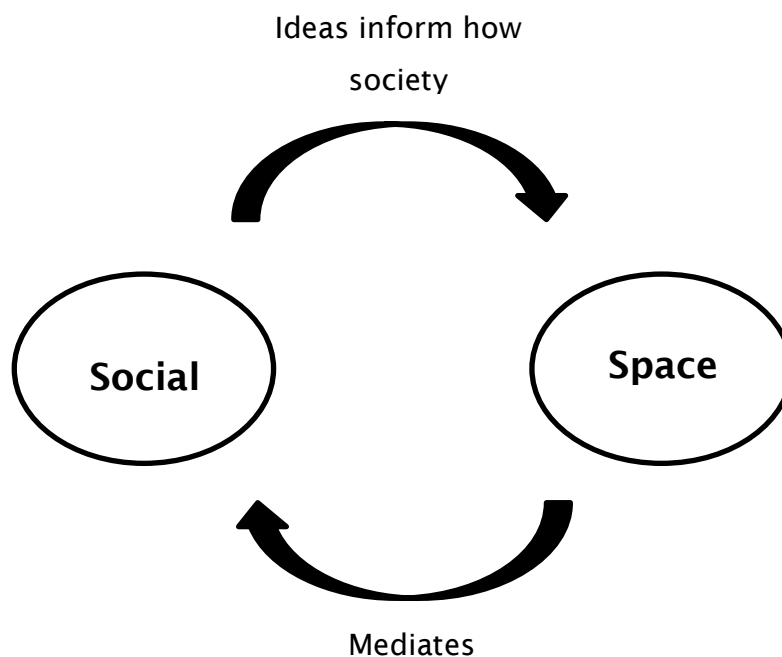
Figure 7: This diagram shows how social ideas are linked to space.

A building orders and divides space for a specific purpose or a range of purposes in a different way to the creation of an artefact. However, just as an artefact can be reused, spaces can be reused and reinterpreted as social actions change. When a building is constructed its use is defined and the space is divided to realise this intention. During and after construction this intention can change and in doing so the use of the space will change. Thinking about intentionality of construction in this way is a good place to start studying buildings in the same way as we discuss other artefacts, though I disagree with this point of view by the end of my thesis. The building has a social identity, defining social interactions, and therefore can be considered as an agent that produces an effect in us (Hoskins 2006: 76). Because of this social identity we can begin by discussing the development of buildings as if they are artefacts in the creation of a typology. It also means we can move away from this method for interpretation and consider buildings as agents which stage social interactions and use of space. Focussing on these elements of the creation of the buildings individually allows me to explore the social context within which these buildings were constructed and explore builders' intentions in their creations (Olsen 2003: 100).

Although the subject of living and buildings in the medieval period is not one that has been neglected (Wood 1965; Emery 2006b; Emery 2006a; Woolgar 1999; Airs & Barnwell 2011) there are remarkably few texts discussing late medieval secular buildings beyond collections of architectural interest or gazetteers (Emery 2006a; Nairn & Pevsner 1965; Turner & Parker 1859; Pearson 1994). There has been a particular focus on the study of castles (Fairclough 1992; Liddiard 2005; Hohler 1985; Mathieu 1999; Creighton 2005; Dixon & Lott 1993). Missing from the literature is work on buildings of the middling classes and gentry society. Considering the number of these buildings which remain standing highlights how problematic this study is. The middle of the 13th century saw slowing of construction of new cathedrals and monasteries. From this point forward hundreds of new houses were constructed and others developed to fit with new styles (Emery 2006b). Neglecting this category of building (secular dwelling) during this period means our understanding of the built environment is lacking. My review is based on reading plus extensive visits to buildings in southern England.

1.1.1 Basic structure

This section of my thesis could be written in a number of ways: chronologically, geographically or according to social status. The literature is vast and spans archaeology, art history, social history and more; making it difficult to master. Many elements are brought together in the construction of a building that we can discuss buildings of the 14th century as a particular type. Although by the late 14th century domestic architecture had developed a plan or structure common across all classes of building (Faulkner 1975; Faulkner 1963; Johnson 2002; Gilchrist 1999; Johnson 2010), almost every build has some element of individuality which becomes apparent when reading the key texts (for example (Cooper 1999; Steane 2001; Emery 2006a; Emery 2007; Goodall 2011; Wood 1965). I am going to approach this by discussing each element of a medieval manor house individually: this structure is very traditional and was used to great affect by Wood written in 1968 and it is still the major text.

Early medieval buildings dating from 450AD onwards show a basic structure that can be seen until the 15th century (Thompson 1995). The plans of these early hall houses have been created from standing remains and excavation reports for examples see Cheddar and Golthe. The general structure of these buildings has been discussed in detail by first Faulkner (Faulkner 1975) in reference to castles and then by Johnson with a focus on the vernacular (Johnson 2002; Johnson 2010). Cooper (1997) highlights that late medieval buildings were "inward facing", unlike the later Renaissance builds, this means they were designed to be understood from the interior not the exterior. By taking this approach he highlights how changing perceptions of display occurred during this "*Age of Transition*" (Cooper 1997) which is apparent when discussing the work of both Johnson and Faulkner mentioned above. The early medieval buildings (pre1200AD) show the hall, with an extension at one end containing a buttery and pantry (services) and passage through to an external kitchen (Gardiner 2000; Wood 1965: 247). These develop to also include a withdrawing chamber, private apartments and chapel, each of which will be discussed here.

Great Hall

The Great Hall like many elements of the late medieval plan is not as simple as much of the literature would have you assume. The development of the hall is given many origins both tied into the rest of the building and individually.

The hall was the centre of the household; its use was at its height during the period leading up to the 15ᵗʰ century. Buildings of this style developed from the early medieval house structure. From the end of 15ᵗʰ century the use of the hall began to decline, although this did not occur at the same time everywhere (Thompson 1995; 179) . The upper classes abandoned the use of the hall and so the structure of houses began to focus more on the comfort of the lord and his guests. It is important to note that halls did not fade into disuse but they were being built on larger and grander scale right up to this point such as Kenilworth, Eltham Palace Christ Church, Oxford and the Great Hall at Hampton Court (Thompson 1995: 150-1; Grenville 1997: 108).

The hall is a feature from the early medieval period (700AD onwards) and evidence for its presence can be seen at Cheddar Palace (M. Richardson 2003; Rahtz n.d.), Yeavering (Karkov 1999) and Goltho Manor (Webster & Cherry n.d.). Excavations from Yeavering show a series of early medieval halls of different sizes all within the building complex (Hope-Taylor 1977). It is the central point of all secular buildings of the late medieval period, from small residences (such as the reconstructed Bayleaf Hall, a timber-framed hall house from Chiddingstone in Kent dating from early 15ᵗʰ century (Tankard 2014) Figure 8), up to large palaces and castles (such as Westminster Palace Figure 9) (Emery 2005). The hall is still found today in some medieval buildings. However, they are not usually used on an everyday basis (an exception being Oxbridge Colleges and Inns of Court which use them daily for serving meals); but for particular occasions, such as weddings, parties and talks. A number have also been refurbished to reflect Victorian fashions for antiquities and customs. The great hall at Eltham Palace (Figure 10) has been maintained on the edge of the newly developed, art deco property and can now be hired out as a wedding venue (English Heritage 2014). The great hall at Ightham Mote, was decorated with wood panelling in the Victorian period (Figure 6) to reflect antiquarian ideals (Garnett 2005). University colleges of Oxford, Cambridge and Durham could be considered as an exception to this rule (Emery 2006a) as could the Inns of Court at Chancery Lane. Here some of the rituals seen in medieval households still take place. Formal attire (often including gowns) are

worn, the hall is entered in strict order following the presiding fellow, those attending remain standing until grace is said and all are seated together; finally again the leaving hall in procession (Goodall 2011: 25). The metaphor of the hall is used to show the status of the scholars (Figure 11).

The primary use of the hall was at the centre of the household, often in the early medieval period forming the only room in the building (Brunskill 2000: 118). In noble households it was used for everyday eating and feasting, communal living and sometimes sleeping. The use of the noble hall was formally ritualised and it could take a significant portion of the day for the household to eat (4-6 hours). Eating had become very elaborate by the 15th century. Entrance to the hall involved a progress (usually from the chapel after evensong) (Woolgar 1999: 88). Food was then distributed according to status, different jobs were entitled to different amounts and types of food. Each dish was tasted by the lord or king before being shared among the rest of the diners according to status (Woolgar 1999: 156).

By the 14th century the hall was usually found on the ground floor. It was at the centre of the household being placed between the service rooms and withdrawing chambers, between the lowest and highest of social classes. It was also the first space a guest would be taken into. The layouts of these rooms remain fairly consistent. Entrance is via a doorway or porch at the low end of the room into the screen passage. The screens passage was an area divided from the main part of the hall by a timber screen through which two doorways gave access to the hall. On the other side of the passage would be three doorways giving access to the buttery, pantry and kitchen. This would take a guest into the "low" end of the hall looking up towards the "high" end. During mealtimes trestle tables and benches would run up towards the "high" end providing seating according to status; the closer to the "high" end the higher the social standing. The upper end of the hall would be emphasized by the presence of a step creating a raised dais for a table to be placed across the hall perpendicular to the other tables. The upper end would often be lit by a large window, sometimes referred to as an oriel window. Behind this upper table would be a doorway through to the withdrawing chambers (Goodall 2011: 24-5).

Figure 8: Bayleaf Hall at the Weald and Downland Museum. This is an example of timber framed Wealden hall house dating from 1405-1430. It was then extended in the 16th century.

Figure 9: Westminster Hall in the foreground of this image of the rest of the palace. It is the oldest surviving part of the building dating from the 11th century (TSO 2014) parliamentary copyright images are reproduced with the permission of Parliament

Figure 10: The Great Hall at Eltham Palace, built in the 1470s. This part of the building has moved from being the centre of the building to lying on the periphery and is maintained for special events and occasions (Foyle 2014a).

Figure 11: Formal hall, St John's College, Cambridge. This is one of the places where Great Halls are still used with a similar form of ceremony they were in the medieval period (Rnt20 2005)

Trying to trace the development of the hall is difficult, as I will discuss below. Halls cannot be placed into a simple typology showing the development of spaces as their origins are varied and influences come from both the continent and native dwellings.

Halls became larger in length, width and height. Early halls were aisled and were developed to allow wider spaces to be built without having to obtain long timbers, which were both expensive and hard to acquire (Wood 1965: 35). Figure 12 from Tidgrove Warren shows the holes for two aisles of posts which would have supported the roof. The lack of long timbers can be seen in the Monk's Dormitory at Durham Cathedral. Here a beam of the oak roof has been cut into a fork to allow it to span the distance as enough timbers of the right length could not be sourced (Johnson, P.Comm). The remains of aisled secular buildings are mostly found through excavation, as at Cheddar Palace (M. Richardson 2003; Rahtz n.d.). The layout at floor level can be clearly seen in most churches and cathedrals, however the construction of these. Unlike in

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secular dwellings the aisles were not considered to limit the use of the space, for example Figure 13 shows the style of building at Malmesbury Abbey which is still used for services today. It is also hard to find medieval secular halls which are still aisled as many standing buildings that were originally aisled had their roofs replaced at a later date (following the development of the hammerbeam roof). The most famous example of a roof which has been updated is at Westminster Palace. Figure 14 shows a drawing of the ceiling (Wood 1965: 45), spanning 20.8m without posts when a hammer beam roof was introduced in 1399. If you look closely at the image you can see how, although the aisles do not reach the floor, the structure of the roof is still aisled, but is instead supported by the wall.

Thompson suggests that the abandonment of aisles began the decline of the use of the hall. Where the aisles had been used for sleeping, their removal reduced the number of functions of the space (Thompson 1995: 176). He also suggested that with the insertion of a second floor into the Great Hall this led to further loss of use.

One of the main areas of confusion with great halls is their location within the building. Some writers suggest that the ground floor hall is the most common and accepted by the 14th century (Wood 1965; Faulkner 1975) while others highlight that actually this move from the first floor never really occurred (Thompson 1995: 171). It was suggested by Wood that ground floor halls like those at Westminster, Penshurst, Bodiam and Ightham were much more prevalent in the south. In the North and along the Welsh border first floor halls are more common and were preferred for safety reasons according to Emery (Wood 1965: 16-7; Brunskill 2000: 102-3, Emery 2006a). Political unrest not along the Scottish borders but also in the south-east coast opposite France meant that until well into the 12th century more defensive structures (towns, secular dwellings and ecclesiastical sites) tended to be the norm. This meant that the hall and living quarters were moved to the first floor and buildings were worked in stone rather than timber. Halls on the first floor appear from two different styles of building, those of the Norman keep and those built in timber.

Figure 12: The aisled hall at Tidgrove Warren. Two rows of posts can be seen running across the image (from left to right) these would have held posts supporting the roof breaking the building into three sections (Photo courtesy of Dom Barker)

Figure 13: Malmesbury Abbey, Wiltshire. This building shows how the presence of aisles in a hall breaks up the width of the room. Unlike in secular buildings the use of aisles continued after the development of the hammer beam roof; in buildings with both stone and wood roofs.
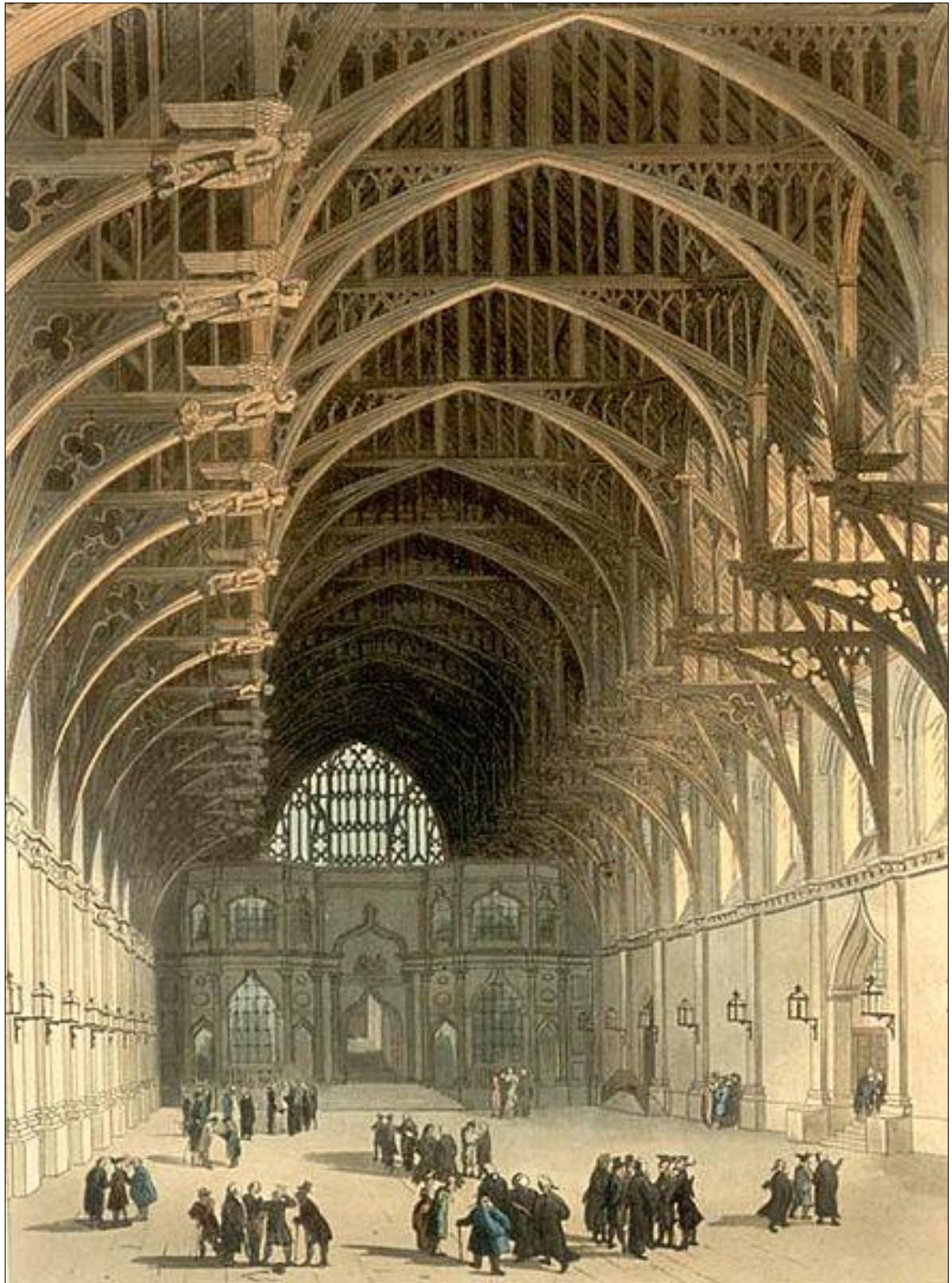
Figure 14: Westminster Hall, London. This image demonstrates the regularity of evenly spaced bays typical of a perpendicular building (Ackermann et al. 1904)

The construction of Norman keeps could be seen as another reason for the choice of the first floor hall. Norman keeps particularly demonstrate how the

layout of these spaces could be confused as a similar origin. Although floor plans did not remain the same moving through a building one, would encounter rooms in the same order. In these buildings one enters via an exterior staircase straight into the hall: the famous example of this is the Tower of London (Impey 2008: 221). The exterior stair allowed a grand approach to the hall, thereby ensuring the prolonged inclusion of a first floor hall as part of the plan of medieval buildings. This can also be seen in the remodelling of Kenilworth in the 1370s (Wood 1965: 29). Kitchens and services can be found on the ground floor directly below the great hall, close to the storage areas, as at Dover castle. In the case of Norwich castle the kitchen and services are found on the first floor as the structure of the cellars allowed for fires and there was convenient access to storage. A common theme in Norman keeps was to place the withdrawing chamber above the Great Hall. This was to restrict access to this space with entry only from above the high table (Wood 1965: 16). This pattern of building can be seen at Dover castle, Rochester castle and Chepstow castle (Goodall 2011). This possibly forms a key point in the development of the layout of medieval rooms. Withdrawing chambers were moved from the low to the high end of the hall: in this design there would probably still have been some kind of access from the lower ends as seen at Dover castle where staircases can be found in each corner of the Great Tower. The easiest way to observe this pattern is through access diagrams, which display the building according to how a person moves through it. This technique was created by Hillier and Hanson (1989) to explore space from more than a bird's eye view. Each space or room is represented as a node. Nodes are joined by an edge which represents a doorway. Figure 15 shows the layout of kitchen, services, great hall and withdrawing chamber based on the plan of Ightham Mote. The design of these buildings comes from the continent and Thompson argues that this is where the development of the first floor hall originated (Thompson 1995).

In contrast, Grenville (following the earlier work of Blair (1993)) discusses the argument that instead of being first floor halls a number of these are in fact chamber blocks which have since lost their halls as at Old Soar (Grenville 1997: 69). Her key point is that whether these rooms are halls or chambers they have a similar function in the medieval period. Trying to distinguish a pattern

between them can to some extent seem pointless and instead maybe we should look to their continuing use (Grenville 1997: 86).

The hall was placed at the centre of the household being placed between the service rooms and withdrawing chambers; between the lowest and highest of social classes. It was also the first space a guest would be taken into. The upper end of the hall would be emphasized by the presence of a step creating a raised dais for a table to be placed across the hall perpendicular to the other tables. The upper end would often be lit by a large window, sometimes referred to as an oriel window. Behind this upper table would be a doorway through to the withdrawing chambers (Goodall 2011: 24-5).

By the 14th century the hall at mealtimes was highly ritualised. Noise was constrained to silence or nothing more than moderate conversation at particular times of day; because the hall would have been the most resonant of spaces and silence was considered to add dignity to a formal occasion (Woolgar 2006: 67-8). His interpretation is based on detailed archival research but would this really be the case? Halls at the Oxbridge colleges are loud chaotic places which even with an element of occasion does not change. Woolgar's work also focuses on the noble households. Gentry households were of a smaller scale so can their use be compared to the noble household? However, this can provide us a starting point for considering the formal use of the hall.
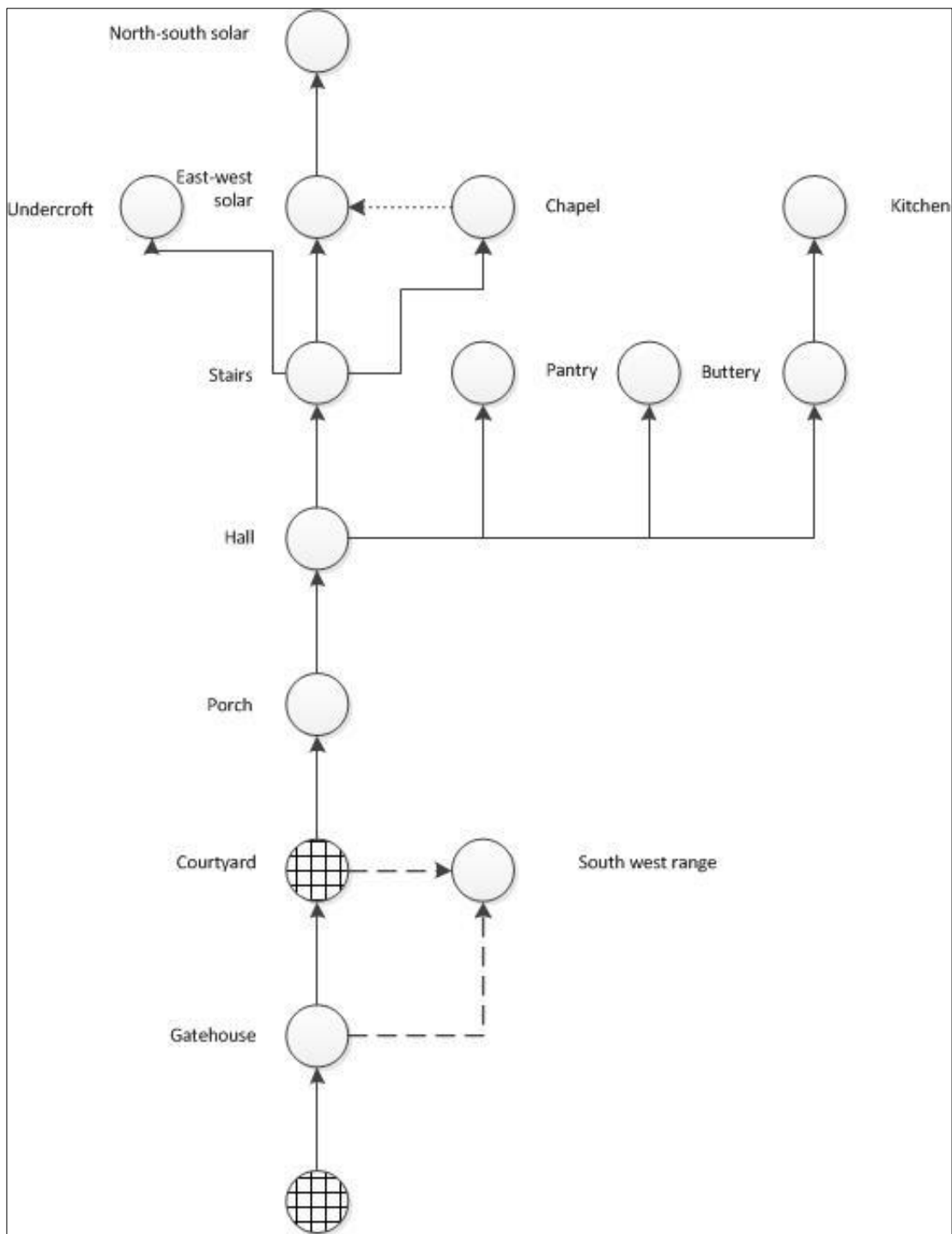
Figure 15: Access Analysis at Ightham Mote. This shows the general layout of a late medieval building based on how one moved through it. Each circle represents a node or space with an arrow representing a doorway, dashed arrows represent possible doorways and shaded circles represent outdoor spaces.

Fireplaces/ hearths/ Braziers

The first halls were heated from an open hearth in the centre of the room (Figure 16) which was a pattern that continued until the 15th century. As building methods improved some began to include wall fireplaces such as at Goodrich Castle (c.1300) or had them inserted as at Ightham Mote (after 1360). They were not adopted in larger halls as the central fireplace provided a much better source of heating to the entire room. A good example of this can be found at Penshurst (c.1341-0) where the original hearth can still be seen. It was towards the end of the 15th century that these began to disappear as at Great Chalfield (1467-80) (see Figure 17).

All halls heated from a central hearth would have been filled with smoke. This was one of the reasons for maintaining the large open ceilings that can still be seen in many locations today (e.g. Penshurst (Figure 16: page 32), Westminster (Figure 14: page 27) and Ightham (Figure 6: page 14) irrespective of the class or size of the building. By maintaining an open ceiling the smoke would be able to dissipate at the apex of the roof and slowly leave through a small louvre making the rooms less uncomfortable (Keevill, Graham 2000: 77). The Bayleaf Hall at the Weald and Downland maintain a fire throughout the winter (Figure 8: page 21). This can give an experience of the smoke, and the smell remains throughout the year. Central hearths were typically only used in large lofty halls, although Wood discusses some other examples (Wood 1965: 257-8). Private spaces had fireplaces primarily for convenience but also as a safety measure. Hearths could not be placed in first floor halls unless there was vaulting directly beneath or if a brazier was used.
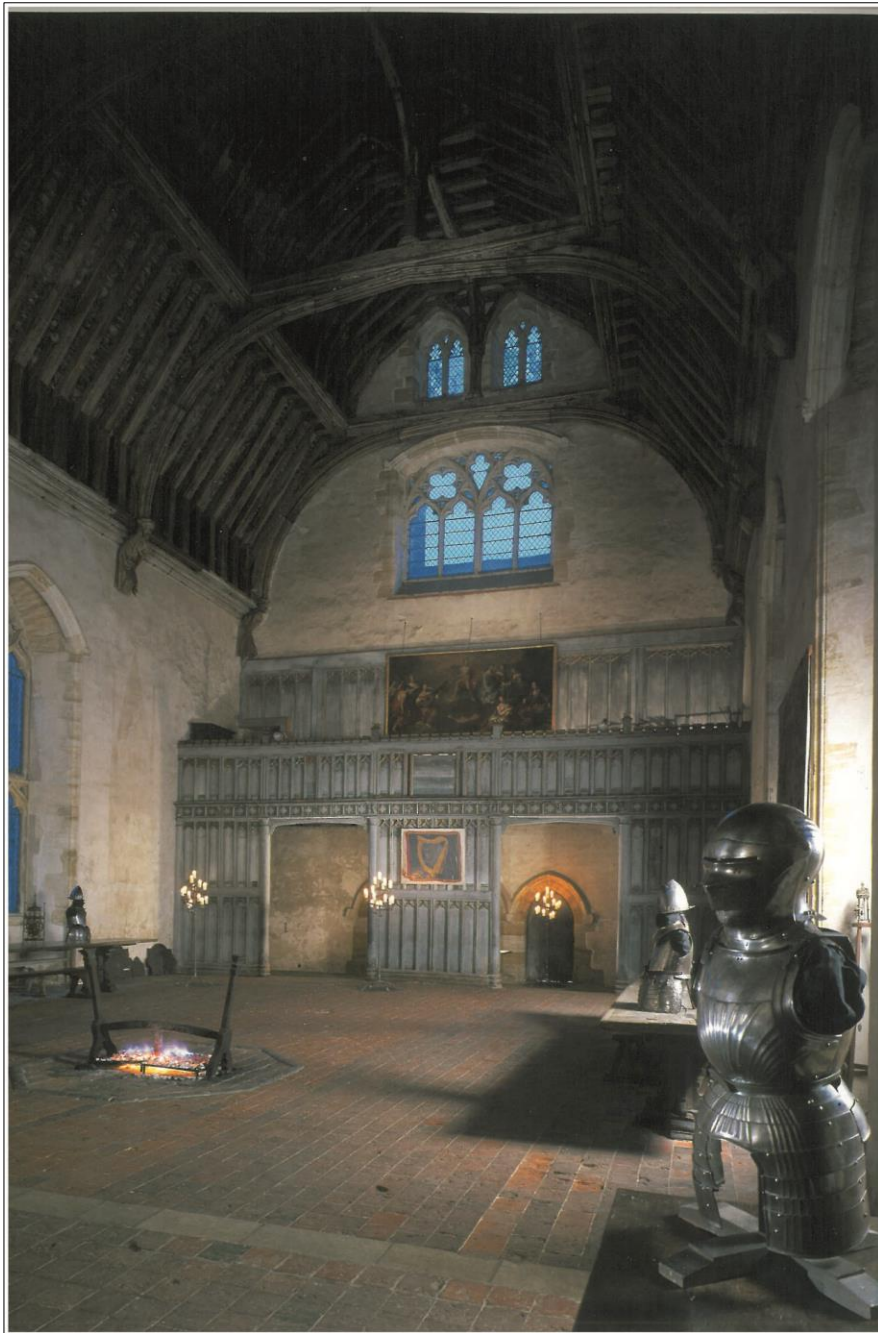
Figure 16: Penshurst Place, Kent. Built in 1341, the Great Hall is one of the few surviving halls which still feature the central fireplace. The large open ceiling is of crown post construction and features life size wooden figures as beam supports. Also of interest are the trestle tables which can be seen on either side of this image. These tables are of medieval date and have remained here since the 14th/15th century (Anon n.d.).

Figure 17: The Great Hall at Great Chalfield, Wiltshire. Here you can see the hall fireplace set into the wall of the building; unlike older building it does not have a central hearth ©NTPL/Nadia Mackenzie (Mackenzie 2014b)

Figure 18: Bayleaf Hall at the Weald and Downland Museum. A fire is maintained throughout the year and provides an atmospheric experience for visitors (Foyle 2014b).

Kitchen

Access to the kitchen was through the central door of the screen passage. This access could provide access directly to the kitchen or outside into a separate building. The kitchen is always found at the low end of the hall. In very small buildings the hall and kitchen were often combined to allow both uses with cooking taking place over the central hearth. Early buildings had a central hearth particularly if they were of wooden construction. As the fashion turned to stone building fireplaces would be incorporated into walls and corners. Larger houses, as at Wolversey and Bishops Waltham, would feature multiple fireplaces or a single large fireplace at one end (Keevill 2000: 144). Later examples also begin to feature ovens or similar built in cooking spaces: at Bodiam (Figure 19) and Kenilworth ovens can be seen in the wall fabric.

Figure 19: The oven in the kitchen at Bodiam.

Kitchens were originally detached from the main building as at Lullingstone in Kent. It has been suggested (Wood 1965: 247) that the kitchen remained as a detached building far longer than would be expected if building techniques were the only limitation. This has been attributed to the risk of fire from an

open hearth being much greater than the enclosed fireplaces that began to appear in the 14th century (Wood 1965: 272). Examples of this include Eysham Abbey, where successive floors were seen when the site was excavated in the early 1990s by Oxford Archaeology (Hardy et al. 2003: 102), and Whalley Abbey where the kitchen and other buildings were destroyed by a fire in 1236 (Greene 1989: 110). However, the presence of fireplace and open hearths in other areas of the buildings discredit the hypothesis that risk of fire is the reason for this isolation. Instead the external kitchen may have been maintained to segregate the sounds and smells for the diners in the great hall. As noted above, noise in the great hall was limited to silence or nothing more than moderate conversation at particular times of day, because the hall would have been the most resonant of spaces and silence was considered to add dignity to a formal occasion (Woolgar 2006: 67-8). If the kitchen, which would have been a loud place, was attached the sound would carry through affecting the quiet of the hall. This concept is a difficult one to agree with and highlights the differences between archaeological and historical studies. Although the archival references suggest that halls were silent, formal spaces in the 14th century it is possible this is in fact the ideal scenario, not always achieved. There are other manuscripts which suggest music and other forms of revelry. My first case study looks at a range of visual sources of medieval life, including a number focussed on sound, see the associated materials folder for some examples. In reality a formal hall as at Oxford or Cambridge (as I discussed above) is a loud experience. Sound in the great hall is the focus of my second case study at Ightham Mote and I will return to this theme in later chapters (see Chapter 5 and 6).

Pantry and Buttery

In larger buildings next to the kitchen there would have been access to the pantry and the buttery. The pantry was used for the storage of bread and other dried goods, while the buttery was used as store for ale and wine (Grenville 1997: 91). These locations were where rations were dispensed to the workers and represents the early form of the bar within a pub (Woolgar 1999: 1). While smaller buildings of the yeomen often only consisted of one space at the lower end of the hall: cooking usually being undertaken in the hall. This space was used as the services for the storage and some preparation of food, or occasionally as a kitchen (Gardiner 2000).

The placing of the service passage provided more than just access to these rooms, it also held symbolic value. It provided a point at which the treatment and presentation of food and drink transformed to a formal procession of serving. The presentation of food was highly ritualised and the movement of food through the service passage was the beginning of its procession to the head of the household.

Withdrawing chamber/ solar/ private apartments

The presence of the service range is fairly consistent across medieval buildings, from their earliest creation in the Anglo Saxon period through to the decline of the hall in the 15th century. A high status building required a place close to the hall to feed its occupants.

The housing of these occupants is more complicated. The size of the household did not matter, the lord would require a withdrawing or "private" chamber. The term private in this context is not the same as it is today and is somewhat inaccurate. Instead it describes a space where access can be restricted by the lord of the household. This space could consist of just one or two rooms, as at Bayleaf Hall, or suites of rooms as at Bodiam (Emery 2007: 123-4). It is meant as an area of separation, as the tasks undertaken and needs that were accommodated in this space were still very public. Instead this division of space was an act of power marking status (Woolgar, 1999: 50).

The first withdrawing chambers were thought to have been above the services and for the owner of the house. Examples of this can be seen at the Yardley Hastings manor house, which features a grand set of withdrawing chambers (Emery 2006b: 185). Whether this formed the origins of the later medieval plan or is just a regional variant has been called into question by Gardiner (2000), which I will discuss in more detail shortly.

The move of the withdrawing chamber to the upper end of the hall allowed for the room to expand into a great chamber with a receiving room or series of apartments, which later became the parlour. The private apartments are linked to the move from public to more private spaces for the lord and his family. Over time the single withdrawing room developed into a series of suites. Private apartments or suites of the 14th century in manor houses consisted of some or all of the following: a receiving room, leading into a private

bedchamber with access to garderobe. The first of these rooms has sometimes been referred to as the oriel room or chamber, as at Ightham Mote. However, there seems to have been no set meaning for the word or the space that it relates to. Margaret Wood discusses oriels as a development of a window or projection at the junction between the hall and the withdrawing chamber. At Netley Abbey it refers to a porch staircase, and at Marlborough as an extension to the hall (Wood 1965: 99-103).

The expansion was more than just the development of the withdrawing chamber. In smaller houses this meant building over the service rooms again or moving the services to allow for another withdrawing room at the low end of the hall. This plan can be found at Great Chalfield. The wish for more chambers by the owner was often not realised in the first building works and did not feature in the original plans. Instead they were added on to existing hall houses. This highlights that before the 14th century very few houses were developed according to a plan beyond the arrangement of kitchen, services, great hall and private apartments. Particularly this can be seen in castles where buildings were constructed as lean-tos against the curtain wall as at Harlech. Work done tracing this style of planning will be discussed in section 1.2.2. Bodiam is considered the first example of a medieval house with a planned interior layout (Faulkner 1975).

Suites of rooms ranged in size and number depending on the type of household. Normally the rooms would exist as a suite of rooms for the lord, lady and other key members of the household (e.g. mother or widow) (Goodall 2011: 28). It was common for elite women to marry young and outlive their husbands. In these cases they would often remarry or be granted households or rooms in their son's household. The Duchess Cecily, mother of Edward IV and Richard III, maintained her own rooms and household (Anon 1995: 196). Beyond these individuals it was rare to have personal bedrooms. Servants would sleep either in the hall or in corners of the service rooms in which they worked (Woolgar 1999: 8).

Squints, or rooms overlooking the great halls, are found in many withdrawing chambers. Placed high in the walls of the great hall they allowed those in the private chambers to observe what was happening in the hall from above. Their use was involved in the seclusion of women in the late medieval period.

Roberta Gilchrist discusses them as a particular aspect of feminine spaces. The idea was that they allowed a view of the hall without the viewer being observed. In Great Chalfield squints are displayed as masks (Figure 20) whereas at Ightham they are windows.

Figure 20: A stone mark squint at Great Chalfield. This is found in the upper walls of the great hall; this allows the hall to be overlooked from the withdrawing chambers ©NTPL/Nadia Mackenzie (Mackenzie 2014a).

Strong room

Vaulted spaces and cellars are found either on the ground floor below first floor halls or running under the building and they were used to provide storage space. The use of vaulting is a prevention against fire, among other things. In later buildings there is often a small vaulted room found at the upper end of the hall (see Penshurst, Great Chalfield, Bodiam and Ightham). At Penshurst and Ightham these are found directly below the oriel room and on leaving the hall one can access both spaces. There has been little discussion of the use of these spaces as a common feature of medieval buildings. I suggest that they are a key feature of buildings constructed during the 14th century and were

used as a location to store and secure the wealth of the lord, be this documents, money or other objects.

Chapel

Houses of the gentry and higher rank can also include a chapel or oratory. These range from small personal spaces on the edge of lodgings, as at Dover castle, to much larger examples allowing the whole household to attend. Often in Norman buildings they are found close to the entrance. Theoretically no secular space should be found above a religious space (Wood 1965: 228). This can be seen at Dover where a series of small chapels are found above each other on the side of all halls and chambers. At Rochester this meant that the chapel was built on an over-hang. Domestic chapels often sit out of line with the rest of castles or manor houses possibly for the reason discussed or as a requirement of aligning the chapel east-west. By the 14th century chapels were fairly consistently found on the first floor, often placed at an angle or projecting from the main façade. This was presumably due to the difficulty of fitting in an east-west aligning window. This often covers multiple floors to allow for a large elegant window, or a more open space.

In later buildings, from the 13th century onwards (Wood 1965: 230), having direct access, or view from the private apartments of the lord to the chapel seems to have been important. At Old Soar and Horne's Place the chapel can be accessed from inside the solar block (private apartments) but also from an external stair so the owners would not have to allow access to their private apartments to all attending services.

At both Bodiam and Ightham the private rooms have squints allowing services to be observed from the adjoining space. At Bodiam there are two rooms overlooking the chapel, while at Ightham the oriel has a squint linking the space. Squints of this type could be interpreted as private pews, used by women, allowing services to be observed from a private location (Gilchrist 1999: 123).

Fixtures and fittings

The common assumption (Woolgar 1999) is that rooms would be decorated by painted cloths or tapestries. The 14th century is early for tapestries to be commonly used even in gentry society. Tapestries were used to keep the heat

in a room as well as provide decoration. Instead of using tapestries, rooms were kept warm with wall hangings which were painted cloths usually in bright colours often featuring scenes from the bible or displays of heraldry (for more about the use of heraldry see section 3.1.4). Wall paintings were also used as decoration and these take a number of different styles, frequently made to represent cloth (Woolgar 1999: 73) however, these were not movable and therefore were not as useful for a traditionally peripatetic household.

The floor of each room would have been strewn with straw, grass or rushes, which were replaced regularly to keep them fresh (Woolgar 2006: 142). Chapels and other areas of high status were often tiled with brightly coloured tiles which are common find on site (Woolgar 1999: 72).

1.1.2   Architectural style

I now move on to discuss the architectural style of the late medieval period which suggests much more about the development of the building.

Architecturally the later middle ages show marked planning and stylistic unity in house design before neoclassical influences came into fashion. The exploration of larger buildings is a complicated task. Buildings such as Knole have over 365 rooms. Recording, discussion and analysis of the use of space is much harder to coordinate and accumulate making projects seem less inviting. The same is true of undertaking a country-wide survey. Many buildings of the medieval period have been developed, knocked down or are privately owned, so that the task seems impossible (Emery 2006b). This has made discussions about the style and function of larger houses a particular challenge.

Art Historians describe late medieval architecture as Gothic architecture. The term Gothic combines several sub styles which emerged from Romanesque architecture dating from the 12th century. Broadly speaking we can recognise gothic style from the pointed arch, ribbed vaults and flying buttresses seen in much ecclesiastical architecture of Europe. These developments were as a result of technological innovation and allowed for larger buildings by way of stronger supports across larger spaces. The decorated style involved highly stylised tracery and rich surface treatments which were developed into the perpendicular style involving the use of lots of straight edges in the lower parts of the windows (Davidson Cragoe 2008: 32).

It is hard to discuss medieval architecture with respect to secular architecture in Britain on a stylistic level. Most books on the subject of medieval architecture focus on the range of Gothic palaces found on the continent or only focus on ecclesiastical sites (Coldstream 2002; Murray 2008; Alexander & Binski 1987). Coldstream (2002) describes late medieval architecture (1150-1550) as "the age of the cathedral" (Coldstream 2002: 23). Emery (2006b) highlights that in England this is not true as the last cathedral was built in 1250 (Emery 2006b). However, either way cathedrals were never "finished" although the last cathedral was not started until 1250 they were continually updated.

The substyles vary as much with location as they do with period, with marked stylistic changes being observed across the continent. Early Gothic is a term used to describe the first origins of this type of architecture in any country. There are four terms used with particular reference to Britain. From c.1170 to c.1250 Early English began to emerge which can be seen through the use of rib vaults, pointed arches and particularly large amounts of detailed ornamentation. Transitional refers to a style which appears around 1200 and combines Romanesque and Gothic forms: it is particular relevant to builds associated with Empire. Decorated architecture is recognisable from the use of tracery and much sculptured ornamentation dating between c.1250 and 1350. Finally the most recognisable English style is Perpendicular of the late 14th century, of which Bodiam is considered one of the first builds of this style. It is recognisable through its highly rectangular surfaces (Coldstream, 2002: 40).

1.1.3   Regional differences

Although there are national patterns of building, as discussed above, there are also much more local or regional ones for this period. Regional building patterns are affected by the geology, travel routes, and social and political climate for each region. Local variation occurs in the south east from its position along the channel closest to France (Newman 1969: 43) but this is not the only influence.

Kent and the Sussex Weald in particular can be seen to have an unusual building pattern as a result of the county's differing patterns of landholding and tenure during the late medieval period (11th - 15th century). In the area of

Kent much of the land was held in gavelkind, a free tenure that allowed men (peasants) to dispose of their land at will, but in exchange owed service and rent to their lord. The main interest of this type of tenure in relation to houses of the gentry was that inheritance had to be divided equally between all sons. This meant that either large family groups would remain in one house, or the division of lands amongst multiple parties meant that holdings decreased in size, which made them much less viable. This is demonstrated to be the case for Bodiam in Chapter 3. It did, however, mean that there was an active land market and properties or land were frequently bought and sold to allow the creation of estates (Pearson 1994: 15).

The Norman Conquest changed ecclesiastical architecture in the region from the original Saxon pattern (Newman 1969: 43). From this change until the Dissolution, much of the land in Kent was owned by the church and the crown, which has led few noble families to make Kent their central residence (Emery 2006b; Pearson 1994: 16). Instead it was a lower class of gentry who made Kent the centre of their estates and it is on these men that this PhD will focus.

The buildings of the late medieval period were the result of the changing political climate and wars with France and Scotland. Building patterns in south-east England were influenced by the Hundred Years' War with France. The knights whose interests lay in their status, wealth and office were the principal builders in this region. They were often from rising families who had gained their wealth and position from the Hundred Years' War and were trying to consolidate their position often by taking county offices and political roles. There was a propensity for the development of housing in this area as it was on route from London to France. As will be seen in later chapters concerning Bodiam and Ightham many soldiers moved into the area from other locations often following good marriages to women in the region (Minihan 2012).

Large numbers of castles were built in this area. Following raids on the coast from France the King (Edward III and then Richard II) awarded a series of license to crenellate and supported a number of building works along the coast. By encouraging the improvement of defences the King also encouraged private landowners to look to their own security in the region (Liddiard 2005: 43-4). New works in the late 14th century appear to be fortified structures or defensive additions were made to other domestic residences (Emery 2006:

284). The concept of the fortified residence in the late medieval period has been questioned and will be further discussed in section 1.2.2.

Large numbers of troops were brought through the county on the way to France and back again. This caused disorder and disruption to business and property, possibly leading to the presence of so many fortified buildings (Emery 2006b: 261). However, many of the buildings being constructed by the gentry classes do not fall into this category: there are large numbers of unfortified buildings. Unlike the border disputes with Scotland which made the border counties unsavoury places to live, Kent was not so directly at risk (Newman 1969: 54). Instead property owners chose to display power in a different way. This gives support to the argument that although buildings can appear military they may not have defence as their primary function but instead were considered as a display of power (Liddiard 2005: 7-8).

An error in the study of both castles and unfortified buildings, particularly of the 14th century is that they are considered independently (Goodall 2011; Grenville 1997; Wood 1965; Liddiard 2005). Their external appearances might differ greatly, but, internally they fall to a common domestic plan, which can be seen across a range of buildings.

The south-east is characterised by timber framed buildings possibly due to the large areas of woodland found in the region (Emery 2006: 263). The Wealden type dominates the area and was traditionally the property of yeomen or small land owners (Newman 1969). The Wealden type features a tiebeam-crownpost roof, which allows a projection of the roof over the eaves through the use of curved braces on which the projection rests (Nairn & Pevsner 1965: 54). Although Emery (2006) suggests that a lack of building stone was a significant factor in common house design (Emery 2006: 263), sandstone from the Weald provided the stone for the castles and domestic buildings discussed above before brick took over from the 15th century. Roofing was of tiles or thatch depending on style of building, design or cost (Nairn & Pevsner 1965: 17).

The geology of the area also encouraged the construction of moats. These range in style from large lakes as at Leeds, to small landscaped gardens as at Ightham. These do not seem to have been completely defensive structures and instead may have had more to do with the fashion for having large bodies of water around buildings.

1.2 How have we approached medieval buildings theoretically?

So far my analysis has been simple and formulaic, giving a very static impression of late medieval buildings. The study of late medieval buildings has not been straight forward and they are not the focus of just archaeologists; their study has been approached by other Humanities subjects (History, English and Music) as well as architecture and engineering. However, conversations between these disciplines have been limited. This section looks at how different schools of thought have emerged out of post processual archaeology.

1.2.1 Castle studies

I have discussed already how church architecture has dominated the study of medieval buildings. The second most common area of interest is castles. The 100 years' war had a marked effect on building works in England. This period has been traditionally described as one of military decline, and domestic planning. Castle studies tend to favour the view that domestic comforts were secondary to the military needs of the building. This began with the works of Clark's *Medieval Military Architecture* (1884) and is still present today in the work of Platt (2007). This view has come from a form of technological determinism: military determinism. Technological determinism states that technology is central to social change, the development of technology is driven beyond the impact of cultural or political change and once introduced society will adapt to support and promote the development of the technology.

Castellologists have as a rule followed the idea of military determinism; the concept that medieval European society has, through the development of buildings (technology), become focussed on the defensive potential of the castle. This has developed and encouraged the militaristic design of the building above all other attributes and the society creating them has supported and encouraged this (Stocker 1992). This statement is important, aspects of defensive design feature in buildings late into the 15th century such as at Herstmonceux (Figure 21) and the gatehouse at Sissinghurst (Figure 22). However, these buildings (Herstmonceux and Sissinghurst) were not constructed with a militaristic purpose (Goodall 2011: 360-2).

A key factor is that castles are described as masculine places. Coulson states that castles in scholars' minds are all about "*dungeons and torture-chambers [...] battering-rams and boiling oil, or at least permanently garrisoned and scientifically murderous castles*" (Coulson 1996: 178). Key to his point is that very few castellologists have been female. This has made the late medieval building a masculine space hiding the women who often ran the estate and defended the castle in times of need (Leyser 1996: 165). The exceptions to this rule is the work undertaken by Gilchrist, who's work will be discussed in section 1.3, Wheatley (2004) and Marshall (2003) who have focussed on castles as residences, and are women.

Figure 21: Herstmonceux Castle (6mat1 2009)

Figure 22: Sissinghurst Castle © Copyright Oast House Archive
(OastHouseArchive 2009)

1.2.2   Aesthetic: Architectural/ Art historical

In section 1.1.2 I discussed the different architectural styles which are found in the late medieval period in Britain. These provide the basis of a very traditional understanding of the building from an aesthetic perspective studied by architectural and art historians.

Studies into medieval architecture from the perspective of an art historian present medieval architecture as a force that maintained creative power well into the 16th century. The disciplines of art history and history of architecture look at the buildings' aesthetic qualities (Alexander & Binski 1987; Cooper 1999; Davidson Cragoe 2008). Buildings are examined with a view to asking questions about what the building was made of, by whom, how it was decorated, what it represented in thought and motive, the architectural space and how this reflects the late medieval world view (Coldstream 2002: 20).

The focus of architectural studies is based on the appearance of each building; describing each build as the result of a deliberate choice. Meaning use of space and architectural symbolism were designed to enforce both religious and political messages through the architecture. The process of building was considered not just material but also metaphysical (Coldstream 2002: 150).

Elite architecture provided a backdrop for ceremony and therefore is about ritual and display. The setting and style of each creation had to be appropriate in signalling the nature of the building. Its structure was suited to the building's function and status. Therefore style and aesthetics dictated the builders' designs (Coldstream 2002; Alexander & Binski 1987). Quantity of decoration by no means indicated status or function. Decorative elements helped to convey the building's intention, its meaning (for discussion on this see Johnson (2012b)) and symbolism indicating function. Meaning and symbolism were at the heart of medieval architecture in a largely illiterate society.

Art Historians have tended to place their focus on religious architecture partially because of the quality and quantity of the remains. There has also been a focus due to the use of space being attached to a set of religious values. Space was considered multidirectional; it was not Cartesian but was sacred. Journeys were of the body and soul and were a metaphor for humankind's journey towards god (Coldstream 2002: 117-121). The high proportions of churches were not just the result of the more transient nature of domestic architecture. Movement through a cathedral provided the journey to bring one closer to God (Coldstream 2002: 19).

Their interest is in the changing appearance of medieval buildings, their structure, and how they were designed and built. The larger numbers of religious buildings and their survival lends itself to their study.

The principal critique of the art historical approach is the focus on the aesthetic, which has been channelled into arguments that critique treating buildings as works of art not as working spaces (Hamilakis 2014: 76). Authors (Murray 2008; Alexander & Binski 1987; Coldstream 2002) tend to observe the decorative features of the particular style without reference to changing use of space. The second critique is that the study of art history has assumed that stylistic changes conform to the development of gothic architecture (1100s until 16th century). The discussion insists that castles are defensive and those martial elements are defensive not a stylistic device used for decoration (Alexander & Binski 1987: 61). This causes issues when considering the changing internal layouts over this same period (1100s-1600s) (see Faulkner 1963) and the consideration that spaces were designed for more than their visual appeal. The focus on their aesthetic appeal can also be criticised. Arnold picks apart the early studies of architectural history where style is understood as a series of developments which occur chronologically, therefore each style must follow in turn, not occur simultaneously and develop differently in different places. A reliance on antiquarian visual recordings have resulted in stylistic qualities of particularly background being championed over other types. As a result the visual focus on a variety of styles is often a biased critique of a building (Arnold 2002).

The focus on stylistic change creates a different interpretation of late medieval architecture to that focussing on military spaces and secular space. This bias has led to the studying of the built environment by art historians focussing on ecclesiastical architecture (Emery 2006b). Furthermore Johnson suggests that today this focus on the meaning of aesthetics has become a discussion on what is important socially and politically in relation to cultural heritage. Focussing on the work of 19th century art historians has greatly influenced our understanding of what is important. For example, our understanding of medieval appearance has been adapted by the gothic revival of this period, to some extent exaggerating what we understand of gothic architecture. Johnson goes further as I will discuss below to highlight the interdisciplinary discord between archaeology and art history. He continues to state that terminology

such as meaning, architecture and social are laden terms which are used with different emphasis (Johnson 2012b).

1.2.3   Planning/ Access diagrams

Approaching questions on the use of space in buildings began by creating and using floor plans. By exploring the building from this perspective patterns within building styles were detected, it provided a practical method for comparing large and complicated building with those much more simplistic. A good example of this is the later medieval plan discussed by Gardiner (2000); the pattern across different classes of medieval building of kitchen and services sitting adjacent to a hall and then the "private" solar apartment at the other end which features within peasant halls right up to the highest class of building in the 14th century.

One of the major issues with the study of medieval buildings has been the reliance on the floor plan. Viewing the space in this way provides a useful mechanism for understanding the structure of the whole building quickly and easily. The floor plan lacks an understanding of the use of, and movement through the space. Faulkner was the first to begin to explore medieval buildings in a different way. He used diagrammatic methods to look at the degree of domestic planning in the construction of a series of castles in the 13th and 14th centuries. Instead of only exploring the buildings in plan view and looking purely at the aesthetics of the spaces he created illustrations that show different spaces and how people might have circulated between them (see Figure 23 of his planning diagram of Bodiam). His conclusions stress that there was a large element in the planning of the residential aspects of the building, not just considerations of the martial (Faulkner 1963). His results are discussed in more detail in Chapter 3.
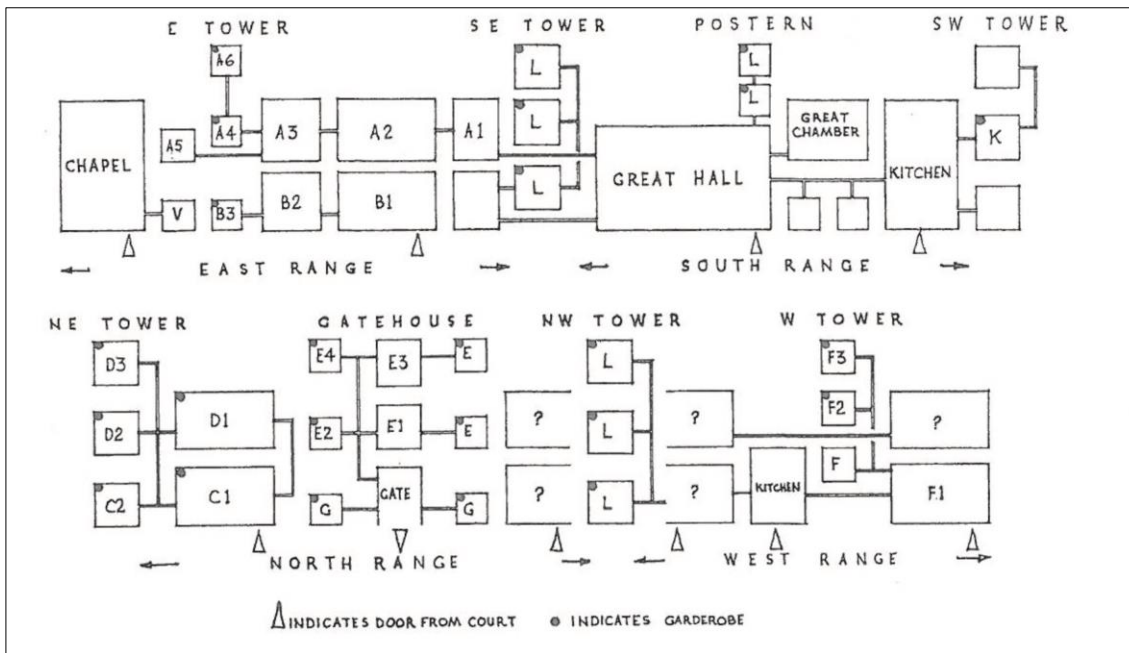
Figure 23: Faulkner's planning diagram of Bodiam Castle. Each box represents a room and the lines between them show the connections that allow people to circulate through them (Faulkner 1963).

Faulkner's domestic planning approach was developed to support the hypothesis that function (realised through planning buildings before their construction) could provide evidence of for intent and therefore meaning (which will be critiqued in the following section) (Faulkner 1975). This was further developed by Hiller and Hanson (1989) into a technique called Access Analysis. Instead of observing the spaces according to size and location they began to explore the links between spaces in more detail, particularly in terms of depth of rooms into a building. A. Richardson (2003), Gardiner (2000) and Fairclough (1992) have since applied the technique to medieval structures. These studies demonstrate the commonality of domestic medieval plan (Fairclough 1992; Gardiner 2000) and how depth relates to gender and hierarchy (A. Richardson 2003). While Gilchrist used the technique to highlight how feminine spaces intend to be found in the deeper parts of the building (Gilchrist 1999; Gilchrist 1988).

1.2.4   Post processual archaeology

The 1990s saw the beginnings of a revisionist approach to castle studies particular by those with a background in archaeology. Prior to this there had

been a strong view that to further the study of the past methodologies had to become more rigorous with the catch phrase of "more scientific". In castle studies this can be seen in the focus on military deterministic perspective and on the physical standing remains.

Post processual archaeology is hard to define as a single theoretical way of thinking: instead it consists of a number of different approaches, some of which are discussed below. Broadly it can be defined as a movement in archaeological theory which highlights the importance of interpretations (Johnson 1999: 101) being based on more than "scientific fact". In this way post processual approaches include engaging with the more subjective elements of the study of the past, understand that data is always theory-laden, exploring the individual in the archaeological record and that we understand the past in the present not the past in the past and how this affects our interpretations.

In castle studies this began by looking at more than the defensive nature of the building through analysis of the domestic ranges or exploring the art historical approach (discussed above). Interpretations of non-military intent began to emerge as did discussions concerning gendered interpretations. All of these moved the study towards a social exploration of the space and greater dissent from the military determinist viewpoint which is discussed in chapter 3 and above.

1.2.4.1   Structuralism

The classic description of a structuralist point of view is that culture is like a language. A language is made of different sets of rules and to understand each other we must adhere to those rules (Johnson 1999: 95).

Through the study of architecture in the past, stylistic observations move on to questioning how people choose to structure the world around them. Unlike other aspects of material culture, buildings are individual in that they both mediate the tasks undertaken within them but also to some extent define what happens within them. To some this means that the builder outlines a set of rules which dictate how the space within them is defined, however, this can develop and change over time. Therefore, it means that we can observe the original intentions of a builder through how they have divided the space. The

building itself although defined and created by someone, as any other object, once created governs action within the divided space. Buildings were actively manipulated to both structure and transform how spaces were thought about in the past (Giles 2007: 107).

Structuralism looks for the underlying rules which govern that structure (Johnson 1999: 95). This way of thinking about late medieval buildings can easily be seen in the way I have laid out the first part of this chapter. I have tried to make medieval buildings conform to a set of rules and use that to explore how the medieval person conceives of them. Johnson has discussed in detail how those rules are expressed across different classes of building in the medieval period. He suggests that because they all follow a particular set of rules they can be "understood" across the classes (Johnson 2002).

1.2.4.2 Marxism

Marxism is a materialistic philosophy and so it lends itself well to the study of archaeology. It is particularly bound up with the division of labour at the base of the creation of things. Despite the type of particular political system (the example used is feudal society) the division of labour as it is described is never realised, meaning that a certain amount of ideology is involved. Because the division of labour is never equal there is always some level of politics wound up not only in our interpretations of processes but also in the things that are being created (Johnson 1999: 92-95). Particularly relevant is the idea that class conflict is the force for change whether technologically or socially (Trigger 2006: 221). Therefore late medieval buildings are the result of class struggles such as the peasant's revolt. Particularly relevant to this thesis is the struggle between the middling to upper classes. Goodall theorizes that many of the decisions about the building of Bodiam by Dallingridge are bound up in a disagreement over power with John of Gaunt, following John of Gaunt's arrival in Sussex (Goodall 2011: 314) which I discuss in more detail in Chapter 3.

Also important in the Marxist way of thinking is the importance of subjectivity and the importance of different interpretations. This concept I discuss heavily in Chapter 2 in relation to uncertainty in archaeological data. Relevant to how we study medieval buildings is the idea that although what has previously been described as an objective statement as a result of scientific investigations cannot always be considered so.

1.2.4.3   Human action

Medieval buildings have been approached from more directions than their physical, structural remains. Archivists and Historians look at the documentary evidence concerning the construction and possessions found within the buildings. For example, Chris Woolgar uses inventories to discuss how people lived within these spaces exploring not just physical possessions but how they understand the space according to their understanding of the world (Woolgar 2010; Woolgar 2006; Woolgar 1999).

In his book of The Great Household in Late Medieval England Woolgar suggests that there is a need to define what a "normal" experience of a household is before we can discuss individual case studies. He examines the basic characteristics of a household in terms of size, membership, dynamics, economics and social context using archival evidence (Woolgar 1999). Although his book focusses on the accounts of the aristocracy and royalty (where there are documents remaining) he suggests that although the costs are much reduced in other social economic groups and households would run in much the same way. "*Nobles imitated royalty, so the gentry aped the aristocracy*" (Woolgar 1999: 5).

Woolgar's research not only examines, translates and catalogues archival evidence but uses it to interpret the daily running of large households. He has pieced together how daily life was timetabled and how time is governed in an age before clocks. He assesses seasonality and how time was perceived differently in the past with the working day changing from season to season based on daylight. From this he discusses the organisation of a day from both a lord's and a servant's perspective and the differences in the working day. He also discusses in depth the consumption of food and how this relates to those consuming it. As the major expenditure of any house it is a major factor in the running of a household. Mealtimes, for the upper classes, lasted for a large percentage of the working day as well as most of the staff being employed towards there creation. His examination of the inventories discusses the experience of dining and eating in a household and the nature of food consumed. He also explores the experience of darkness. In comparison to today even with lit candles the rooms would have been darker and the light quality much more limited.

One of the most important elements that he highlights was that most medieval spaces were multifunctional. This raises some of the most contentious issues with techniques such as planning analysis and access analysis: they consider each space to perform a specific function (Johnson 2012b; Parker Pearson & Richards 1994) and so do not take into account spaces which are multifunctional. Quiney also highlights that a lot of houses were reused and developed from earlier buildings that had been brought not built for purpose. The result of this action is the same as issues with multifunctional spaces: techniques such as planning analysis struggle where a space designed for one purpose is adapted for a different use (Quiney 1990: 81).

1.2.4.4 Phenomenology

I have already touched on phenomenology in my introduction. I return to it here to discuss how medievalists have embraced it. Woolgar's work, although in one sense very traditional, is also a very practical way at exploring how people live in buildings. In the early 1990s archaeologists began to explore how human subjectivity can be used to interpret sites. This is the principle of phenomenology as archaeologists have seen to apply. Tilley published *A Phenomenology of Landscape* (1994) which argued that the two dimensional (2D) representations of landscape like maps do not interact with how people experience landscapes. Instead he suggested that one needed to be in a landscape and understand it through all of ones senses to understand how the people of the past would understand it.

Johnson defined phenomenology as "*the study of the structures of human experience and consciousnes*s" (Johnson 2012a). Our understanding of the world around us is based on bodily experience. Our experiences contribute to our interpretations of how people in the past experienced life, whether we accept that or not. These experiences are of course subjective, they are built up of our own pasts and memories. Clearly how we look at space today is not how space would have been viewed in the past: "*any understanding of the architecture of the past is quite different and alien from our own experiences of architecture and social practices in the present*" (Parker Pearson & Richards 1994: i). However, what phenomenology can do for the study of the past is bring out this element of personal experience and subjectivity.

The application of phenomenology has been critiqued as overtly subjective. Interpretations suggest that modern (usually man's) experiences can be used as a direct parallel to those of past peoples, this is not possible (Fleming 2006).

Medieval studies has yet to fully explore the experience of living although there are many books which claim to talk about living in buildings (Ottaway & Rogers 2002; Hohler 1985; Thompson 1995; Dyer 2001; Gies & Gies 2010). Work like Woolgar's encourages use to look towards bodily experience. Phenomenological approaches, although not baggage free, provide a path to move away from questions that cannot be answered. We cannot know what Dallingridge really wanted Bodiam to do. But we can begin to ask questions about how Bodiam was experienced on a day to day basis: how people moved around the building and who was moving through it. What people saw, smelt and heard which could be partnered with Woolgar's research to tell us what a medieval person thought about those things.

Unlike in a prehistoric setting the archaeological and documentary record is much richer in material allowing us to put together these ideas and ask new questions of our buildings.

1.3   Towards a lived experience

Johnson states that "*It is common to assert that medieval buildings must be understood "socially", and that the "meaning" of domestic space is important*" (Johnson 2012b: 381). His paper discusses how these themes have been common in archaeological studies and other disciplines; but until recently studies of domestic space have been held back by what I will summarize as two major points relevant to this study: the nature of interdisciplinary work and the engagement with social approaches.

I have stated above that this thesis takes an interdisciplinary approach to exploring medieval buildings. This is an approach which is not new to medieval studies. However, frequently projects like this are held back by what Johnson describes as a lack of engagement with other disciplinary approaches. These projects reuse methodologies but do not engage with the *baggage* of their methods. Secondly different disciplines also mean different things when it

comes to social approaches. For example, engaging with the social interpretations of buildings has been considered successful at exploring *meaning* and *social use of space*. However, as Johnson writes these engagements still have a number of concerns. The use of the word meaning is problematic; it has been used to mean a range of things and often different interpretations according to discipline (which I will discuss shortly) (Johnson 2012b).

Space is traditionally explored in plan view, even following the work of Faulkner. Even moving into a 3D (three dimensional) space the idea of movement through space can be overlooked and even more likely is that internal furnishings will not be considered. For example modern understandings of medieval French cathedrals are of large open spaces. When in fact the buildings in the middle ages would have been divided by screens and encumbered by liturgical furniture and tombs (Murray 2008: 390).

Castle studies have continued to fall into the trap of portraying the medieval period as devoid of women. This focus on masculine interpretations was briefly touched on in section 1.2.1. The move to reinterpret castles as domestic spaces also brought women in to focus. Most papers (Woolgar 1999; Emery 2006b; Goodall 2011) suggest that even when castles are being interpreted as residential units there were still a limited number of females as most servant roles were male (Gilchrist 1999: 120). However, high-status women required space designated for their use and in fact were often called upon to run the household and estates while their husbands were away (Gilchrist 1999: 120). In the case of Dallingridge at Bodiam he was frequently away at war in France or in London on business. They were also involved with hunting and other male gendered tasks. There has been little discussion of the female role in the castle or in fact what spaces they inhabited.

I suggest moving beyond the term social towards lived experience. Ideas from prehistoric studies applying phenomenology have begun to discuss the experience as more of a narrative attempt at looking at the past: lived experience being one approach taken to explore this. We begin to look at the buildings in terms not just of the documentary evidence but also the experience of moving through them and existing within them. We can begin to explore the nature of tasks undertaken in each space and what the divisions in

space mean to those experiencing them. Although now considered highly contentious (Brück 2005; Fleming 2006) Tilley's (2010; 1994) work on moving through the Wessex landscape suggested considering a much more subjective approach, understanding the landscape according to personal experience. Murray has also considered this personal experience when teaching architectural history he states *"The student must form a direct and personal relationship with the raw material of his study, the buildings themselves, visiting as many as possible and developing a systematic way of looking, understanding, documenting, and interpreting what he sees."* (Murray 2008: 383). It is this element of physically engaging with the places we are studying that is important in Tilley's work. I suggest his methodology as a starting point to think about the experience of buildings. Engaging not only with my subjective experience of a building but beginning to think about what makes up an experience; the sights, sounds and other interaction that is involved. This multisensory element is also considered by Murray who highlights a need for *"reconciling our experiential responses with the task of dealing with buildings as entities that can go beyond the written document in providing vital access to the past."* (Murray 2008: 383). His work is important in suggesting that our understanding needs to consider more than contemporary sources and acknowledge that buildings are understood according to a series of social constructed rules which are not recorded. The approach and movement through spaces are what affects and makes up this experience. For example, approaching Bodiam Castle a visitor passes past and below displays of heraldry. The placing of heraldry at these points is more than just a demonstration of ownership. Heraldry meant different things to different members of society and therefore would be read and experienced in different ways. It is through these different ways of engaging with the building that will allow us to access different experiences of spaces beyond our own understanding. I return to this discussion in chapter 3.

Inherent with lived experience comes the idea of multisensory experience. Although this has been approached by medievalists (Woolgar 2006) there has been less of an engagement with what this means for everyday life and more towards the highest level of society. Phenomenology is questioning how we think about the past but it lacks method to support those questions. I suggest that digital techniques provide a possible way forward. Visualisation provides a

way for us to produce high quality images of a past we have envisioned as a result of excavation, building survey, geophysics, archival research etc. Although visualisation has been embraced by heritage bodies as a method for display (Naimark 1998; Limp 2009; Anderson 2008) its use as a tool for research is just as engaging. The nature of the visualisation process forces the creator to make decisions and research the nature of each aspect of the space creating a dialogue between different disciplines about different aspects of the past. Although its theoretical background is less than simple (as will be discussed in the next chapter) it provides a new way of thinking about medieval domestic spaces allowing us to move beyond questions of meaning and function towards a multisensory engagement. In essence it provides a methodology for approaching the elements of experience in the past.

This chapter has introduced you to a basic structure of a late medieval secular building. It has then discussed how they have been approached theoretically by different disciplines. I concluded by suggesting that phenomenology seems to be the strongest theoretical grounding. However, it lacks in method to support its ideas. I suggest that digital techniques could provide that methodology. In the next chapter I move towards discussing digital technologies in more detail and how their use has been practically and theoretically critiqued.

Chapter 2:   Visual and Acoustical approaches

This chapter is a discussion of visualisation and acoustical approaches to archaeology. It will first introduce the background to digital media approaches, giving an overview of the development of archaeological computing as a discipline. I will then lead into a section on visualisation and the main issues encountered with the creation and use of this media. The focus of this will be on how projects have been planned, the population of images; the lack of life in visualisations and producing images for the intended audience. In this section I will focus mostly on virtual visualisations, such as those produced as part of the Portus Project (Southampton 2014), rather than all uses of visualisation. For example I will only briefly touch on the work of Alan Sorrell and traditional illustration (Perry & Johnson 2014).

I will then discuss the study of acoustics in archaeology. Unlike visualisation I will draw more intensively from case studies that are not digital but theoretical and experimental. The study of acoustics in archaeology has been limited, possibly constrained by the ocularcentric nature of the remains. Therefore it has been possible to present a comprehensive overview of the work in this thesis. This will lead into a discussion of perception and the move towards multisensory experience involving the idea of "*real virtuality*" (Chalmers & Zanyi 2009) and the perception of experience.

The chapter will then move to the question of uncertainty and how it has been approached in simulation of the past. This encompasses questions of the terms real, reality, realism etc. and the move to photorealism. It also explores the use of metadata as a means of justifying representations and how multiple visualisations or interpretations have been used to highlight uncertainty.

Finally the chapter ends by focusing on the perceived issue with ocularcentric approach to archaeological simulation and how my thesis aims to address this.

2.1   General background

Computers have been used in archaeology for over six decades with 2012 holding the 40th CAA (Computer Applications and Quantitative Methods in

Archaeology) conference. Originally this conference explored applications in data management and analysis but now it encompasses a huge range of different technology, techniques and methods including simulation, modelling, survey, web applications and data sharing.

This thesis is primarily concerned with approaches to simulation and modelling of the past. These have tended to take two routes: my interpretation of digital media (visualisation, simulation and cultural-heritage applications) and spatial technological approaches. These tend to focus on wider landscape through simulation and modelling of environments using geographic information systems (GIS). The two approaches can ask very similar questions and apply similar computing techniques but they are rarely considered together. There is an assumption that GIS focussed work does not ask the same kind of theoretical questions as digital media approaches which use a less quantitative approach. Traditionally GIS has tended to focus on theoretical issues concerning the meaning of space and how it can be understood quantitatively, while virtual realities focussed more on fidelity issues and the representation of the past. However, in recent years with the developing of modelling techniques, the two have been brought closer together with landscape questions exploring the experience of space (Lock 2003) and virtual pasts using 3D models as a basis for quantifiable analysis (Papadopoulos & Earl 2009). Neither of these approaches have been applied in detail to the medieval period.

The digital media approach has until recently been mostly concerned with the visualisation of the past through a variety of media. This has mostly been described as "Reconstruction" (see glossary for discussion) and is mostly made up of standalone images, websites, animations or virtual realities. It has met with much criticism from wider areas of the discipline, being understood as expensive, technically demanding and of little interpretive value (Goodrick & Earl 2004). The technology was driven by a "*this would be cool*" (Kantner 2000) mind set and an experimental approach. The results of which have meant that in most cases the aesthetics of the models are focussed on and have been produced *with* the intention of displaying results of data collection rather than as a method for interpretation (Gillings 2005). Exceptions include analysis projects such as those discussed by Wittur (2013).

This situation led to the assumption that display was the only use for computer-generated images in archaeology. Therefore the critique of these images has been towards their display of results, it has not been self-reflexive and has not led to the images evolving. Technologically produced visualisations fall into a void between technological products and subjective renderings of archaeological material. They engage elements of both practices but frequently fail in embracing the advantages of both. For example they do not engage with the ability to change and develop the renderings following presentation of the final image (Bateman 2000).

While being produced as a method for displaying results they are described as being "*self-explanatory and less theory-laden*" (Moser, 1992: 832). Instead the images need to be approached with the same critical eye that is applied to other areas of archaeological illustration. The process of engaging with images is the beginning, they need to be critiqued, explored and further developed before being presented. They also need to be engaged with in a state beyond the final presentation of results: they can be used to engage with, through the development of an interpretation and as a method for recording.

2.2   Visualisation

"*The visual image is […] a key element in the process of scientific thinking and discovery as such, not just as a descriptive afterthought or afterimage, but as a constitutive element, a speculative, theoretical construction*" (Mitchell 1998: 55).

The use of visualisation as a means of presentation has origins deep in the past. Even as early as the medieval period one can find depictions of Stonehenge (see Figure 24) (Piggott 1978: 8). This practice continues as antiquarians engage with early illustrations from the 16th century onwards (see Figure 25), discussed in more detail in Pearce's edited volume (2007), Piggott (1978) and Smiles & Moser (2005); and develop with the painting of sites in the romantic period through landscapes (see Figure 26) (Lewuillon 2002: 223). Early images are still engaged with today, when considering sites which have since been destroyed such as the Sanctuary at Avebury (see Figure 25). There is also the depiction of past events: a good example being Turner's Snow Storm depicting Hannibal and his army crossing the Alps (see Figure 27). These

developed into the first reconstructions, which still continue as a subject for artists today, the most celebrated being the work of Alan Sorrell explored through a project at the University of Southampton by Dr. Sara Perry and Prof. Matthew Johnson (Perry & Johnson 2014). He was particularly known for his images being rigorously researched while still providing the imaginative leap needed to bring the sites to life (see Figure 28 for an example) (Sanders 2013). There was also the 3D recreation of sites such as John Soane's architectural models of classical buildings (see Figure 29). Computer modelling builds on these approaches by allowing models to be built, analysed and adapted based on further research and reassessment without having to increase the cost of resources.

Figure 24: Stonehenge being constructed by Merlin in *Roman de Brut* by Wace produced between 1338-1340 (British Library, MS Egerton 3028, f.30) (BritishLibrary 2014b)
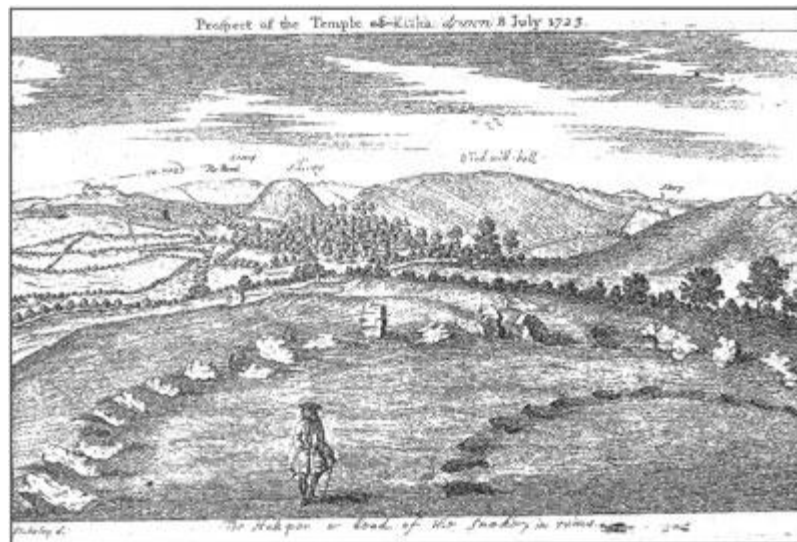
Figure 25: William Stukeley's depiction of the Sanctuary near Avebury. Since the Sanctuary has since been destroyed this is now one of the key references to the site (Avebury-web 2014)

Figure 26: Landscape of Bodiam Castle by Turner in 1817. Landscapes paintings show not only sites but also often include the working landscape surrounding them as well (TateLondonGallery 2014a).

Figure 27: Turner's Snow Storm depicting Hannibal and his army crossing the alps 1812 (TateLondonGallery 2010).
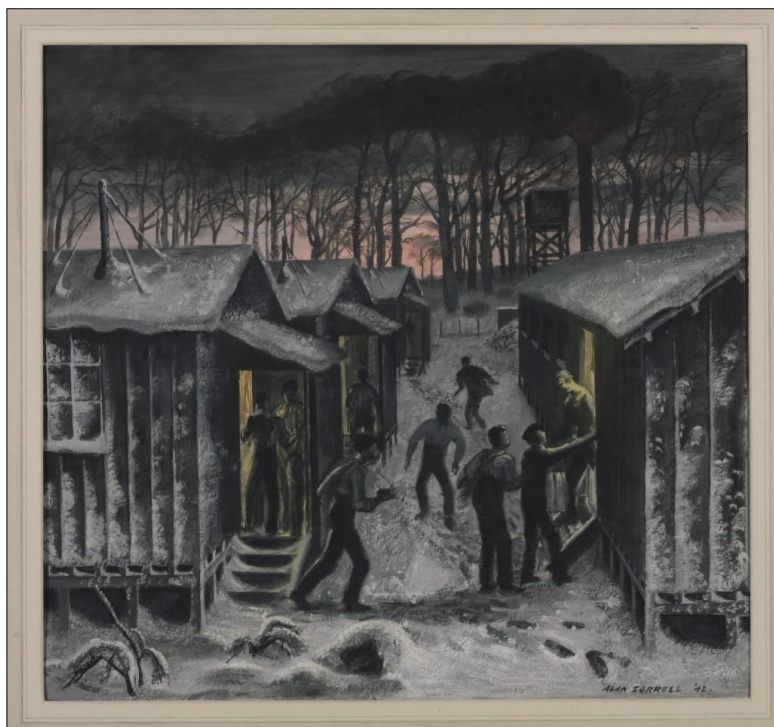
Figure 28: Alan Sorrell's Up in the Morning Early: RAF Camp 1941 (TateLondonGallery 2014b). Sorrell was one of the first archaeological illustrators who rigorously researched his visualisation of the past. His images

are famed for their feeling of life through his use of lighting and portrayal of people (Perry & Johnson 2014).
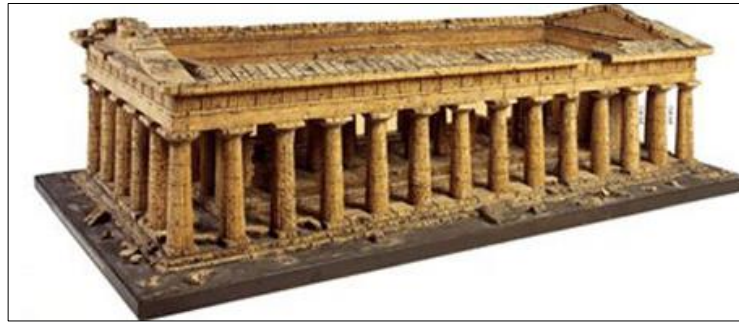
Figure 29: John Soane's cork model of the Temple of Zeus or Apollo. He used these as inspiration for his own architectural designs (Soane 2012) Courtesy of the Trustees of Sir John Soane's Museum

Beyond site specific images are also the illustration of other aspects of the past. Moser has analysed the presentation of past hominid societies discussing how visions of the past were inspired before a scientific understanding of human evolution existed (Moser 1998). Work has also focussed on the nature of archaeological illustration (Lewuillon 2002; Moser 2012), photography (Bohrer 2005) and graphical illustrations (Shennan 1997).

Methods for quantifying archaeology such as graphical techniques have been carefully explored and critiqued, as has the analysis of photographic techniques (Moser, 2001: 265). However other methods of representation (often those used in popular culture) have not, Moser states *"[it is assumed] that representations are unproblematic and that they do not require any interpretation*" (2001: 264). Images are used as a method of dissemination but they also produce knowledge about the past through a visual language of communication. Created images are often designed to give overviews of an archaeological period, activities, sites and/ or groups of artefacts (see Figure 25). They therefore frequently display a compression of these elements with artefacts, peoples and activities from a diverse range of locations and periods in time being represented as a single image (Bateman 2000). The consumption of the representation is often taken as fact; in essence the image is taken as the "real thing" not an interpretation of the data (Gillings 2005; Frankland 2012). They are therefore in need of critique just as are other methods of illustration, presentation and dissemination.
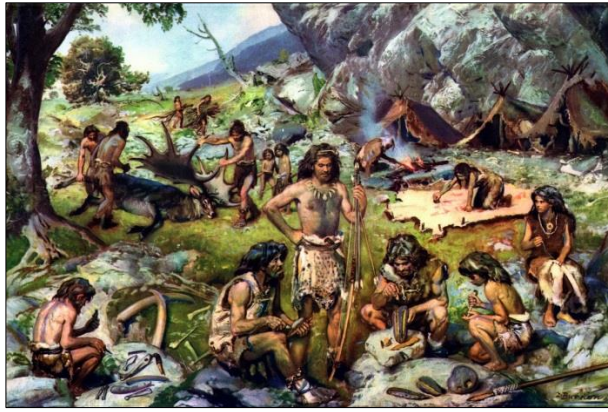
Figure 30: Illustration of "prehistoric man" produced by Zdenek Burian in the early 20th century (1zoom.net 2014). The images bring the past to life, however, present a view that combines multiple activities and artefacts from different periods. The image presented here also present a gendered understanding of the past with women undertaking the domestic task while the hunting, gathering etc. are undertaken by men.

With the beginnings of digital representation (the technology allowing the generation of multiple images or other methods of presentation) it might have been assumed that these issues would fade away as the critique of other computing techniques had been intensive. However, this was not the case. The role of archaeology in the application of computing has, like most new technologies, taken second place with other disciplines taking the lead. So specialists with backgrounds in computing or electronics became involved with interdisciplinary projects and the critique of the results is not intensively archaeologically based (Goodrick & Earl 2004). As stated above this led to a series of images in the world of popular culture being produced with less of an aim towards historical accuracy and more towards the aesthetics of the image (Martinez n.d.); (Moser, 2001: 271) the common example being "*The Mummy*" (see Figure 31) where in it is meant to show Thebes, yet Pyramids from Cairo (800km away) are also shown. One could argue that authenticity does not have a role in popular culture but at what point should a line be drawn? The application of technologies without thorough analysis of their potential has led to their utility not being fully realised and limiting their development and engagement with them as a result (Gillings 2005). National Trust sites, such as those I am working with, are public sites. They are visited by members of the public and consumed in a comparable way to films. Therefore by the same

reasoning should visualisations produced on behalf of the National Trust for interpretation also be concerned with authenticity?

Figure 31: Still from *The Mummy*. This scene is meant to show Thebes. However the background shows the pyramid of Giza found in Cairo 800km away (Sommers 1999)

Visualisations were seen as just a method for presenting results and digital imaging had the added interest that it allowed the creation of ingenious pictures (Gillings 2005). They were the last stage of conclusion and inference as a method of presentation for large architectural features (Hermon & Fabian 2000). This could be referred to in the same way as Tufte (1983) refers to *chartjunk* in his work on information design, whereby elaborate images are used to obscure a lack of information. Where experts in data visualisation such as Tufte (1983) and also Shneiderman (Card et al. 1999) have already highlighted this, archaeologists have yet to embrace their expertise. Instead, we need to consider the technology as an opportunity effectively to model and simulate real-world processes in order to understanding complex interactions of humans in their environment (Zubrow, 2006).

The aim of image makers to represent reality (see glossary for a discussion on real, reality and realism) as closely as possible has been a focus of archaeological representation. Since the emergence of digital imaging, photorealism has been the intent of visualising the past: these images aim to look like photos (Goodrick & Earl 2004). This creates the impression of the places being "real" and existing. Presenting images in this detail provides them with a level of authenticity that makes them increasingly engaging; allowing

them to be consumed by a variety of different audiences without having an underlying knowledge of archaeology or representation. Chalmers (2002) was the first to create images with physically accurate lighting (lighting conditions that mimic the real world, sunlight and shadows). His intentions were to create a "sense of place" for the sites or artefacts that were being detailed by making them "feel" more like the real world (Chalmers 2002: 7). The idea of perception and "feeling real" will be discussed below in section 2.3. Chalmers means that the impression of the place seen in the image more closely represents what we would conceive of as reality or real world as we see it today. Sense of place means a feeling or acceptance that the image we see in front of us is a real place. Without correct lighting conditions the sites fail to look authentic and as such aspects of the original sites are not realised or experienced by those viewing them (Sundstedt et al. 2004). This links to the aims of realism in the creation of virtual images. Below I will discuss issues that are encountered with photorealism and the intention to produce photorealistic issues. It could also be argued that the need for physically accurate lighting etc. is not necessary to produce an engaging experience.

The game Minecraft has provided a different mechanism for engaging with sites and places digitally. Minecraft is a game which allows, among other things, for people to build structures in a variety of virtual environments (Persson 2009). This has led to the creation of heritage sites, museums and places which players can visit and explore (Clarke 2013). The popularity of the game provides accessibility and an engaging experience without visualising places in a realistic way (Anstey 2014).

Visualisation projects with the intention of producing photorealistic images tend to have two aims behind them: either to represent artefacts in their context (Zányi et al. 2007) or to correctly relight sites, for example, examining Upper Palaeolithic cave art under candlelight (Chalmers 2002). In particular Palaeolithic cave art studies had very compelling results. Cave art sites tend to be displayed under bright electric lighting instead of candlelight. The flickering nature of candlelight gives the paintings and engravings the impression of movement which is lost when presented out of this context. In another similar study the combination of natural lighting from the roof and candlelight in Byzantine churches made icons (currently displayed in museums) appear to have glowing halos (Devlin & Chalmers 2001).

The work of Chalmers, Zanyi, Sundstedt et al. also raised questions about moving beyond the open spaces of a building. As soon as a room is furnished the nature of lighting will change as will the perception of a space (Devlin & Chalmers 2001). Thus, questions arose about how using visualising technology can be used to explore the use of space within a building i.e. can be used to assist interpretation. By modelling and analysing lighting conditions, spaces can be assessed to see whether specific tasks are possible within them. When combined with the material remains this allows spaces to be reinterpreted. An example of this is the work undertaken by Papadopoulos & Sakellarakis on a ceramics workshop in Greece (2010). By exploring both the conditions required for the creation of ceramic vessels (through an ethnographic study) and a lighting analysis of the building they realised that there was not enough light for the building to be a ceramics workshop: therefore their original interpretation needed to be revisited. In this context Devlin and Chalmers (2001) highlighted the fact that it was not necessary to aim at photorealism of physical accuracy for this type of analysis (Papadopoulos & Earl 2009). Conclusions can be drawn based on the accuracy of the evidence provided and can be used to inform interpretations. As with all archaeological work the evidence has to be carefully assessed before deeming the level of accuracy the analysis can provide. Lighting analysis can allow the use of spaces to be reassessed without making them appear "real" or produced for aesthetic reasons. However, it does require materials to react in a physically accurate way.

Using these technologies to explore the use of space has more applications than just creating physically-accurate lighting. How furniture and fittings were applied and their uses can be explored by means of visual presentation and manipulation of spatiotemporal data (Tost 2007). Once furnishings have been positioned one can begin to question ideas about place and memory linking into how we perceive space.

In section 1.2 I discussed the use of access analysis and other techniques based on plans of a building. They lack the ability to explore how furnishings and fittings affect the experience of spaces. Including furnishings provides a starting point to explore the medieval experience which more closely aligns to our own understanding of space and place. This can be furthered by repositioning objects to re-question and re-address the interpretation (Gillings

2005). Virtual Reality offers a method of approaching both Euclidian and Cartesian data by allowing the construction of computer-calculated spaces, which can be explored to understand how spaces are perceived in the present as well as the past. Alongside this we can look at the idea of space not just as spatial data but as a social construction linking together spatial, temporal and behavioural simulation (Tost 2007).

2.2.1   Intended Audience

I have demonstrated above that visualisations can be created with different intentions and as such they require different focuses and therefore different audiences. A major reason for this scepticism in the creation of models is that they are often produced with no audience in mind. Research questions require specific approaches depending on the intended audience (Sundstedt et al. 2004). The approach taken will have to question what the model is intending to show and why / what the social context for the image is and how it is being approached, and what other data is required to accompany the image (Bakker et al. 2003).

The three main intentions for the use of digital media are teaching, research and public consumption (Kantner 2000). The presentation of a model is central to each area and requires different accompanying material and a different mode of presentation in each circumstance. In reality it is the research questions that offer the least complication. Models produced for research purposes will already have justified the use of visualisation and the intended audience will be other academics. Models of this type will be presented in a method that discusses the modelling process or research associated with it highlighting the aims for creation. Examples for this include work on the Herculaneum Amazon head by Graeme Earl (Earl 2009) and Gareth Beale (Earl et al. 2009), Heather Papworth's work on colour in virtual models (Papworth 2004), and Earl and Papadopoulos work on lighting conditions (Papadopoulos & Earl 2009).

It is the use of visualisation as teaching material and public consumption that post more problems. Teaching material requires questions to be asked about the nature of the engagement intended with the images. Do the images allow students to question their construction or are they designed to tell? When the

material is being used for teaching purposes, the choice of objects within the image has to be carefully analysed - whether the object's presence implied definite presence in the location or time period. This questions whether all teaching materials should come with an accompanying description of underlying archaeological and interpretive decisions. Furthermore, do these questions undermine the student's imagination and interpretive skills: can the creation and use of digital models be implemented as a learning experience (Kantner 2000)?

Images produced for public consumption are mostly designed to inform, but how much data is it possible to include to accompany the image? Uncertainty, reality and multiple interpretations of the past will be discussed in the next chapter as methods for approaching how we present models of the past. This will highlight the problems with presenting in an image the difference between the "real" and an interpretation (Eiteljorg 1998). How can we inform at the same time as emphasising that the results are only one interpretation of the data.

2.2.2   Populating Images

Another aspect to consider when creating images is the inclusion of people. The majority of digital visualisations are not populated. As archaeologists we tend to study the past through material remains so we tend to focus on objects, buildings and sites forgetting that they were once created, used and inhabited by people (Tost 2007). Thomas & Jorge (2008) has suggested that this demonstrates an intention to objectify the past by presenting it in an uninhabited state. However, by presenting our visualisations unpopulated we project a dissocialised, inaccurate interpretation of the past (Bateman 2000). In essence a less human experience of the past.

Many visualisations do not include people due to time constraints (Watterson 2010; Whittaker 2011) or due to the difficulty creating realistic characters (Chalmers & Zanyi 2009). Unlike in the creation of images of buildings, objects and sites, where photorealism is an option, the creation of believable people is much harder. If one was to introduce a visually weaker aspect to the image it would draw away from the rest of the visualisation. A hypothesis put forward by Masahiro Mori (1970) known as the "*Uncanny Valley*" puts forward an

explanation for this. The hypothesis came out of work in robotics, and suggests that the greater the resemblance of a robot to a human the more positive a human will react to them until a certain point where the response becomes one of repulsion. It is described as a valley due to the shape of the function that a graph plotting Human Likeness against Familiarity (See Figure 32)(Mori 1970).
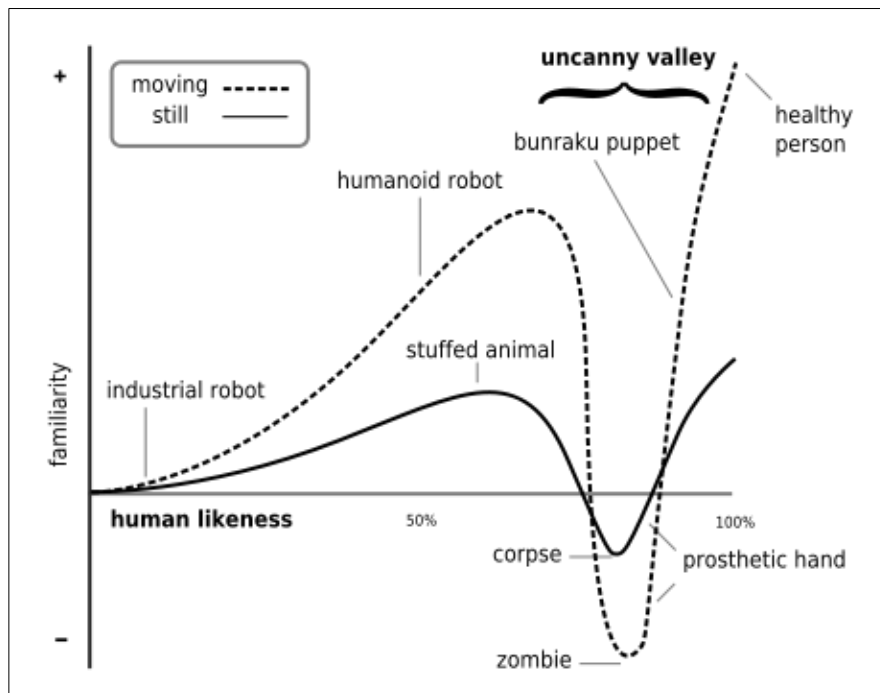
Figure 32: The uncanny valley (Mori 1970). This shows the phenomenon of representing people. There is a point where something is very close to representing human likeness where people become very uncomfortable with what they are observing.

In a still image the lack of movement relieves some of the uncomfortable emotions associated with images of people. However, in these still images people become a decorative feature not agents of change within a scene (Tost 2007). There is a balance which must be reached between providing a populated view of the past without unsettling the viewer in photorealistic portrayals of the past.

2.3 Acoustics

"*A general characteristic of contemporary society is our fascination, indeed obsession, with the visual*" (Moser 2001: 266)

This chapter so far has been primarily concerned with the visual and the visual simulation of the past. Unsurprisingly, when 60% of our mental processing power is devoted to visual processing (Hermon & Fabian 2000) we are programmed to experience the world in a visual way (Ray 2008).

But the world is not normally experienced in a visual way alone. Our understanding of the world is based on all of the senses in combination not just one isolated (Chalmers & Zanyi 2010). This is not the only reason it is a focus in the wider field of archaeology - there is a huge amount of visually engaging material left behind whereas smells, sounds and tastes have gone (Dawson et al. 2007).

A primary theme in the subject of digital media applications is to begin to explore a multisensory experience of the past. The first applications of GIS were critiqued as being "*primarily visual and distanced*", far departed from the way past communities would have engaged with the landscape and environment (Thomas & Jorge 2008: 1). Instead, technological approaches should be complemented by a more humanistic experience of place. When discussing societies whose sensory map is different to our own this becomes particularly relevant.

Dawson et al (2007) have explored an example of this with the study of light in Arctic dwellings. Although approached from a visual perspective, the authors highlight that vision cannot play a key role in the low lighting environments of winter in the Arctic. The article concludes that tactile senses would have been crucial in the undertaking of tasks in winter as the ability to see would have been limited. The paper shows the need to examine sensory perception from a wider theoretical perspective. Although visualisations can give an understanding of how the spaces would have felt from our modern perspective i.e. how we would perceive the past *not* how the people of the past would perceive it, the lighting distribution gives the visualisations a sense of place. However, this would not give an understanding of the limitations such darkness would give (Dawson et al. 2007).

The world around us is multisensory. In the creation of visualisations we are creating a past that is "*silent, odourless and intangible*" (Mlekuz 2004). Although visual analysis of the past is the most accessible today, Dawson's

(2007) example shows how we can use visual analysis to explore the other senses thereby presenting a multisensory past.

There has been a move to try and embrace the study of the senses in archaeology both as a method for simulating past experiences as well as exploring how the senses were perceived in the past. When simulating the past through senses other than visual, they are portrayed with accompanying images, as without the visual they lack the authenticity required to make them believable (Thomas & Jorge 2008).

In this section I will introduce the work that has so far been undertaken to explore sound in the past, mostly referred to as Archaeoacoustics. This includes both digital and non-digital methods. I will firstly give a literature review which will be divided into two sections: the first discussing all work undertaken in this area; and the second the theoretical implications of this. I will then turn to discussing how acoustics are approached from an acoustical engineering and architectural background. For a summary of the work undertaken in archaeoacoustics at heritage sites see Figure 33.
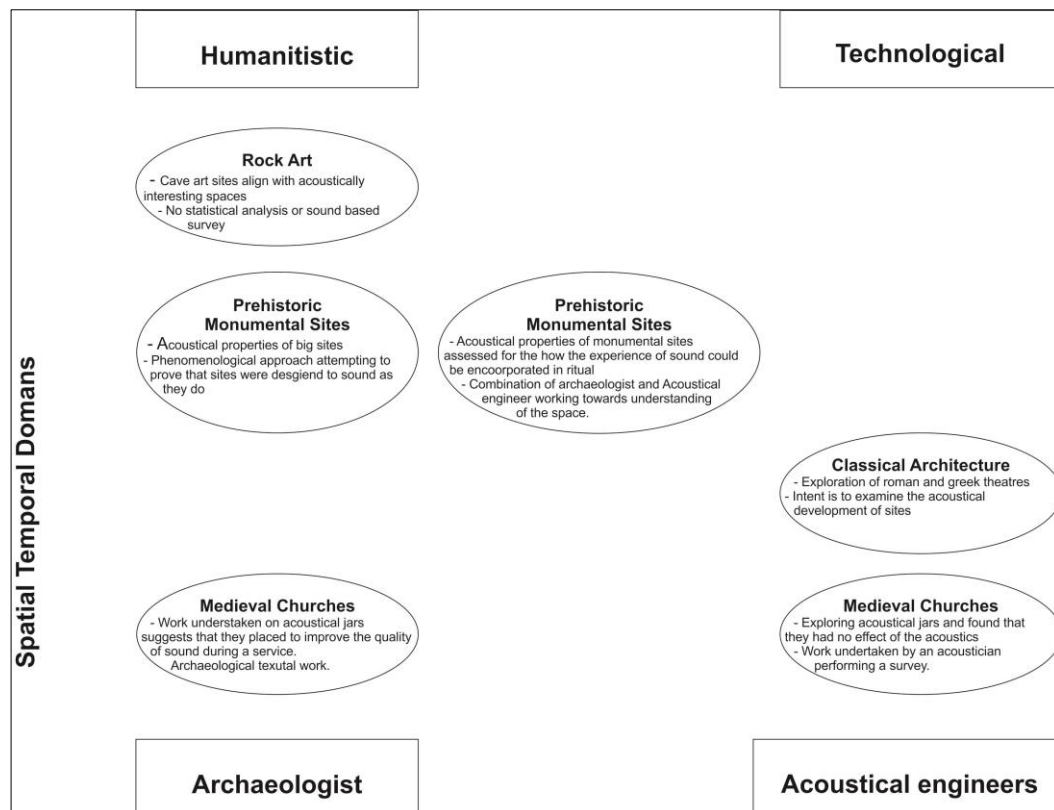
Figure 33: Diagram demonstrating the state of research of archaeoacoustics. Details the work undertaken from different parties with an interest in sound in the past

2.3.1 Literature review

Studies of the senses in the past have been limited primarily to research focusing on the visual. Work on sound, acoustics or hearing, although present in the literature, are widely spread and focus on a number of different areas of archaeology and the past. Discussing it is problematic with work being divided across the discipline in a number of ways. I could approach this review by concentrating on the divide between work undertaken by archaeologists and acoustical engineers/ computing specialists or on the development of the study of sound. Instead I am going to explore how sound has been explored across different periods. I have chosen this method as much of the work done in the area of archaeoacoustics explores the idea of intentionality with sound. This study is a work on places as a setting to explore sound, as such I am not going to discuss in detail work undertaken exploring sound makers

(instruments, voices or sound created as a by-product to another action). Instead this section will give an overview of the literature exploring buildings, caves, monuments and landscapes. Having focused on this I will then be able to critique past approaches and discuss theoretical constraints which emerge when discussing other divides in the study of sound in the past.

Architecture, both natural and of human construction, alters and creates particular effects that shape the acoustical experience of a place (Scarre & Lawson 2006: viii). Work on places has taken different approaches and focussed on different aspects according to period, for the Palaeolithic (and later periods) a large body of work has explored rock art, prehistorians have tended to focus on monumental architecture while work on the medieval and classical periods has looked as standing remains and buildings.

Palaeolithic research has explored the meaning and reasons behind the creation of rock art, why, where and who produced it. One of the theories that has come to be prominent in more recent studies has focussed on the role sound had to play in site selection, or how the experience of these places involved a multisensory experience beyond the role of the visual. Chalmers discussed the role of the visual in reference to cave art and the need for realistic lighting in the visualising of these sites (2002) however, acoustical research now suggests that beyond the visual, acoustics had a huge effect (Kleinitz 2010; Reznikoff 2008; Reznikoff 2006; Waller 1993; Waller 2006).

Papers exploring rock art sites primarily use abstract constructs such as "*ritual*" (Cross & Watson 2006: 107), "*celebration*" (Reznikoff 2006: 77) or "*mysterious phenomena*" (Waller 2006: 32) as explanations for context or content of these Palaeolithic paintings. Waller, for example, highlights the fact that explanations involving/ invoking hunting magic are inconclusive as the pattern of decorations and locations does not fit, while art for art's sake does not explain the unusual locations selected or patterns of decoration (1993). Waller is unusual in attempting to highlight how culturally selected locations can be analysed statistically, and looking for a scientific method for exploring something which was previously considered too subjective to observe (Waller 2006). He suggests that a formal study of acoustics is required, as until now these properties of sites have never been recorded but only commented on in a subjective manner. His approach uses statistics to highlight that there is a

"*statistically significant sound reflection*" frequently found at Palaeolithic art sites. He also goes further as to comment on the content of the paintings and how this is affected by the context.

Reznikoff also looks at resonance and echoes in relation to these paintings (2008; 2006). He has studied the resonance of stone in cave sites to explore the link between stone types (more or less resonant) and distribution of cave paintings. In different papers he suggests that these paintings have a ritualistic and celebratory significance and are used for singing and celebration (Reznikoff 2008: 4138) or, alternatively, that it is impossible to "know" exactly what these spaces were used for (Reznikoff 2006). Importantly, in the discussion of lived experience, he discusses the use of sound as a method for replacing vision in areas of very low light. Light does not travel well in caves especially when we remove modern electric lights and torches. Even with candle light or lamps vision is much reduced. This is especially true in areas of caves with restricted access, requiring one to crawl or scramble, where lamps or torches could not be carried. This highlights that gaining understanding of the space is particularly challenging as it requires an entirely different working knowledge to perceive and understand the site than how we would move around and understand the site today (Reznikoff 2008).

The writers of these papers had not approached enough sites to quantitatively assess the results i.e. they had selected sites based on observations of rock art and acoustical phenomena and had not taken a random sample of cave sites.

These are two Palaeolithic examples but these approaches have been taken to examine rock art sites in other periods. Kleinitz discusses the relationship between rock art and zones of percussion in the fourth Nile cataract during the 3rd or 2nd millennia BC (Kleinitz 2010). Goldhahn explores the non-visual experiences and perceptions of humans in Neolithic Scandinavia. He uses philosophical ideas from Marx. For example "*an object is perceived differently by eye and by ear. So the object of the eye is a different object than that of the ear*" (Marx cited in Goldhahn 2002). Utilising this observation he presents an audio-visual perspective to encompass not only sound and vision but consider ephemeral experiences when interpreting rock-art sites. He suggests that when undertaking fieldwork multisensory phenomena should be recorded alongside the visual. Finally Waller moves away from discussing purely Palaeolithic sites

and takes his work to that of painted rock sites in Arizona. In this paper he suggests that acoustics may have been a motivating influence for the production of rock art (Waller 1999) his argument is the same, that locations are selected based on their acoustical properties and these often influence the subject of the paintings.

Prehistoric monumental architecture is another key area of study in archaeoacoustics. There has been a huge focus on trying to understand the experience of sites such as Stonehenge, chambered tombs and other standing stone sites which have started to break into looking at the soundscapes of the wider landscape. Two studies began independently in the 90s: one, working considering artificially constructed spaces according to their acoustical properties (Watson & Keating 1999) and a second project wishing to explore whether megalithic tombs were created in shape and dimension to make sounds from ceremonies and chants as strong and resonant as possible (Devereux 2001: 76-7).

Aaron Watson has undertaken a number of studies at prehistoric monuments around Britain focussing on how despite their dominance in the landscape visually and spatially they have rarely been considered in their acoustical setting. He suggests that at most sites the acoustical setting was not intended, however, properties were manipulated to orchestrate the spaces. He records primarily the acoustical properties at two sites in Scotland, a stone circle (Easter Aquorthies) and a passage grave (Camster Round). They were selected due to interesting acoustical properties that had already been observed at these locations and there was the potential for recording these properties. They highlighted that today we experience monuments in a totally different way to how they were in the past. Peaceful stone circles and quiet passage graves could be transformed into settings for sound effects and acoustical performance. An important factor in these studies of artificial structures is that intention to produce these effects is considered. Watson highlights that it cannot be proved that these acoustical effects were intended but we can say that they were probably exploited (Watson & Keating 1999).

Devereux began work investigating the acoustical resonances of a sample of megalithic chambered mounds (mostly passage-graves). The technique which has been employed at these sites has been to use a speaker and microphone

to record the acoustical properties. Then these are analysed, creating a less personal technique than employed at rock art sites. Work undertaken here and by Watson employs a combination of both phenomenological techniques within the technological setting (Devereux 2001). I feel that this technology is not always employed correctly. In both instances they use an omnidirectional speaker (Devereux 2001: 80) to create noise in all directions. However, both discuss the spaces in terms of chanting or singing: noise which can only come from one direction (the mouth of an individual), meaning that the sounds being recorded are affected by echoes or resonance that would not have been possible in prehistory. However, he did discover a pattern in the results highlighting that the resonant frequency of all the tombs he observed fitted into a narrow band that could be excited by a baritone voice. However, this is hard to test, performance will lead to the modification of a sound to exploit the acoustical properties of the space, it is not a static process. He suggests this is by design (Devereux & Jahn 1996; Devereux 2001). Whether this is the case or it is an effect that has been exploited and refined over a series of buildings has yet to be debated.

Stonehenge was also investigated by Watson as part of their project studying Neolithic monuments. Their findings highlight changing acoustical conditions inside and outside the, now ruinous, circle. They then move to explain the potential reasoning for this and whether this effect was intentional. The effects themselves cannot predict this; however, the stones have been intentionally shaped in a way which improves their ability to reflect sound (Watson 2006). His paper then moves to discuss the fundamental nature of our study of sound in the past which I will consider in depth in the next section.

In progress is the landscape-perception project being undertaken by Paul Devereux and others. The project takes two approaches to explore the natural sounds and acoustical properties of monuments and other sites. This is undertaken through the investigation of the acoustical parameters of a place by use of electronic instrumentation. The aim is to explore direct sensory ways of perceiving landscapes and to record those explorations. Work has been undertaken at a number of sites and explores the overall experience of sound at these sights, towards a multisensory approach (Wozencroft & Devereux n.d.).

Moving out of prehistory a series of projects have been undertaken on buildings from the Graeco-Roman world and then later medieval buildings. These projects all tend to have similar aims looking towards exploring the development of their construction in reference to sound or how sound is projected within them. These are often undertaken by acousticians rather than archaeologists with a research interested in the acoustical properties of the space.

Two papers have emerged from non-archaeologists exploring Greek and Roman theatres. The first by Rocconi (2006), discusses the documentary theoretical sources as a crucial aspect of their construction as opposed to a totally empirical examination on the spaces. In comparison a paper in the *Journal of the Acoustical Society of America* explores the transition from Greek to Roman theatres through a series of computer models. Both highlight the interesting spaces and how acoustics played a major role in the experience of these buildings (Farnetani et al. 2008).

A similar approach also undertaken by acousticians has been to explore the acoustics of St. Peter's Basilica in Rome. This paper (Martellotta 2009) compares a series of approaches: Acoustical survey, Geometrical modelling and Statistical modelling, to find the best way to explore very large spaces which contain interesting surfaces, with the aim of exploring why the space has a particularly low reverberation time.

Acoustical studies have a particular interest in religious spaces, especially churches and mosques. There are a series of papers discussing comparisons between ancient and modern buildings of these kinds. These papers explore how spaces are maintained, restored and conditioned for new use in older buildings (Galindo et al. 2009) while comparing them to newer buildings which have been built towards the same acoustical functions (Zerhan & Sevda 2002).

Other explorations of ecclesiastical spaces have been undertaken by archaeologists and acousticians working in collaboration. One of the pioneers in this field is Damian Murphy (2006) working with sites of interesting acoustical properties of archaeological importance. His work is not directly based on furthering the study of acoustics in archaeology but rather combines the aims of expanding a library of virtual acoustic spaces while at the same time creating a record of unique acoustical spaces for preservation purposes.

These aims allow another remit of using the results of these surveys to allow further interpretation of historic buildings and sites from an acoustical perspective. He explores different types of space (a church, mausoleum, chambered cairn and cathedral) using an approach focussed on impulse response and how it can be applied with an aim towards auralization (Murphy 2006).

Other people have also examined specific features from churches and cathedrals namely focussing on so called acoustical jars (see Figure 34 and Figure 35) and the apse of churches (Figure 36). Acoustical jars are ceramic vessels which have been set into walls in medieval churches as seen in Figure 34, they were designed to improve the acoustical quality of a building (Crunelle 2005). They were inspired by the work of Vitruvius who discusses the use of tuned bronze cases in Greek and Roman theatres (Godman 2007). Reznikoff (2006) discusses both in reference to planned engagement with acoustical spaces. His analysis of acoustic jars highlights how these devices are meant to have the effect of improving the resonance of sound in churches. However, Murphy demonstrates that at St Andrew's Church, Lyddington they do not respond as predicted and in fact have very little effect (Murphy 2006). Whether this is an isolated example where they do not respond as theorised is unclear.

Figure 34: Acoustical jars in situ at St Andrew's church in Lyddington (Murphy 2004). The concept of the jars was designed by Vitruvius to make sound

resonate in the space. This is an example where they have been created to that plan but the results have been unsuccessful.

Figure 35: Close-up of the acoustical jars at St Andrew's Church in Lyddington (Murphy 2004)
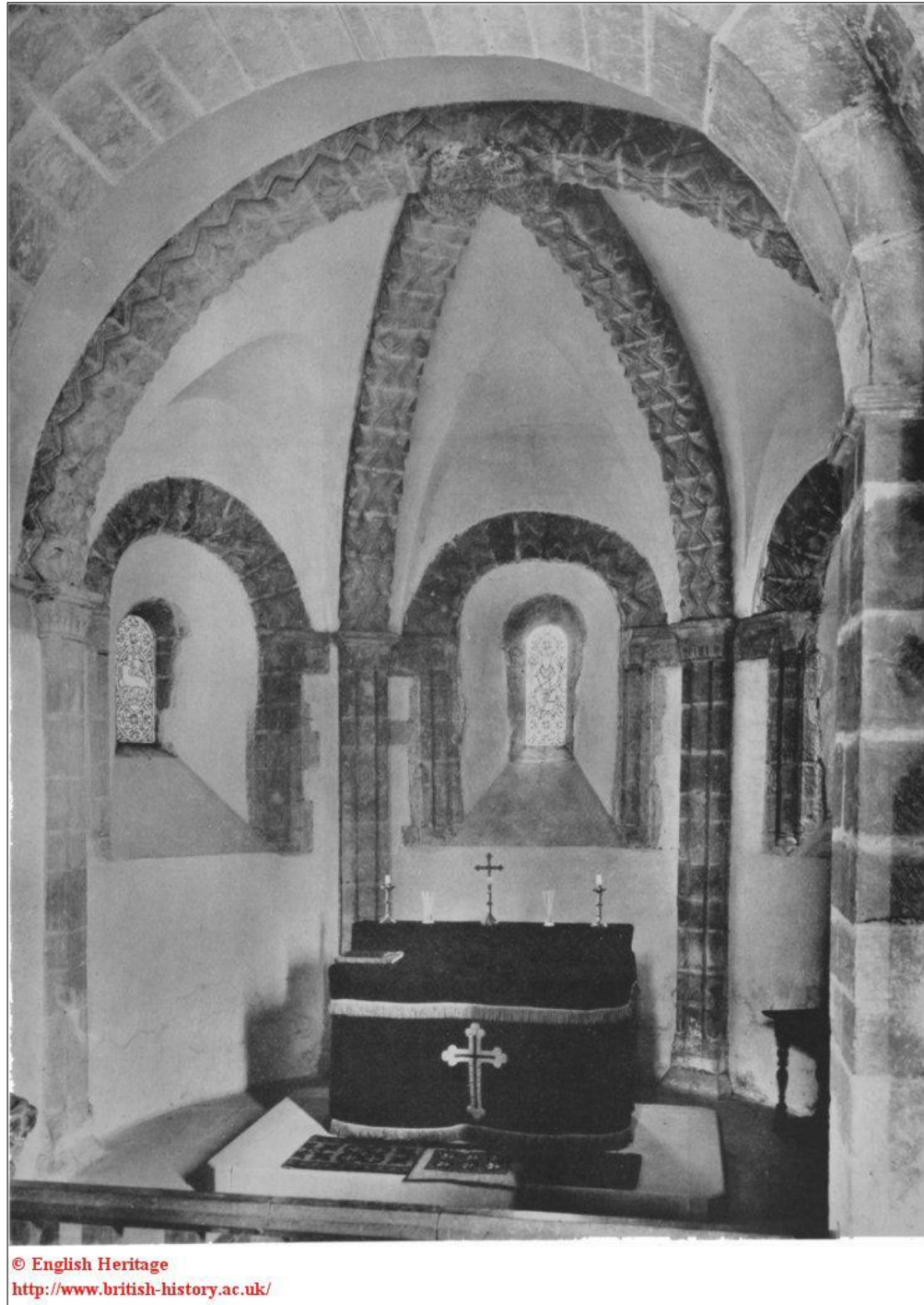
Figure 36: An apse at Kilpeck Church (BritishHistoryOnline 1931). This is a semi-circular recess often found in churches. The apse is a half dome found behind the alter. Its curved shape focuses sound coming from below it allowing it be amplified down the rest of the church. When found in association with vaulted ceilings a voice is projected in such a way that the resonance and the harmonics give the impression of a choir

The apse however, is a feature which has an obvious acoustic effect. "Apse" translates to circle or vault from Greek and Latin. Its use refers to curved surfaces in architecture. The apse is a half dome found behind the alter. Its curved shape focuses sound coming from below it allowing it to be amplified into the rest of the church. When found in association with vaulted ceilings a voice is projected in such a way that the resonance and the harmonics give the impression of a choir (Reznikoff 2006).

These studies have all explored religious spaces or public spaces. There are very few engagements with domestic structures. Lawson has discussed Scandinavian timber buildings with a suggestion that their design aimed to encourage the acoustical resonance, however, he has not modelled the buildings in detail and his ideas are supposition (Lawson 2006: 88).

The other approach to exploring sound has been through archival work. Woolgar has engaged with the senses in late medieval England. His work focuses on how engagement with senses can be traced through archival sources and how it has changed from today. An example of this type of work explores the nature of reading, in the medieval period all reading was done aloud and most people would only hear readings in church. Hearing was the sense through which the word of God was conveyed and therefore understood in a different way to how it is today (Woolgar 2006: 64-5). Today it is considered secondary in importance to vision in nearly every walk of life.

Beyond these approaches there are also a few computing based approaches to sound in archaeology which do not tend to appear in the general literature concerning acoustics. There have been applications to explore acoustic space by looking at the profile of sound over a landscape. In this instance Mlekuz (2004) acknowledges that in actuality, to *see* something is entirely different to hearing it, as sound has to be actively produced whereas for an object to be seen requires no effort. In this sense there is more than one type of sound – those in the foreground and those in the background. There are sounds that are created to be heard and those that are created as a by-product of the activities of daily life. The sounds differ based on who is hearing it, and to actively explore the sound space being created, one has to include and acknowledge both types of noise (Mlekuz 2004).

The digital side to archaeoacoustics has involved the acoustical survey and modelling of spaces. These can then be compared, contrasted or refilled with sound (auralization). By modelling the acoustic spaces Murphy's (2006) intention was to provide some insight into the nature of the construction of the building and the characteristics of the space. Another aim is that through the refilling of these rebuilt spaces with sound a more informative visitor experience will be reached. By expanding the results beyond research into visitor experience the ability of sound to create a new understanding of the sense of place or space by manipulating its acoustic properties can be explored (Murphy 2006).

As discussed in section 2.4, experience now and in the past is multisensory. The study of sound in the past is gaining substance with work becoming more popular and mainstream, the radio documentary NOISE (Hendy 2013) traced the origins of sound back from the Palaeolithic through to the modern day. However, we need to move beyond methodology and experimental work into exploring the theoretical constraints of studying sound in the past.

2.3.2 Theoretical issues

Devereux and Jahn said that the reason sound has been overlooked in archaeology is "*it is instinctively felt that sound is too immediate and ephemeral to have significance for archaeological investigation*" (1996). Unlike when exploring the visual or tangible remains of the past sound does not leave a mark. It has to be studied indirectly through recreation of soundfields, the soundmakers or experiences. Since then the study of archaeology has moved towards trying to explore the experience of the past through phenomenological discourse critiquing its overly visual methods (Hamilakis 2002; Weiss 2008: 15). Through these studies, focussing on the ephemeral or intangible, such as work undertaken by Daisy Abbott of the Glasgow School of Art (Hamilakis 2011) aspects of the past have become more important to archaeological investigation. These include papers discussing Oral Histories, Echoes and weather which have no method for quantitative enquiry but engage with the lived experience of the past.

When beginning to think about studying acoustical properties it is important to think clearly about intent. At Bodiam an echo from the top of Dokes field has

been recorded by a number of antiquarians, however it is unlikely that this was foreseen as part of the buildings construction in the 14th century. It is very easy to attribute acoustical properties as intentional in the construction of a space. Scarre (2006) demonstrates on a number of levels how this is something to consider more deeply through a few examples. St Paul's cathedral is a good example of a clear acoustical feature that was not intended in its design. Following its construction it was discovered that a whispering gallery occurs around the base of the dome where whispers can be heard on the other side of the space some 30m away, but it was not intended in the original design. Another example is the appearance of vaulting in wealthy cathedrals and monastic houses, probably in association with the founding of the Cluniac monastic orders. The association is due to the rich history of impressive religious ceremony which included lots of singing and chanting, which is considered at its most beautiful when sung in vaulted spaces. However, another advantage of stone vaulting is it was also a method of fire-proofing. So it is hard to prove whether it was a result of it creating the desired acoustical effect or purely a safety precaution (Scarre 2006).

A different exploration on intent illustrates that we also need to consider whether intent is the same across cultures. Watson demonstrates that our western understanding of intent does not fit with every society: in terms of sound at Neolithic monuments a design might be adopted but not always because of improved function but also for "ritual" reasons. There might also be an element of intention that our modern mindset cannot predict or that motivation for innovation came from multiple intentions (Watson 2006). We can compare this idea of innovation from multiple intentions to the development in castle studies discussed in Chapter 1. Bodiam highlights that castles were not developed with a single intent in mind. Its creation and use was for multiple reasons not just military in the same way that Neolithic monuments were not developed entirely based on their acoustical properties. A technologically determinist approach cannot be assumed, the design is not focussed purely on the improvement of the defensive features but a series of social factors are also involved. Another example is Lower Palaeolithic giant handaxes which are too large to effectively use and therefore have been created for a use not technologically derived (Wenban-Smith 2004). In both of these examples the technology (castle or lithic) has been developed towards

aims that are not defined totally towards ease of use. Instead there is a social element involved that cannot be explained without knowledge of intent of the creators. Castle studies has largely accepted this concept and has, as discussed in section 1.3, moved towards understanding buildings according their lived experience instead of use and meaning.

Sound, however ephemeral it has been considered, is becoming something that we can engage with on a quantitative level, which has been the main critique (Till 2014). Although the earliest studies of quantitative acoustics for architectural purposes were undertaken early in the 20th century applications in archaeology have been slow and not adopted as quickly as visual techniques.

This focus on the visual (discussed in more detail in section 2.4) as encouraged the lack of engagement with sound and acoustics. Visualisations can now integrate sound, this is often the case in museums and cultural heritage settings. However, no matter how carefully the visualisation has been researched the sound has rarely been approached with the same rigour when used at all. For example in medieval ecclesiastical settings Gregorian chanting is employed as background noise ignorant of the correct style, setting and use. Equally the audio background to prehistoric sites is filled with sounds produced by instruments found from mainland Europe (Till 2011). If our visualisations are being critiqued in even more depth than ever before, with a greater focus on academic integrity, the same has got to be true of the sound and other senses they include.

I have already discussed how the origins of visualisation were based in computer science rather than archaeology. The same is true of auralization and acoustics. When working with new techniques and equipment there is a preference to trial in interesting spaces (Murillo Gomez, 2012: P. Comm). This causes issues when trying to undertake archaeologically significant work as well, as the techniques employed do not always take into consideration archaeological limitations and the nature of the evolving site. This is also an issue when it comes to site selection, as papers tend to only explore the unusual or monumental sites. Engagement with everyday places and spaces rarely occurs and as such does not add to our understanding of everyday life and experience when only focussing on the ritual. The same is true when

working with archival sources; the sources focus on high status ritual and do not explore every day experiences or noises.

This lack of engagement with the everyday continues beyond site selection. Sites are not explored as a whole but instead focus purely on the areas of the site where acoustical phenomena occur. If not they also only look for acoustical phenomena in areas of visual interest, such as in the paper by Cross and Watson where areas with and "impressive visual backdrop" are focussed on (Cross & Watson 2006). The same is true of rock art sites, the major critique of the papers by Reznikoff (2008) and Waller (1993) is that they do not explore a random selection of sites or areas within sites. Both papers only explore cave sites which feature cave art or within the caves only look at areas which feature cave art. This prioritisation of the areas with visual stimulus make it impossible to conclude that these areas were selected for their acoustical properties particularly as all caves with exhibit some of these phenomena.

Equally this visual focus extends when discussing results, most papers discuss the results in relation to series of graphs and maps. None of them provide audio accompaniments to explore and demonstrate the nature of the results of their studies. Watson comments on this visual approach to acoustical stimuli without providing an adequate conclusion (Watson 2006). Against this we do need to ensure that we do not take an overly acoustical approach to sites and fail to appreciate the full multisensory experience of place (Watson 2006).

Leading on from this, approaches frequently do not consider the changes of sites over time. The landscape and perception project (Wozencroft & Devereux n.d.) recorded a series of sites as they stand today, as we do with visualisation, but did not engage with the remodelling or reuse of those places. As did Devereux (2001) by recording a site which had been reconstructed in the 1800s (Devereux 2001) he then used this as the start of a discussion about the design of burial mounds. Acoustics, as in visualisation, theoretically stands on the interpretive decisions that the creator makes. Most sites have changed over time either through human interaction or just decay meaning that the changes have to be explored. Archaeologists are adept at peeling back the layers of these changes and making interpretations based on the remains. This is not a skill that acousticians have yet begun to employ. Although they use technology to predict the acoustical properties of future buildings and to find solutions to

problems with existing ones they have yet to engage with using it to alter spaces. For example in *Stoneage soundtracks*, the removal of the roof in Cairn I (Devereux 2001: 84) surely would have majorly affected the acoustics of the space which has not been considered in the book.

The changing of space over time is a concept archaeologists are happy with assessing through excavation reports and standing remains. However, there are other factors which affect the acoustics to consider; primarily the number of people within a space or the properties of the materials. Often the correct equipment is not selected or used appropriately or the abilities of the technique are not fully understood.

Woolgar's work highlights that the experience of sound (and equally all senses) is dramatically removed from how we perceive it today (Woolgar 2006). This includes not only changing environments but also changing engagements with sound. On the medieval scale humans are not that removed from today. However, the papers which focus on sound in the Upper Palaeolithic should also be considering that we do not know that early modern humans (and potentially Neanderthals) engaged with noise and sound in the same way as modern humans do.

These two problems highlight one of the key issues of working on the acoustics of the past: understanding the limitations of different disciplines. Projects so far suggest that understanding the "scientific" approach undertaken by acousticians is too challenging. However, it is in essence the same skills that we readily employ in visualisation. In archaeology we have developed our engagement with visual recording and have developed specialists to undertake this work who are trained archaeologists. Visual recording is a central part of an archaeologists training, being able to record excavations, buildings or finds. In the study of acoustics we can assess the qualitative experience and comment on the meaning of the results, yet we do not yet have the skills to undertake detailed acoustical surveys ourselves. Without the skills to undertake these tasks ourselves a number of interdisciplinary projects have begun to emerge engaging acoustical technicians to undertake the survey work and processing to provide us with results. At the same time a number of older projects have begun to record or model older (by the large classical or popular heritage sites) without the archaeological background to interpret the results.

Acousticians are interested in engaging with the problems surrounding historic buildings but are not qualified to explore the human aspects of the results or to interpret what the results mean (Murphy 2014).

Projects which do not include using acoustic technology also exist in archaeology. In these, archaeologists do not engage with the technology but move towards a phenomenological discussion on the experience of a site or location. These papers tend to engage with prehistoric monuments and consider their use within ritual ceremonies but do not engage with the everyday.

In summary I feel this literature review and discussion of the theoretical issues with working with acoustics highlights that archaeologists do not understand the technology enough to engage with it without the help of acousticians. However, acousticians need more guidance on the nature of archaeological sites and how we can explore the past. Even projects where they work in collaboration they often do not discuss the importance of both aspects of their work and how they affect the overall study. We also need to move beyond focussing on the extraordinary sites: the monumental prehistoric architecture, Roman and Greek theatres or cave sites and instead consider how these techniques can be used to explore the everyday experience of living.

2.3.3   Building and architectural acoustics

The field of architectural and building acoustics has its origins in the late 19th century studies undertaken by physics Professor Wallace Clement Sabine. He was given the task of improving the acoustics of a newly constructed lecture hall at the Fogg Art Museum at Harvard University. He undertook several years of research using what today would be considered inaccurate equipment of a stopwatch and organ pipe. His measurements observed the reverberation time of the space (the time required for sound to decay to inaudibility) over different frequencies. He explored the differences between the lecture hall and that of spaces with "good" acoustics. His team spent nights experimenting with different materials to see the effects they had on the acoustics of the room eventually finding the link between absorbing area, reverberation time (see glossary) and size of chamber (Chodos 2011). He formally defined reverberation time which is the characteristic still used today in understanding

the acoustical character of a room. The observation of different spaces concluded that concert halls required a reverberation time of 2-2.25 seconds as opposed to lecture halls or spaces that are used for public speaking which requires a reverberation time of just under a second to allow the voice to be projected clearly (Barron 2009: 5).

The field of architectural acoustics has developed too as a discipline alongside both acoustics and architecture. Buildings now have to conform to legal requirements regarding the acoustical performance of the spaces within them in the UK. This concerns the type of building and can include sound insulation between rooms to improve privacy, control of reverberation which helps the intelligibility of speech, control of background noise (masking noise again for privacy) and vibration isolation. The legal requirements state that:

"Dwelling houses, flats and rooms for residential purposes shall be designed and constructed in such a way that they provide reasonable resistance to sound from other parts of the same building and from adjoining buildings … in such a way that

internal walls between a bedroom or a room containing a WC, and other rooms;

internal floors provide reasonable resistance to sound [but not if the wall contains a door]

The common internal parts of buildings which contain flats or rooms for residential purposes shall be designed and constructed in such a way as to prevent more reverberation around the common parts than is reasonable. Each room or other space in a school building shall be designed and constructed in such a way that it has the acoustic conditions and the insulation against disturbance by noise appropriate to its intended use." (Government 2010).

However, acousticians are limited in their work by the architects and are frequently only called in after construction. This means that they have to conform designs to the internal planning of a space already laid out and will often conflict over the use of materials in a space. These are the two things which can affect the acoustics of a space, the level of absorption of the surface properties of the room and the volume of the space. Surface properties can be

absorptive or scattering, fabrics are usually absorbing while dressed stone will scatter the sound. It gets a little more complicated when the surface is very textured, specifically when gaps or changes in the surface are smaller than the wavelength of the soundwave. This means that they are not accurately picked up by the modelling software, changing the results of the simulation. Accurately modelling these surface properties is important to the fidelity of the results. In visualisation studies there have been papers exploring extant lighting techniques trying to reproduce their physical qualities (Papadopoulos & Earl 2009; Papworth 2004). In the same way acoustic studies do not have a bank of relevant surface properties to apply to ancient fittings, meaning we have to substitute modern alternatives.

Today the technique has developed only in the sophistication of the equipment used. The same formulas are used to calculate reverberation time. Instead of a stopwatch and instrument we use a loudspeaker and microphone linked up to a computer to accurately record the time lapse and properties of the equipment. There is a range of different equipment that can be used to record room spaces. These can include directional, omnidirectional and binaural microphones and directional and omnidirectional loudspeakers. We can also use a better range of frequency of sounds using electronically produced noises. These are usually either a chirp signal, pink noise or a sine sweep (see associated material). A chirp (Compressed High Intensity Radar Pulse) is a single frequency pulse source. Its advantages are that acoustically a short signal noise provides better results at recording the target but only at a specific frequency. Pink noise plays a series of frequencies over different octaves, these are played at once then averaged to find each individual response to frequency. Each octave will have an equal amount of noise power, which means that the sounds last a different length of time. The sine sweep uses a wide band of frequencies to check the response of the room; it plays each frequency in turn and individually: it is better than pink noise in enclosed spaces as unlike pink noise each frequency can be observed individually and therefore more accurately; it will also take less time as there is no need to play different frequencies for different times.

The other development to the field of acoustics is the ability to simulate acoustics. Auralization allows the acoustical properties of space to be simulated and anechoic noise convolved to sound according to those

properties. A few archaeological projects have started to explore how this technique can be exploited in the same way as in visualisation projects including the *Icons of Sound* project exploring the aesthetics and acoustics of Hagia Sophia, Istanbul (Pentcheva 2011) and the *Virtual Paul's Cross Project* which digitally re-creates the sermon given by John Donne on the day of the Gunpowder plot (Wall 2014). A range of different programs are available (Odeon, CATT-Acoustic) which offer slightly different advantages (this will be discussed in Chapter 6). However, they are not yet perfectly accurate. They can offer an estimate as the nature of constructed spaces but too many factors can still be involved with surface properties to correctly simulate the acoustical experience.

2.4   Perception and multisensory experience

The sensory and sensuous experience of the past is socially and historically specific. The senses are bound up with the world of experience and to understand them we must look at the fully embodied experience. In doing so we have to explore the range and form of sensory experience and consider how they change across both time and space. Our understanding of the past is multisensory and therefore we need to move beyond an understanding of the visual past, tactile past and acoustic past and instead begin to think of all of them at once and more frequently. An individual's sensory map is the product of personal experience, of our own history. Simulating this background is impossible as it is the product of our personal memories of both our experiences and what we have learnt from our surroundings (Hamilakis 2011). If we are really to explore the multisensory experience of the past we have to acknowledge that our understanding of life is informed by our perception of the things that surround us and how we engage with them.

In chapter 1 I discussed how theoretical archaeology has explored this in depth in reference to the phenomenological way of thinking. I discuss it further in reference to lived experience. As technology has developed the work focussing on digital visualisation has developed and has started to further explore the idea of multisensory experiences and how our models can be perceived in a more realistic light.

Engagement with virtual worlds does allow for new approaches to old research questions (Hermon & Fabian 2000). Questions about function, use of space and observations of landscapes and sites can be observed from different perspectives. But at the same time the place, space and time of the site or artefact is irreversibly changed.

The digital modelling of objects allows them to be released from their context, making them more accessible, but also removes some of their meaning. The object within its context allows us to engage with both the object and subject and their relationship. When removed from this embedded context not only is the meaning of the object to some extent lost but also a sense of the place from which it has been removed is gone (Malpas 2008) and therefore the materiality of the object is also removed. This is what makes an object a thing, it is the aspects which define it, making it what it is. Therefore modelling an object isolated from its original context makes it harder to understand. However, by placing it back into its context through modelling allows it to be considered as part of its setting and as part of its world, allowing to be perceived in its original space.

There are concerns with the adaptation of these new technologies. Martinez discussed these in particular reference to the focus on how we present objects instead of preserve them (Martinez n.d.). By focussing only on the presentation of a replica of an artefact (digital or material) there is a concern not enough resources will be placed on the preservation of the original. If a building has been recorded and those images are made available online, does it matter if it is then destroyed to make way for other developments? Through this, the appreciation of heritage may be lost, driving people away from the original sites and objects and just appreciating them as images (Malpas 2008). Linked to this is the idea that structural analysis-type applications of digital media are not valid uses of the technology as they do not account for questions on the experience of dwelling (Gillings 2005). By this I mean analysis such as the work undertaken by Papadopoulos & Earl (2009) which do not consider creating a visually compelling image but instead focus on the numerical analysis that the models allow. However, I do not agree that this makes this type of digital work meaningless. Instead I suggest that both types of work should be undertaken in collaboration. Therefore a numerical analysis can be combined with one that considers response to visually compelling images that question experience.

Taken together the two can discuss the lived experience of a space with a double layer of analysis.

Malpas (2008) and Gillings (2005) both raise concerns with the removal of materiality of digital models, which is particularly highlighted when discussing the modelling of physical landscapes. Landscape studies focussing on GIS have discussed this at length, critiquing that they are more than physical spaces, but are socially constructed (Mlekuz 2004). Edgeworth's work on rivers can really highlight how true this is as it is almost impossible to find a river which has not been changed as a result of human action (Edgeworth 2011: 14), and the same is true of landscape though it is less apparent. Although it has been suggested that virtual reality can link spatial, temporal and behavioural simulation through combining an understanding of both Euclidian and Cartesian (see glossary) space (Tost 2007), the lack of perceptual input means that questions of space and memory are hard to approach (Gillings 2005). Vision has been frequently confused with this understanding of perception. What can be seen of an artefact or site has been considered in the same light as what the artefact or site means (Mlekuz 2004). Mlekuz has explored not just the simulation of sound across a landscape but also what the sounds would mean to someone - how it is perceived and understood. So for example in the modern world we understand the sound of a church clock chiming to give us the time; in the medieval period the same was true but it was the only method for telling the time (Woolgar 2006: 68). In the same way, Woolgar has looked into the meaning of how other senses were understood by medieval people instead of trying to recreate them. Evidence for the perception of visual images, noises and smells in the past can help to understand the medieval lived experience (Woolgar 2006).

Therefore the mapping of an experience in the virtual world should attempt to replicate that of the real environment. This idea of perceived realism need not attempt the simulation of the perceptions of past societies but at least represent the real world of the past as correctly as possible (Chalmers & Zanyi 2009; Hermon & Fabian 2000) by which I mean such things as shadows and dirt should appear correctly. In this context we need to further investigate how people, taking into account all experiences of the study of the past, would perceive the images we are creating. Unlike in film studies archaeologists and consumers of heritage are not naturally sceptical of many photorealistic

images that are put in front of us (Prince 1996) even though the images may not be physically (true to what is physically possible) or perceptually (they are not how we would imagine them) valid when created through this type of media (Devlin & Chalmers 2001). However, as soon as they are placed in front of us there is some confusion between our understanding of them as fact instead of as an interpretation. We need to start distinguishing between "*seeing and knowing*" (Moser 2001: 280) what visualisations and simulations are telling us.

Movement is an important element in our personal understanding of space. Goodrick and Earl (2004) have argued that we only experience or understand space through movement and perspective. As has been seen in online communities since the move from traditional (chat room style) communities to those involving embodied avatars they provide a different and more engaging and personal experience of virtual worlds (Forte & Pietroni 2009). Movement allows us to engage with the space around us; the same is true when observing virtual models. These models allow further levels of engagement and accessibility which are now often limited in real world sites. By this I mean most heritage sites and objects provide limited access, are only displayed in certain ways, or are now in a ruinous state but can be visualised and made more accessible by modelling them (Gillings 2005). Once modelled the creator and others can then manipulate the objects and allow access to spaces which are prohibited in cultural and historical sites allowing an increased level of interaction (Martinez n.d.).

I would argue that virtual space only has meaning when considered in 3 dimensions. In moving away from maps, plans and sections focussing on space in 2D and beginning to explore the nature of space in 3D we are beginning to think more about the experience of being in the space as it is experienced in real life. A 2D drawing can give information on a space relating to size and dimensions by adding the third dimension a space can be completely transformed. This is particularly relevant as the medieval views expressed in maps were not realised as details of measured space but as a philosophical understanding of the medieval world. As such maps and plans in 2D space as we see them today are a modern construction (Parker Pearson & Richards 1994; Edson 1997). Although the same can be said of virtual realities I propose

that by trying to recreate the scenes of the past we can document an experience of the past

Through the construction of a 3D space that can be explored and manipulated the space can be understood more according to the experience of being in it. Whereas in the construction of a 2D space the space can be understood according to size and dimension, the experience of the space is intangible. The understanding of space in 2D plans is a modern occurrence; in the medieval period movement through built space was understood through series of social cues and patterns in architecture. While the understanding of space over large scale distances was understood according to memory and time.

However, with these proposed limitations in mind these tools can be reapplied to approach the "fuzziness" of archaeological data. The three dimensional nature of archaeology is lost in the older methods for studying space whether this is buildings or deposits (Hermon & Fabian 2000). This means that new methods such as visualisation and other digital technologies can give new meaning to old sites. Bakker et al (2003) shows how a two dimensional plan can be reinterpreted once it has been visualised in 3D to give a place new meaning.

The goal of virtual reality is to synthesise stimuli that produce a realistic illusion of another world or to develop a virtual environment that is presented in such a way that the user perceives as real (Hermon & Fabian 2000). The move towards "*Real Virtuality*" as it has been dubbed by Chalmers and Zanyi has been attempted and documented in a number of articles. In this, they suggest that the aim is to produce high-fidelity multi-sensory virtual environments that evoke the same perceptual responses from a viewer as if they were actually present. So far their articles detail the nature of technology to date and what can be done with it. There has, however, yet to be a move to true "*there reality*" (Chalmers 2008; Chalmers & Zanyi 2009; Zányi et al. 2007).There has, however, yet to be a move to true "*there reality*" (Chalmers 2008); (Chalmers & Zanyi 2009); (Chalmers & Zanyi 2010). This is because of the need for highly specialised equipment and resources. Gavin Kearney has begun a similar move towards fully immersive environments. His approach explores the creation of a person binaural field when experiencing a virtual environment (Gorzel et al. 2010).

It is in museum exhibitions that types of immersion have most been attempted. Janet Cardiff is an installation artist who has produced a series of audio-based installations. One of the most well-known is her forty-part motet which consists of a series of forty speakers, each playing a recording of an individual voice singing a part of Thomas Tallis' *Spem in alium*, arranged in a circle in the exhibition space (often sites of historical interest). The installation allows the visitor to walk around in the space bringing individual voices closer or further away. The result is an encounter with a changing space and acoustical experience. It brings back emotional experiences to those listening; to some it reminds them "*of being a choir boy at school*" (Earl, 2011: P.Comm) and to others it is "*the only piece of art to ever make me cry*" (Perry, 2012: P. Comm). These anecdotal responses highlight a different way of thinking about these spaces, an emotional response not an analytical one.

A similar immersive environment is the Museum of London's *Expanding City: 1666-1850s* gallery, which allows the public to stroll through recreated pleasure gardens of the late 18th century. It is an immersive theatrical space which places the visitor at the centre of a narrative being depicted around them through video, audio and lighting. It breathes life into the remains of the period through the use of the artefacts in a simulated setting allowing a narrative of the pleasure gardens to be told. Another classic example of this is the Jorvik Viking Centre in York which incorporates smell into the exhibits. When Jorvik first opened in the 1980s it was heavily critiqued for commodifying the past and not providing an "authentic experience" (Rampley 2012: 4; Williams 2004: 11; Walker & Chaplin 1997: 93). Authentic experience in this context means a historically accurate experience. Williams takes this critique a step further to explore the motivation of visitors and concludes that they are not necessarily interested in authenticity (Williams 2004: 11), which I have discussed above in section 2.2.

Although multisensory understandings of the past are important the experience of the past has far more bound up with it. Understanding of our present environment is bound up with memory, cognition, meaning and action (Ray 2008). So understanding how our ancestors would have perceived sites or spaces is not possible, but we can experience these sites for ourselves and mimic their experiences (Chalmers & Zanyi 2010).

2.5   Uncertainty

The previous sections have allowed me to explore the literature relating to work on acoustics and visualisation of the past. This section will explore the major issues with working with these techniques and how they have come to be addressed.

Visualisations whether hand drawn or produced by a computer all contain an element of uncertainty. The very nature of archaeological data is fragmentary or "fuzzy". All the material archaeologists recover is incomplete and at a distance from us due to its degradation over time. As such whether we are dealing with visualisations or any other method for studying the past we have to take into account that what we are putting forward is an interpretation of the available data. The problems with uncertainty have become particularly apparent since the ability to create hyper real images can resemble photographs. This level of realism leads to viewers responding with a false sense of reliability in the images that is not seen in other types of illustration. This section will discuss uncertainty before introducing realism in computer graphics and discussing two suggested methods for dealing with uncertainty in visualisation through two approaches: metadata and multiple interpretations of the past.

The primary problem concerning visualisations of the past is that they are often portrayed as the final result, the only answer (Moser 2001: 276). The past is portrayed as the "real thing" not as an interpretation of the data (Gillings 2005). By presenting only one image there is no method for dealing with fuzzy data and decisions have to be made about ambiguity in the simulation of the past, which to some has been seen as an advantage in that it forces the archaeologist to make interpretations (Tost 2007). With the move towards photorealism it becomes harder to differentiate between the known evidence and the hypothetical aspects of the image (Eiteljorg 1998). This has been questioned at length with emphasis on issues of realism (discussed below) and a number of solutions have been put forward to account for this ambiguity involved with image creation.

Returning to the use of the word 'reconstruction', discussed above, it is forgotten not just by the public but also by archaeologists that reconstruction is not possible without all original data about the site, artefact or building.

Instead we can only create a model based on the available data, filling the gaps with inferences (Eiteljorg 2000).

2.5.1   Realism

The very nature of the computer generated image has led to many problems. The public as well as many archaeologists assume that an image generated through a computer remains objective (Eiteljorg 1998). As I have already stated, in film studies viewers are continually making assessments about what they are seeing, perceiving the reality of the images facing them (Prince 1996) but this is assumed not to be the case in archaeological visualisation. In cultural heritage non digital three dimensional (3D) models and hand-drawn visualisations have long been a standard method of data presentation. It is the move from these sketches that has generated a level of reality blurring the distinction between what we know and what the model conveys. The realism of past hand drawn visualisations was never enough to forget the artistic licence involved in their creation. When the data recovered are incomplete (as is always the case in archaeology) much of the created image is heavily dependent on a number of interpretive decisions (Kantner 2000).

With the move towards photorealism and the hyper real, uncertainty has become more complicated. The creation of these images from the "objective" computer means the visually compelling image which resembles a photograph instils belief in the representation. The generation of fabrics and textures allows an image to appear more real (see Real, Reality, Realism etc. for more thoughts on real/ realism) (Kantner 2000). This led to the illumination of these visualisations with physically accurate lighting, as discussed above, giving them an air of authenticity previously not possible.

Due to the blur between data and inference, meaning it is often hard to distinguish where the material evidence ends and interpretation begins, it is now more challenging to gloss over the unknown the model is presenting. It is also harder to tactfully avoid areas of a visualisation which was possible when only two dimensional (2D) sketches were being created. In a virtual reality, missing information must be filled in to create a complete world (Kantner 2000). This generates the need to distinguish between the real and hypothetical without sacrificing the visually compelling image. The fear is that

as the quality of the images improve, the scepticism surrounding them will also decrease (Eiteljorg 1998). This has to some extent led to shying away from the visually compelling image, for fear of misrepresenting the past (Zányi et al. 2007).

There have been two principal methods for accounting for the perceived reality of computer generated images: the inclusion of large amounts of metadata with each visualisation or image, and the creation of multiple interpretations of the data that can be compared and analysed as contrasting opinion. These two approaches will be discussed in the following sections. Kantner (1998) suggests that achieving realistic views of architecture or artefacts should not be the aim of these models. We can instead use our models to explore lighting conditions, analysing structures and inconsistencies in data (Kantner 2000).

Chalmers and Zanyi (2009) suggest that images do not appear visually compelling when the environments lack dirt, and look too clean and crisp (Chalmers & Zanyi 2009). In my blog I have discussed the presence of soot across every used hearth at Dover castle. Digital images of medieval buildings rarely show this evidence of use (see Appendix C) (Cooper 2012). Numerous models that have been produced are often too clean and don't accurately represent the nature of life and buildings when they are being lived in. Specifically the presence of soot transforms the space, darkening the room as well as adding a scent of burning fires.

Computer games are a rarely discussed area of historical representation. The analysis undertaken by Gardner concludes that those playing often forget that what is being represented is not how life was. Specifically in relation to violence, it is the question of how much is misrepresented that is interesting (Gardner 2007). The norms of the past are made to conform to the norms of the present to make an accessible gaming experience. I agree with Gardner in that I am not sure whether it is something we need to worry about rather than just be interested in. The issue as far as visualisation is concerned I believe is towards giving a more rounded view of the past allowing engagement with characters at the lower levels of society.

2.5.2   Metadata

Simulations are created with one aim (often as a method of presenting some part of a research project) and are then viewed out of their intended context. The questioning and interpretation are thus removed and just the final result shown (Bakker et al. 2003). A model is produced to answer a specific question and the details it omits will vary according to the problem (Hermon & Fabian 2000). By including texts or narration to accompany a model this allows the resources and all the hypothetical aspects of the image to be shared with the viewer. This acts as the metadata for the interpretation and in doing so allows the interpretation to be critiqued for historical accuracy.

In order to be accepted as scientifically valid, a 3D model must be presented alongside its sources and the presentation must discuss the evidence on which it is based. The degree of speculation that is involved with the image's creation needs to be quantified (Hermon et al. 2006). This transparency of the image is essential for it to be considered as a valid creation. By allowing the model to be critiqued alongside its sources, it can be developed and improved.

Eiteljorg (2000) believes that the degree of speculation involved with an image's construction should be included along with the image. Hermon proposes a method for quantifying this speculation by listing how strong the evidence is for each aspect of the image is and based on this creates an index for the results (Hermon et al. 2006). This method works by quantifying each decision enforcing the user to consider the nature of each course of action as they go along. So for example original masonry would have a low degree of speculation whereas a floor plan created a few 100 years later would have a higher degree of speculation. However, despite this quantifying of uncertainty, at the base of this quantification, subjective decisions are still required about the quality of the archaeological remains. In defining how "fuzzy" the data are, a choice or interpretation is still being made. So every decision to do with envisioning the past involves some level of subjectivity, whether this is selecting a level of accuracy to record data on site, how much degradation to remove from the remains during modelling, what objects to place in the space, or how high ruined walls reached.

It is clear that the image needs to be associated in some way with information about the creation process or else, as Eiteljorg (2000) argues the technology

should not be implemented. However, it is the nature of the accompanying information that needs to be considered. Traditional metadata which support an image through association cannot be presented in the same way with digital images and therefore cannot provide the information needed to authenticate the creation process, especially when concerned with the photorealistic images of today. Instead, the suggestion is that a detailed narrative would be better suited to describing decisions made about the creation process (Earl 2009). In this sense our images can begin to be fully integrated with the texts they are accompanying (Bateman 2000). However, this is still not always an option and the same information can be conveyed much more quickly or effectively. Instead the use of multiple images showing different interpretations has been suggested as an option.

2.5.3   Multiple Interpretations of the past

The second method for dealing with uncertainty is the display of multiple interpretations of the past. Still images limit the presentation of the past to one view or vision showing just one interpretation or one person's view (Moser, 2001: 276). This is particularly true when the image is likely to be removed from its original context or if it is being displayed without other information (Bakker et al. 2003).

The presentation of multiple interpretative images or multiple interpretations highlights the subjective nature of each of the images or worlds. By using a computer as discussed above there is a reliance on the results that appear from it (Eiteljorg 2000) meaning that our suspicion over the image is reduced based on its apparent realism. This method can allow the complexity of the archaeological data to be presented to the public, showing that the nature of historical evidence is always fragmentary.

There have been a number of approaches suggesting how multiple representations of the past can be taken beyond just a method for presentation. The first method for exploring space allows objects or aspects of each virtual model to be altered, creating alternate readings of the data (Papadopoulos & Earl 2009). Using this technique virtual reality can be used for the visual presentation and manipulation of spatiotemporal data (Tost 2007).

The second is to catalogue all data and information required for visualising the past in one place, allowing them to be updated, modified, corrected and checked as new data is gathered. This allows multiple interpretations to be produced and compared and by association also allows for the movement between different periods or phases on the site (Tressel 1996). However, this only works for online interactive presentations of data. The simulation, feedback and communication will allow for collaborative reconstruction over long distances (Forte & Pietroni 2009).

The idea that "archaeological computing is not something that is ever 'complete' but rather is a process" (Lock, 2003: xiii) is particularly relevant here. It is the incompleteness of the archaeological record that is fundamental in limiting the past reality. It is the present that acts as a link to ancient conditions (Papadopoulos & Earl 2009) and it is through processes such as visualisation that we can begin to piece together the past creating a narrative. The process of virtualising allows creativity to become involved in our interpretations (Bakker et al. 2003).

2.6   Conclusions

Chapter 1 introduced the state of study of late medieval buildings and suggested digital techniques as a way of approaching those questions. This chapter has discussed the use of digital techniques in the study of the past with a focus on representation and acoustical studies. The introduction of these techniques can allow us to examine our research in new ways and assess the evidence towards different aims. In visualisation the introduction of 3D visualisations can allow us to think about a built space in a way that 2D plans and elevations can be limited. The production of them also provides a research methodology bringing together a range of evidence and techniques with the single aim of understanding the experience of the past. The adoption of acoustics and a multisensory understanding of the past takes these ideas further towards a more experiential way of thinking.

However, there are also a number of issues with employing these techniques which have arisen and form a major part of the literature surrounding visualisation: they are also critical issues when working in acoustics. I have highlighted above how there is a divide between the work undertaken by

acousticians and archaeologists and that the tools and ideas being used are yet to align themselves successfully. By this I mean archaeologists do not seem to be totally aware of the limitations of the simulation software, while acousticians do not consider the limitations with working with fuzzy data sets.

In reference to visualisation, although there has been much discussion as the use of computer graphics in the creation of images, there has been limited engagement with the use of these techniques as an interpretation process rather than as a means to display results. This is bound up with the lack of engagement with how the creation of visualisations can be used to inform our engagement with the lived experience of the past. By this I mean visualisations are rarely taken beyond the single image "showing us what the past looks like". Rarely are they presented as a single interpretation of a point in the past or as a method for fostering debate. There are also problems with the nature of sites represented. For the most part work is undertaken on the extraordinary sites, the large scale monuments, the royal castles or the great Roman ports. The focus is often, particularly in the world of acoustics, on the monumental and ritual spaces and rarely considers the everyday experience.

Finally, the critical issue with digital work has been the focus on visualisation. This ocularcentric approach has meant that approaches to living in the past have lacked a level of engagement. It has also led to a number of approaches towards a multisensory engagement not being met with a full understanding of the technology or a strong theoretical grounding.

My thesis seeks to explore this idea of perception and how we can use digital media to explore it in reference to the lived experience of late medieval buildings. Lived experience is a way of thinking that explores how people understand the world around them and until now has been heavily critiqued for not engaging with data based evidence. The issues I have discussed in this chapter are the same issues I discussed in Chapter 1 when addressing lived experience in late medieval buildings. In medieval studies I am questioning how we can apply phenomenological approaches while being rigorous in our arguments. Digital methodology has also been critiqued as lacking rigor and failing to engage critically with the data, although a strong academic discourse has developed to discuss how to work around these issues (discussed in this

chapter). By applying digital techniques I can provide a way to explore lived experience that isn't simple or transparent.

In the next chapter I suggest that the creation of auralizations and visualisations can be a mechanism for thinking about what our interpretation would have meant for the medieval person. Further using this method of research in the creation of a model and therefore an interpretation, we can think about the lived experience of a place beyond the final illustration.

My approach will be to undertake a visualisation project that takes account of the issues with subjectivity, realism and presentation. I then present an acoustical case study that explores the options of approaching a theoretically and technically appropriate project. Bringing the two together in the final project towards a lived experience of late medieval buildings.

I conclude this with a clear understanding of the critiques of both late medieval buildings and digital technologies. Understanding these issues allows me to frame two relevant case studies. These case studies bring together timely themes from both chapters. The first, chapters 3 and 4, suggests visualisation as a research methodology at Bodiam Castle. The second, chapters 5 and 6, based at Ightham Mote, moves beyond visual experience to discuss the acoustic experience.

Chapter 3:   Bodiam

Leading on from the previous two chapters on late medieval buildings and digital media this chapter places Bodiam at the centre of a visualisation project. Chapter 3 will act as an introduction to the case study, with chapter 4 detailing the results.

The aim of this first project is to explore through the creation of visualisations how both subjective responses and analytical results can be used to discuss the experience of life in medieval buildings. This chapter draws on the issues raised in chapter 1 about the current position of research in late medieval buildings i.e. how we can draw on theories of materiality (Hoskins 2006: 74; Hodder 2008: 30) and phenomenology (Cummings 2002; Tilley 1994; Parker Pearson & Richards 1994; Ingold 1993; Cosgrove 2006). These theories provide a base for the application of digital media, as discussed in chapter 2, for the generation of materials that can be used directly by the Trust for informing the public.

This chapter first introduces the site and history of the building and then explains how Bodiam was selected as a case study. I review the work already undertaken on the site, both theoretical and practical; and how space has been studied both at Bodiam and further afield. Finally the aims of this project are introduced and I consider how visualisation can be used to explore lived experience in this context.

3.1   Introduction to the site

Bodiam Castle was built by Sir Edward Dallingridge (c1346-c1395) around 1385. The building and some of the grounds surrounding it are now owned and managed by the National Trust. The castle (Figure 37) is presented as the Trust's "*fairy tale castle*" being *"one of Britain's most romantic and picturesque [castles]"* (National Trust 2012). It is a property that centres itself on children rather than interpretation providing engagement through a series of costumed volunteers, guide books and a small visitor's centre.

Figure 37: Bodiam Castle in Sussex, viewed from the north-east. This image shows the outward display of the building

Despite Bodiam's central position within long-standing academic debate (See Section 3.2) the onsite interpretation provided by the Trust is limited. The last guidebook was updated in 2005 and the visitors centre provides minimal information (see Figure 38). Information is provided through a short film and a ground-floor plan of the building. The only information boards around the building are found in one of the towers (Figure 39).

Figure 38: Display at the visitors centre at Bodiam Castle. Located next to the former ticket office to the north of the castle (O'Leary 2014).
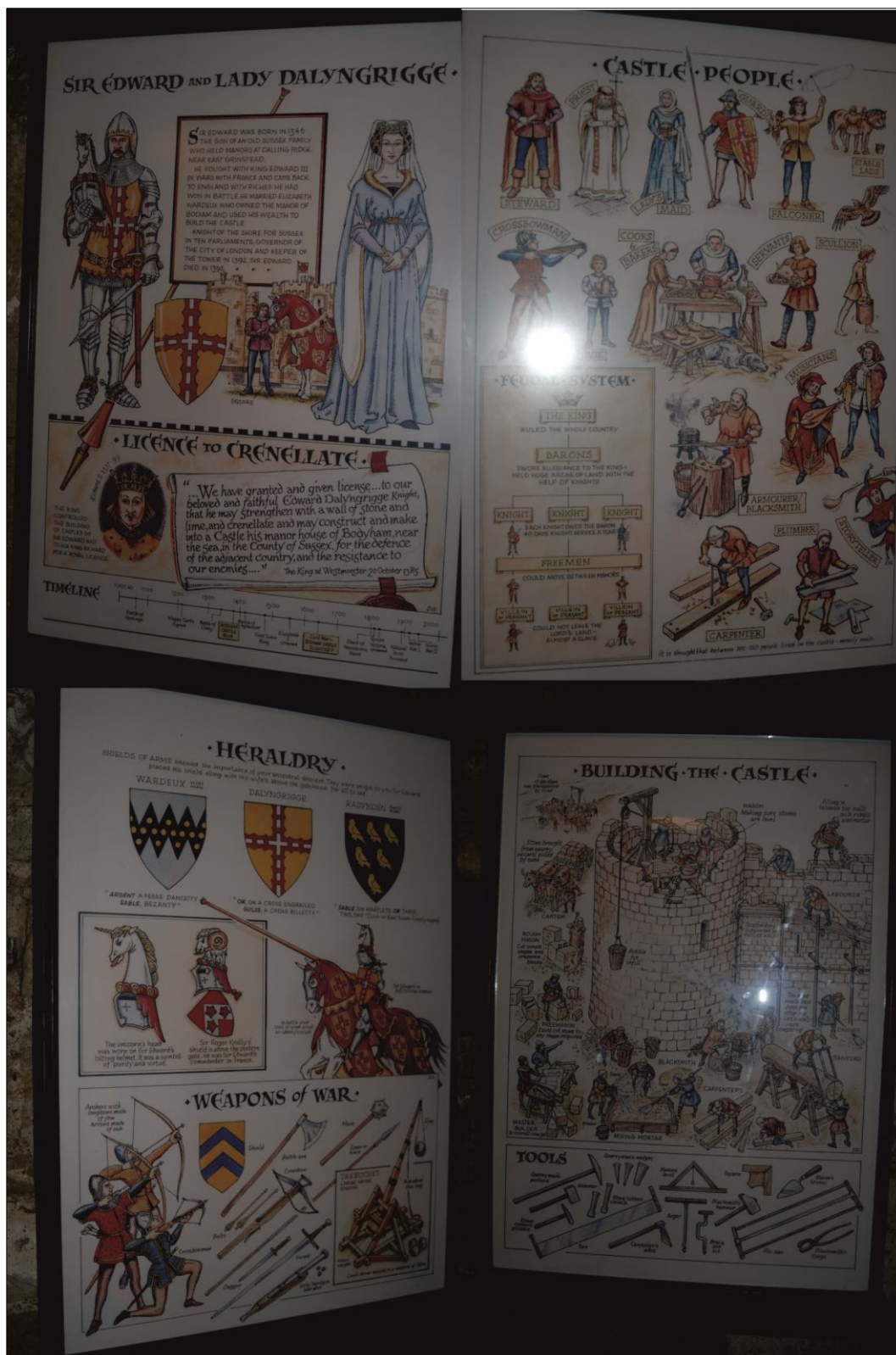
Figure 39: Information Boards at Bodiam Castle. These are the only sources of interpretation at the building.

3.1.1   Location

Bodiam Castle is situated on the East Sussex side of the East Sussex/ Kent border (see Map 1: page 7). It is placed on the south slope of a ridge running down to the northern bank of the river Rother and its flood plain (Barker et al. 2010: 7). Built on a ridge of higher land running between the river Rother and the Kent ditch, which extends slightly south (See Map 2) (Barker et al. 2010: 7), Bodiam has been located in an area overlooking the Rother flood plain.

Suggested as being an area for the natural pooling of water (Coulson 1992: 87), water fills the moat both from internal springs and from springs found in a valley to the north and west (Johnson et al. 2001). Bodiam is part of a much larger landscape of watery features: pools to the south, fishponds to the east and west, a cascade leading down from the north-west; and the Rother's estuary, leading to the sea, to the south of the building. These can be observed from a viewing platform overlooking the castle dubbed the Gun Garden to the north (Taylor et al. 1990).

The property extends as far as the river to the south; to the west it is limited by the houses in the village of Bodiam and the modern Bodiam/ Sandhurst Road. In the east the border lies on the valley floor lands of Court Lodge Farm and Justyns to the north.
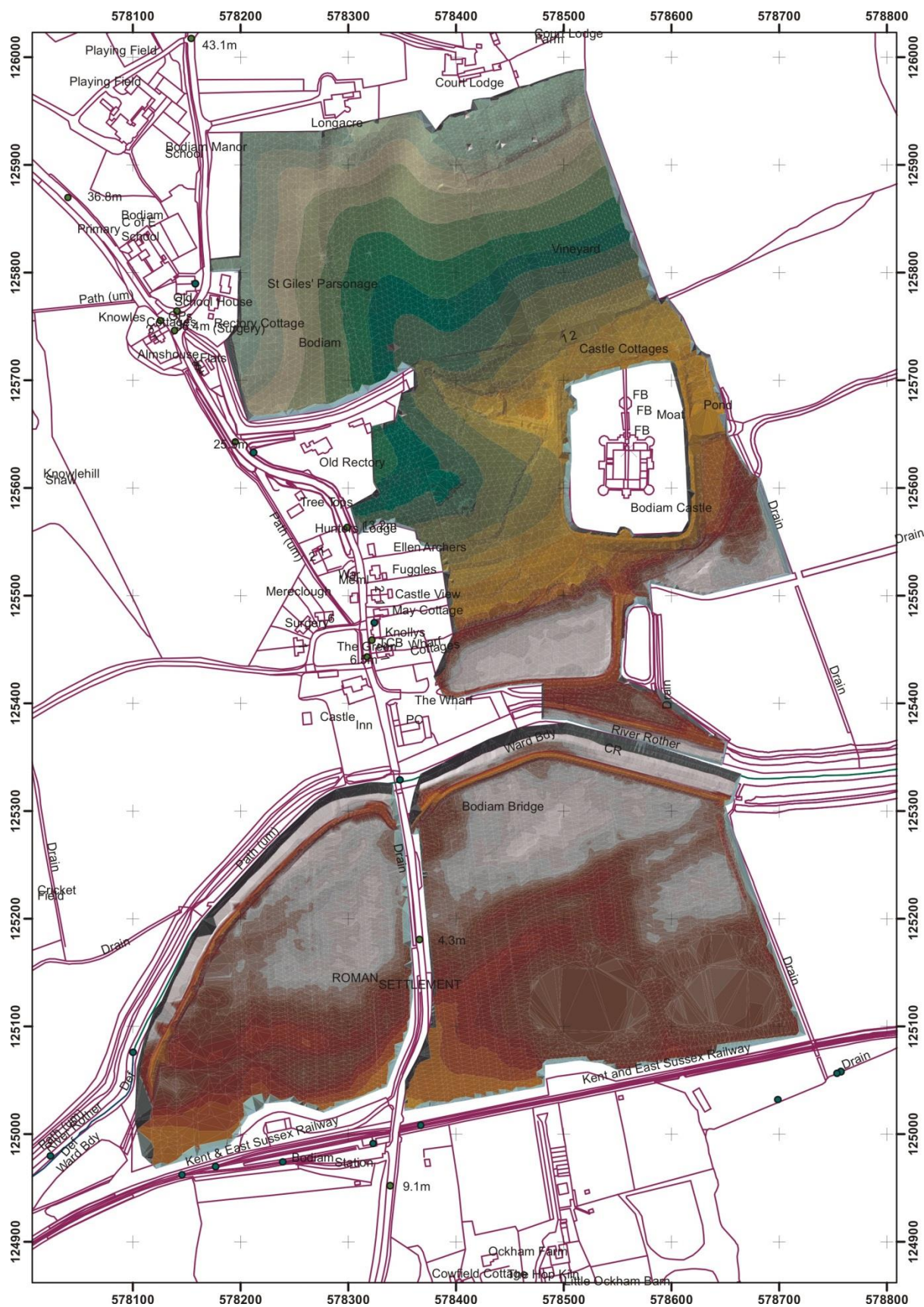
Map 2: Topography around Bodiam Castle (Barker et al. 2012)

3.1.2 History of the builder and later owners

Sir Edward Dallingridge (c1346 – c1395), having gained much wealth and power from fighting in the war in France (1367), returned to England to marry Elizabeth Wardieu in 1377. Through this marriage came the lands at Bodiam and a moated manor house to the north of the castle (Saul 2010).

Dallingridge was the second son and eventual heir of Roger Dallingridge (c.1315–1380) and his wife, Alice (d. 1360×64). His father had been a prominent landowner and administrator in Sussex (Saul 1998: 125) and it is to this Sir Edward owed the beginnings of his career as a soldier (1359-60) through his connections with the Earl of Arundel (Saul 2010).

During the 14th century England was at war with France. Between 1359 and 1387 Dallingridge took part in many campaigns through which he amassed his fortune (Goodall 2001: 4). He made a name for himself through his connections with prominent men including Sir Robert Knollys, a famous veteran of the war, and the Earls of Arundel. In fact his relationship with Knollys can be traced through more than its appearance in documentation: Knollys's arms are found on the postern gate of the castle along with his tourney helmet.

It was these relationships Dallingridge relied on when he led opposition to John of Gaunt's tightening of control over lands he had acquired in Sussex. Having interrupted local courts and assaulted Gaunt's ducal officers, Sir Edward was promptly prosecuted and imprisoned in Arundel Castle. The Earl of Arundel secured his release on appeal to the king when visiting Arundel as a guest (Saul 2010).

Dallingridge's father negotiated his marriage to Elizabeth in 1364: this was the final of three key marriages which elevated the family in Sussex society (Saul 1998: 127). Elizabeth was the heiress of her father and through her Edward inherited all the lands at Bodiam as well as properties elsewhere (Saul 1998: 127). They were in possession of the lands at Bodiam by 1378 (Saul 1995: 19) following the death of Elizabeth's father. Sir Edward then began to amalgamate his lands in Sussex by selling off property in the Midlands and acquiring more land locally (Saul, 1995: 19). Dallingridge then turned his attention to his political career: he was from this point regularly appointed a commissioner of

array in Sussex, he was named a tax collector and became an MP (Saul, 1995: 20).

Having started his political career he began his building works at Bodiam. The current standing remains date to 1385 evidenced by a licence to crenellate issued in that year (see Appendix A). Some scholars consider that this dates the beginnings of his building works (Curzon 1925: 51) and others the culmination of this work (Saul 1995: 20). Whichever the order of the works, Dallingridge planned a large-scale undertaking and wanted to centre it at Bodiam. In 1383 he obtained a Royal Grant for a market and fair at his manor, moving it from a field adjoining the church; and in 1386 he was granted a second licence to divert the course of the river to power a watermill (Curzon 1925: 27).

We can compare him with his contemporaries in terms of his military career, his move into politics and his enhancement in local society. The late 14th century owners of both Scotney (Roger Ashburnham) and Ightham Mote (Thomas Couen) had similar backgrounds. All moved from a military career into local government. However, they all chose different styles of living. An assumption made about gentry society in this period is that men, like Dallingridge, Couen and Ashburnham, having moved up in local society chose to present themselves in the same way through living in similar types of building. At these sites, all situated close together, this is not true. Dallingridge and Ashburnham chose to build entirely anew while Couen developed a local watermill into a small manor house. Bodiam was built very quickly (within 10 years) on a large scale; while Ashburnham began a smaller build than the site at Bodiam and may not have ever been completed (Bannister 2001).

Bodiam remained in the Dallingridge family until 1470. Following the death of Sir John Dallingridge (Sir Edward's son) in 1407 the manor was retained by his wife Alice for the next 40 years. On her death instead of passing to Sir John's sisters children they are inherited by Sir Edward's younger brothers second son (following the death of his oldest child) Richard Dallingridge. Bodiam finally leaves the Dallingridge family in 1469 when it passed on to the Lewknor family through the marriage of Philippa Dallingridge Richard's sister. To see these relationships more clearly see Appendix B.

The Lewknor family held Bodiam until the accession of Richard III at which time a Sir Thomas Lewknor came into ownership of the castle. Born around 1456 Thomas Lewknor moved away from the family allegiance to the House of York and when Richard ascended the throne he was declared a traitor. In May 1484 Bodiam was besieged or surrendered without much military intervention. Although the property was returned to him after the Battle of Bosworth, it is assumed neither he nor his descendants continued to inhabit it.

From 1543 onwards the property at Bodiam experienced a long series of sales and divisions of property leading to the ownership of the castle being split in two. Around 1623 the Tufton family began to amass the separated pieces of estate in which they succeeded by 1635. They then sold on the property again in its entirety to Nathaniel Powell. It is either under his ownership or the Tufton ownership that the interior of the castle came to be dismantled during the Civil War. The Powells owned the property until Sir Thomas Webster entered into possession in 1725. After this the building fell into further disrepair and ruin.

In 1829 the castle was purchased by John "Mad Jack" Fuller to prevent the building from being further dismantled for building stone (Curzon 1925: 48). It is he who put in place doors to prevent the further plunder of stones from the interior of the building. It was not until George Cubitt took over the castle in 1864 that restoration work began on the internal and external ruins (Curzon 1925: 82). It was a combination of his work and Curzon's (whose work often overshadowed his predecessor) which led to the building appearing as it does today. Curzon left a detailed account of his undertakings at the castle in his book Bodiam Castle; much of his work can be seen in the stonework of the standing remains. On Curzon's death in 1926 the property was left to the National Trust which has maintained it ever since (Thackray, 1991: 10).

3.1.3   The design of the building

Dallingridge's licence to crenellate gave permission to "*strengthen […] and crenellate […] his manor house of Bodyham*". It was issued following a series of French raids on Rye and Winchelsea. Instead of fortifying or "*making into a castle*" the original manor house Dallingridge chose to construct a new building at a different location.

Bodiam is considered to be built in the perpendicular style (Curzon 1925: 10-11) with Henry Yevele, a prolific master mason who undertook a series of royal building works in the late 14th century, associated with organising the building work (Coulson 1992: 73; Harvey 1978: 107; Goodall 2011: 317). On closer inspection of the building a number of different masons can be traced from the marks (Figure 40) left in the stone on the building; this suggests that, although the original design may have been Yevele's the work itself hints at local builders undertaking the construction (Cooper et al. n.d.).

Figure 40: Mason's mark at Bodiam Castle in the Gatehouse. These are found all over the building.

The exterior of Bodiam is that of a quadrangular medieval castle, as discussed in chapter 1. The design can be traced to a range of earlier buildings found elsewhere in Britain (such as Harlech, Bolton and Maxstoke (See Figure 41, Figure 42 and Figure 43) (Nairn & Pevsner 1965: 419). Outwardly the building gives the impression of perfect symmetry and military strength (Thackray 1991: 1) the assumption being that the building was "*wholly planned*" before works started (Nairn & Pevsner 1965: 419). The castle rises directly out of the moat, without a berm (meaning that the stonework sits in the moat without a

raised space separating the castle from the water) (Coulson 1992: 88) and sits almost in its centre. With the added reflection and in combination with the surrounding watery landscape, the approach to the building makes it appear larger than it really is.

Figure 41: Maxstoke Castle (BritainFromAbove 2014)

Figure 42: Bolton Castle (WheretoWalk 2010)

Figure 43: Harlech Castle (CadwWelshGovernment 2014)

Bodiam itself is rectangular with circular (though not completely round) towers intersecting the walls at each corner and square towers in the middle of each wall. The northern and southern square towers were used as gatehouses, providing entrances to the castle. Domestic ranges line each of the external walls (Emery 2006: 317). The interior is a regular four-range house arranged in a courtyard plan. The house is tied into the outer walls, unlike the similarly shaped Harlech Castle where the internal buildings are separate from the wall. This internal planning at Bodiam suggests that the building was designed with consideration given to the interior layout and domestic comfort as well as the exterior appearance (Faulkner 1963: 235; Nairn & Pevsner 1965: 421). Within, the walls are high enough to provide two floors above basement-level cellars (see Figure 5: page 12), which are found all along the eastern elevation and at the base of each corner tower (see Figure 44) (Emery 2006: 317).

In reality the building is far more complex than the first outward and internal appearances suggest. The apparent rectangular structure is not regular with the chapel misaligning the eastern wall (Figure 45) and the circular corner towers intersect the walls in two different, irregular ways breaking their round appearance (Figure 46 and Figure 47). The martial interpretation of the building as protection from the French (Braun 2008: 106; Williams 1974: 10; Lower 1860: 227; O'Neil 1960: 49; Simpson 1931: 84; Platt 2007: 87) or from internal threat (Simpson 1946: 152), has long since been questioned (Coulson 1992).

The internal layout of the building seems a much easier thing to approach than the outward display; as such it has often been ignored. Most authors discuss the interior as having the standard domestic plan of a 14th century medieval manor house (Emery 2007; Faulkner 1963). The entrance to the main gatehouse is accessed over a series of two drawbridges (though no mechanism has been confirmed for their ability to move up or down) and through a barbican. The gatehouse is decorated with a series of armorial shields (Dallingridge, Radynden and Wardieu) and Dallingridge's tourney helmet is engraved onto the stone (Figure 48), which would tower overhead before a visitor walked under the portcullis through an outer gatehouse and into the courtyard (which is discussed in more detail below).
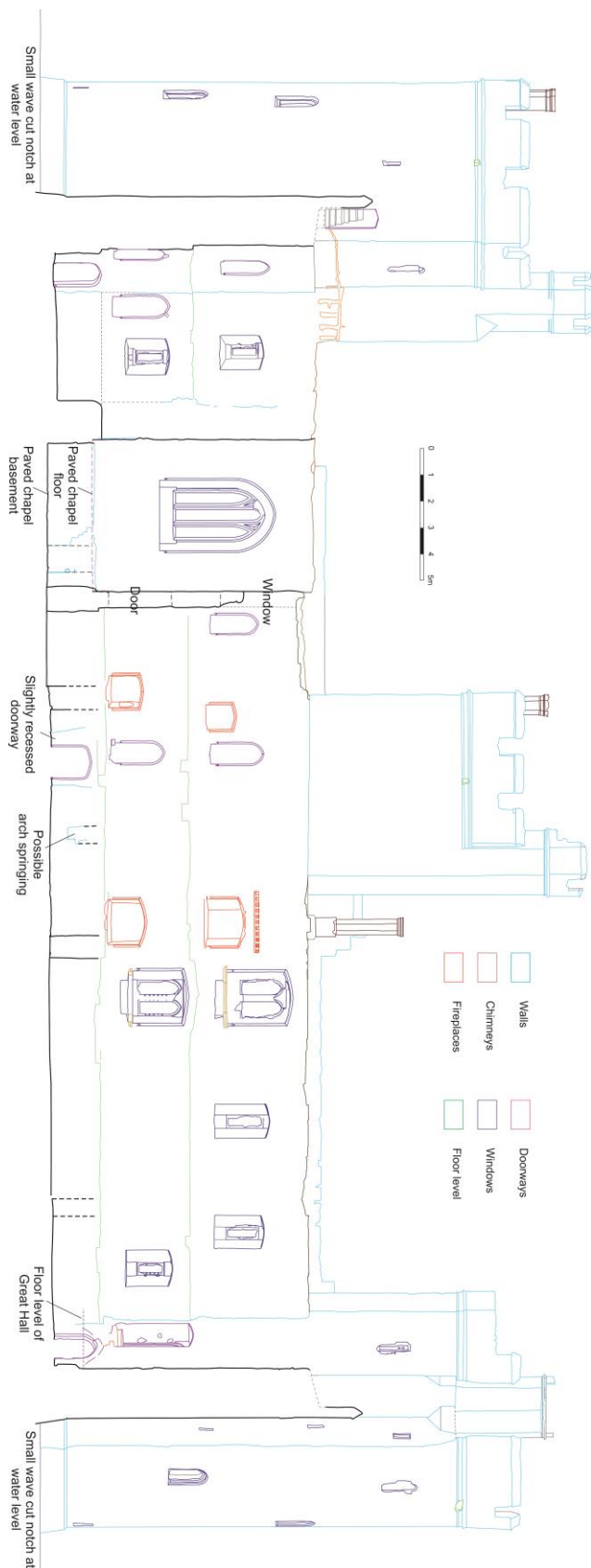
Figure 44: Elevation drawing of the Eastern Elevation of Bodiam Castle. Survey work undertaken by myself and Penny Copeland with James Miles and University of Southampton students. Drawn by Penny Copeland.

Figure 45: Eastern elevation showing the misaligned Chapel wall, photo taken from the east. This is one of the examples of how the building is not as symmetrical as it first appears.

Figure 46: The north-west tower taken from the courtyard. The tower is different from the towers in the rest of the building, the circular appearance is cut into in the interior of the building unlike the south-east tower in Figure 47

Figure 47: South-east tower taken from the west of the courtyard. Compared to Figure 46 the internal appearance of the tower is different. It "chamfers" the internal curve.

Figure 48: Heraldry at the Gate of Bodiam Castle. The shields are the arms of Radynden, Dallingridge and Wardieu (from left to right) with Dallingridge's tourney shield pictured above.

The southern and eastern elevations are lined with the typical layout of kitchen, pantry and buttery leading through a screen passage into the Great

Hall at the lower end; whilst the high end of the Great Hall has an entrance into a private suite of chambers, which leads through into the Chapel (Johnson 2002: 20). It is the other elevations that prove more challenging. The plan supplied by the National Trust based on a survey made by J. Tavenor Perry in the early 20th century (Curzon 1925: ix) suggests that the western elevation was used by servants and the garrison (a fact that was repeated by Simpson (1946)), while the north eastern corner features suites of apartments for the household or guests (Figure 49). There are no plans for the other levels of the building.
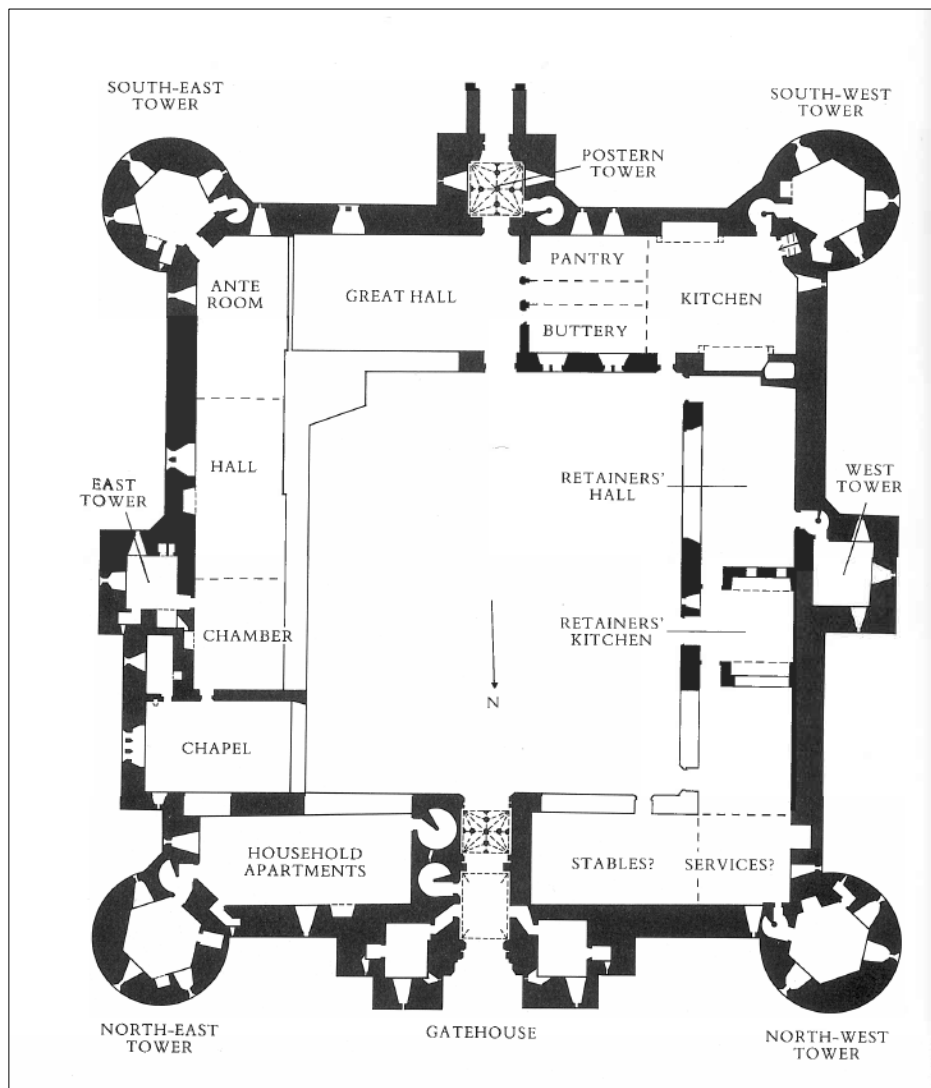
Figure 49: National Trust plan of Bodiam based on the Tavenor Perry illustration produced for Curzon's survey of the building

As a result of this between 2010 and 2012 Penny Copeland and I undertook a complete resurvey of the building. We produced floor plans for each level of

the building and elevations of the east range (see Figure 50, Figure 51, Figure 52 and Figure 44: page 120). Through the undertaking of this survey we learned much about the construction of Bodiam and how the building has been changed since its original construction. Although at first this building appears well planned; closer observation suggests otherwise. Faults in the building works, changes of mind and overall indecision can still be seen in the stonework today (Cooper et al. n.d.). They include areas where windows have been built at floor level across two levels (Figure 53), long straight (or pig) joints in the stonework where two different teams of masons or gaps between seasons of work have left a joint in the masonry until the coursing levels out (Figure 54). Closer observation also reveals a series of discrepancies which imply that the design of the construction has changed following its outset. The best example of this can be seen on the north-western tower: here the string course ends short of the corner of the tower where the beginnings of a corbel can be seen (Figure 55).

These are just a few of the inconsistencies found in the building works; the rest will be detailed in Cooper et al (2013). The western elevation provides even more challenges for interpretation. Tavenor Perry's survey found in Curzon (1925) suggested the rooms were servant's quarters and a garrison. These descriptions are problematic. There are a series of fireplaces which are larger than those in the rest of the building (Figure 56). The windows facing into the castle are ornate and are decorated with tracery (Figure 57). Finally this area of the building shows evidence for an impressive timber framed ceiling by way of a series of recesses in the curtain wall (Figure 58).
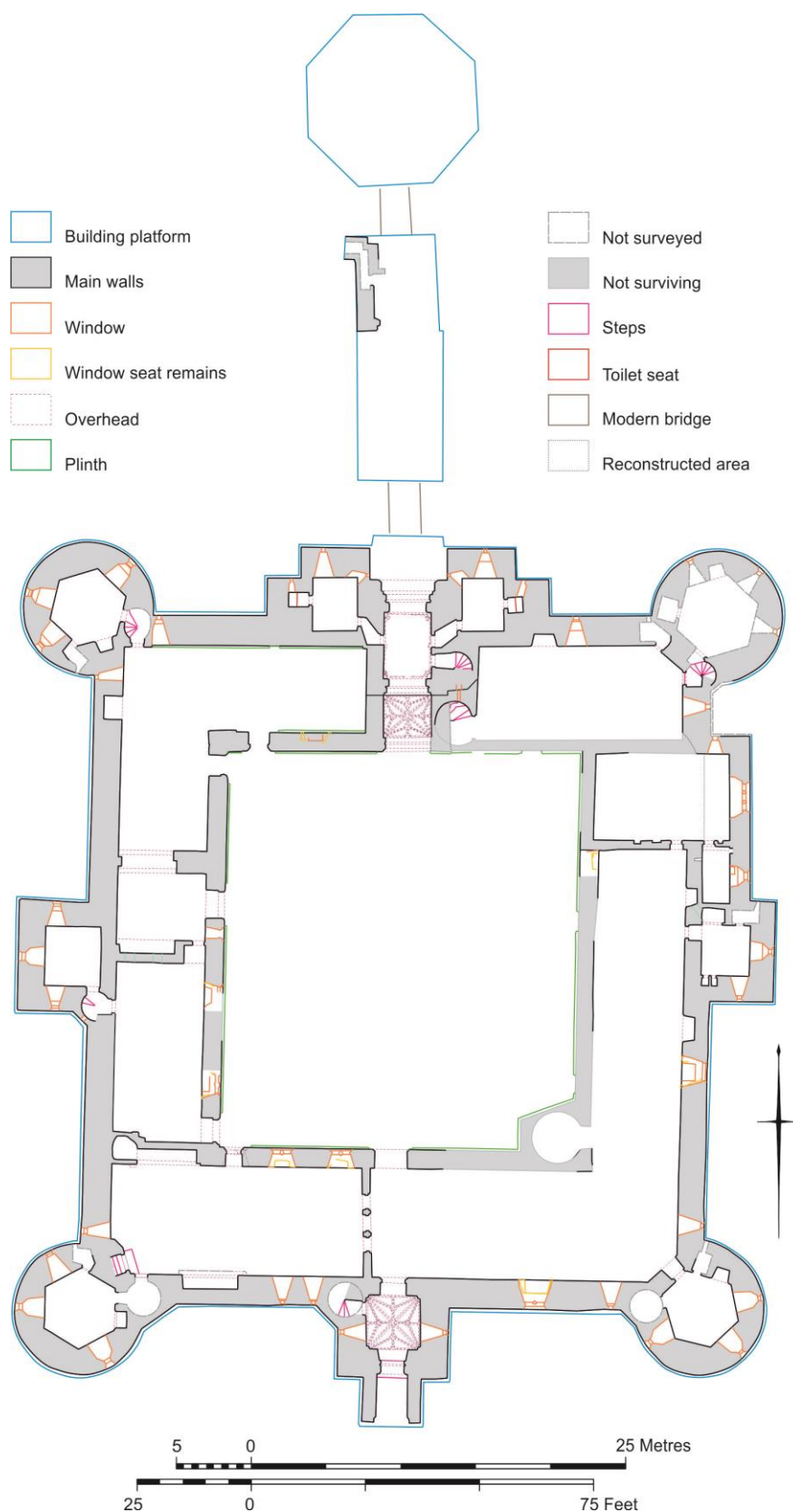
Figure 50: Completed Ground Floor Plan. Survey work undertaken by myself
and Penny Copeland with James Miles and University of Southampton students.
Drawn by Penny Copeland.

Building platform
Main walls
Window
Window seat remains
Overhead
Plinth

Not surveyed
Not surviving
Steps
Toilet seat
Modern bridge
Reconstructed area

5   0   25 Metres

25   0   75 Feet
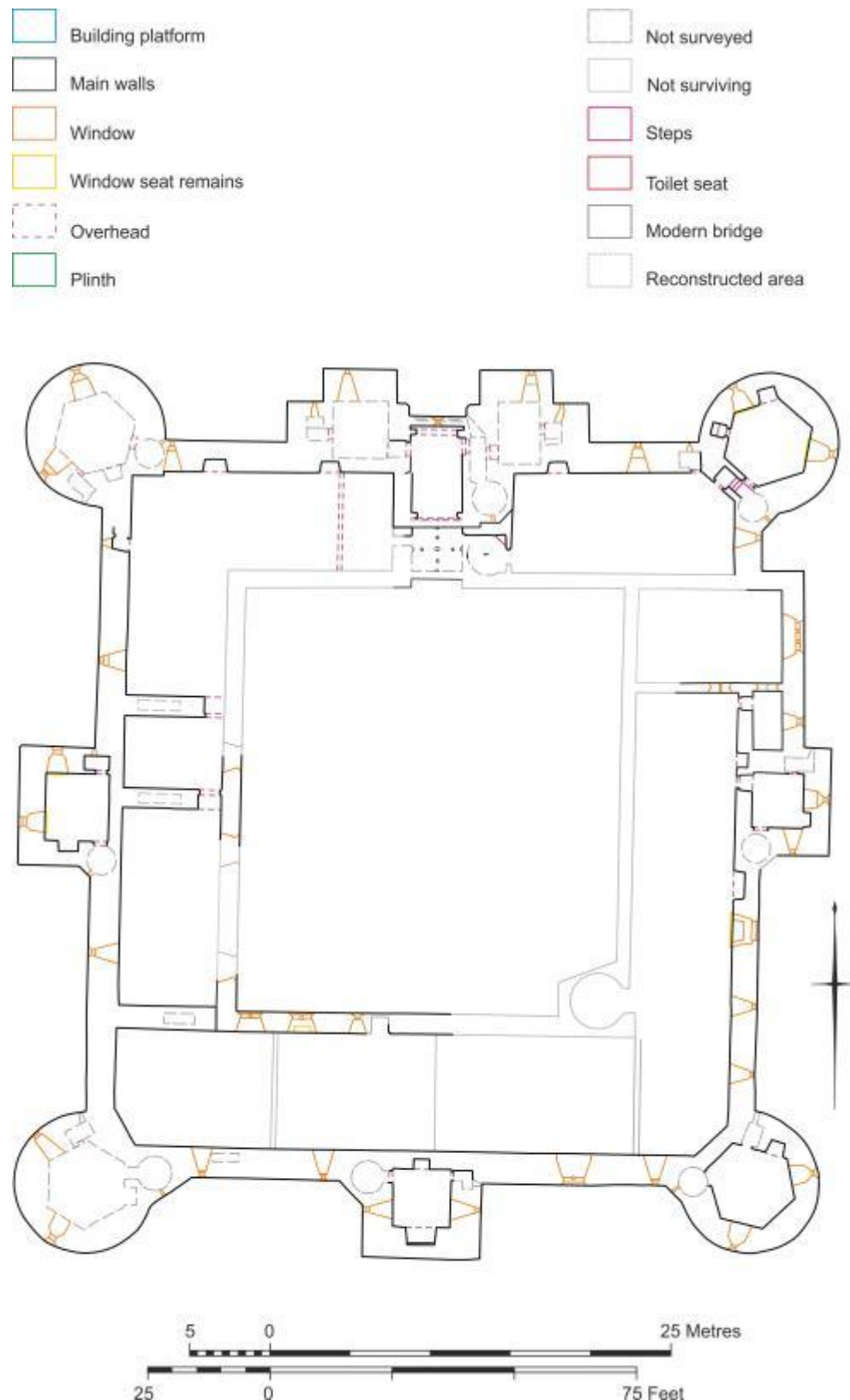
Figure 51: First floor plan of Bodiam Castle. Survey work undertaken by myself and Penny Copeland with James Miles and University of Southampton students. Drawn by Penny Copeland.
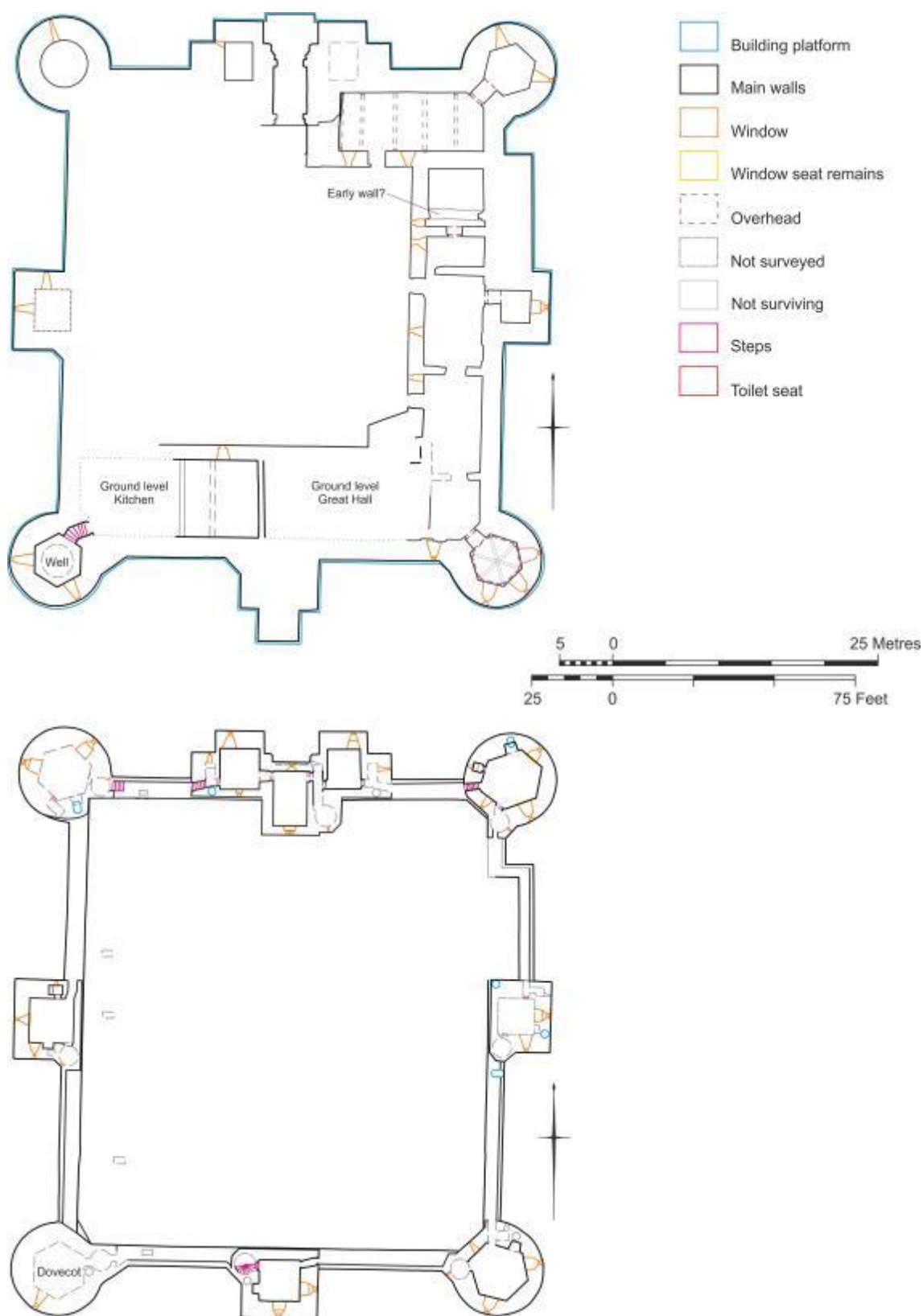
Figure 52: Basement level floor plan (top) and second floor plan (below). Survey work undertaken by myself and Penny Copeland with James Miles and University of Southampton students. Drawn by Penny Copeland.

Figure 53: Kitchen window below floor level. Probably evidence for a cellar for storage below the buttery.

Figure 54: Straight Joint in masonry on the northern elevation. This probably represents the break between two seasons of building works during construction.

Figure 55: Corbel and string course on the north-western tower. This is one of the pieces of evidence for a change of mind during the construction of the castle.

Figure 56: Western range fireplace. Here the opening of the fireplace has changed direction multiple times.
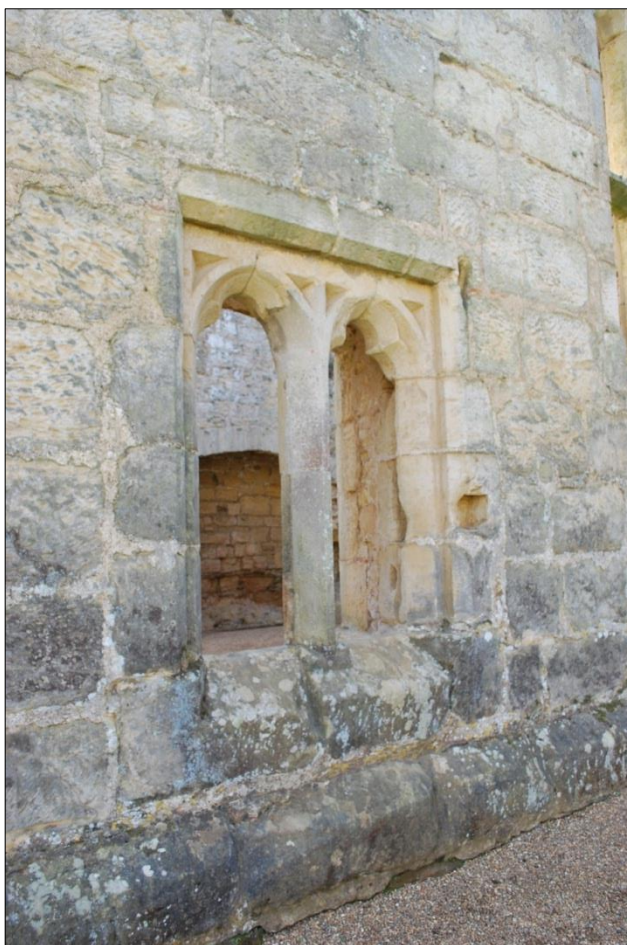
Figure 57: Western range window seat.
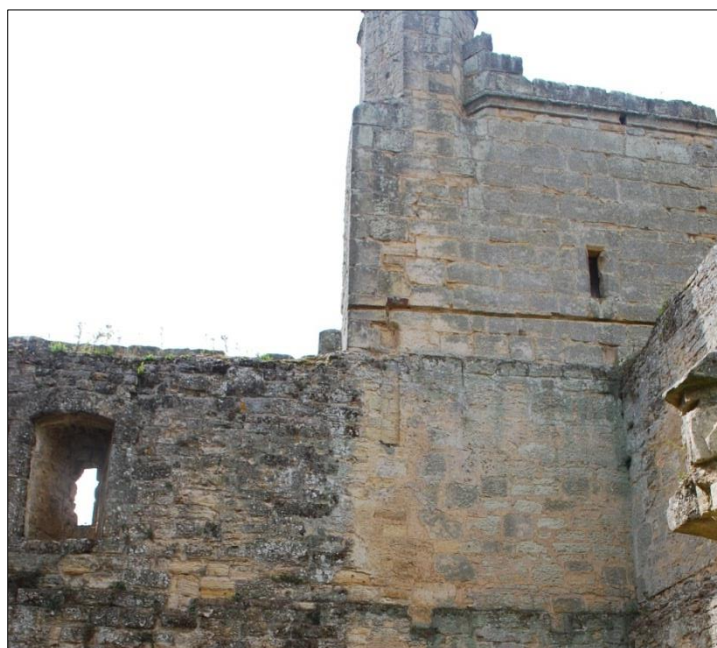
Figure 58: Western elevation roof recess on the west tower.

3.1.4   Heraldry at Bodiam

For guests of status the approach to Bodiam Castle could have been a long and complex journey through a carefully constructed landscape, designed to show the castle off to its best advantage and exposing the guest to a series of armorial shields. The route taken followed the edge of the moat, along the southern face of the castle, past the postern gate, and then around to the main gate on the northern face. Even if this extended journey was not untaken all those entering the building they would have been greeted by shields adorning both the postern tower and the gatehouse.

The remains of three coats of arms which can be found on the gatehouse (Figure 48: page 123), have been attributed to a number of owners. It has been agreed that the central shield represents the arms of Dallingridge (Lower gives an in depth account to the origins of the shield (Lower, 1857: 287)) and at least one of the others represents the arms of his wife, Elizabeth Wardieu, but sources disagree whether this is the left shield (Thackray 1991: 31; Morris 2003 : 152) or the right (Clark 1884: 246; Curzon 1925: 59; Sands 1903: 123).

The suggestion that the other shield was that of the de Bodeham family (Clark 1884: 246; Curzon 1925: 59; Sands 1903: 123; Tipping 1921: 244) who owned the land a century earlier can be easily dismissed as their coat of arms is featured in a number of Rolls of Arms (The Dering Roll) and does not resemble that of either the left or right shield (see Figure 59) (Timms 2011). Thackray (Thackray 1991: 31), Morris (Morris 2003: 152) and Curzon (Curzon 1925: 59) instead suggest the arms of Radynden fill the gap. The manor of Radynden was inherited by Edward from a relative before the building of Bodiam.

Figure 59: De bodeham arms from the Heralds Roll (College of Arms MS B.29, 14 657)(Timms 2013)

On the Postern Tower three more shields and another tournament helmet are featured. The tournament helmet and the only shield with engravings bear the

arms of Sir Robert Knollys. He was Sir Edward's patron and his captain in the wars against France (Thackray 1991: 31; Curzon 1925: 61). His coat of arms is featured at an angle of 45 degrees (see Figure 60).

Figure 60: Heraldry found on the postern tower at Bodiam. The shields to left and right have been left blank while the centre shield and tourney helmet above belonged to Sir Robert Knollys.

3.1.4.1   Background of Heraldry

The origins of heraldry are often assumed to be a method of identifying combatants whilst on the battlefield, as a man in armour is hard to recognise. It is a further recognition of status, in a feudal society: in that the creation of coats of arms is bound up with your right to hold land and therefore the return

from undertaking military service. If you held a coat of arms you would have earned the right to hold land, you would therefore be one of a select group, someone with the right to lead. The coats of arms were, therefore, not just a way of distinguishing your leader or opposition, but also a way to distinguish a man of status and noble rank (Fox-Davies, 1909: 19; Woodcock & Robinson, 1988: 1-2).

This argument has since been strongly contested: military service was just one method of obtaining land tenure and even before closed helmets were commonly adopted men were riding into battle bearing coats of arms. The bearing of arms was actually the result of an individual demonstration of vanity and display; and rather than a method for recognition on the battlefield, it was more likely a method for display and status at tournament. As the rules of tournaments restricted those entering to the elite, only those would as a result bear arms. Still at these early origins of coats of arms were self-assumed, owners frequently altered them at a whim (Round, 1920: 324; Woodcock & Robinson, 1988: 2-3).

The first shields were simply decorated and many of the patterns were based on stripes or crosses of bands of leather. These provided extra strength to the wooden surface of the shield and a surface for painting. These patterns became increasingly complex and elaborate developing rules and terminology in there creation as their use became widespread. The increasing complexity included creatures and the introduction of quartering the coats of arms with other coats of arms from which the individual could draw lineage (Woodcock & Robinson, 1988: 12-3). This came to be organised through a series of laws and a terminology for the meanings of what they depicted. With the general assumption that no two people could bear the same coat of arms, they were considered personal property and used as a method of distinction (Woodcock & Robinson, 1988: 14).

3.1.4.2   Language and Meaning

There is a detailed language that goes into understanding what each coat of arms means including the tinctures which covers metals, the colours and furs featured on the device and each has an order of distinction associated with it. Every shield is made up either of a single one or a combination of these tinctures. There is a whole vocabulary used to understand the blazon (formal

description of a coat of arms) which denotes positions and divisions of the coat of arms (Woodcock & Robinson, 1988: 52).

It was not until arms were inherited from past family members that it became heraldry as we think of it today. Only when the devices were used for more than distinguishing an individual but were wrapped up in family motivation did it become true heraldry (Crouch, 2002: 29). Symbols like this had an earlier origin than use on shields as civil personal marks (Woodcock & Robinson, 1988: 4-5), or seals which appear to originate from north-eastern French provinces as early as 1090s (Crouch, 2002: 29). These were a series of devices created by the descendants of Roger de Beaumont who adopted seals with the same checked device. This is evidence that aristocratic attitudes were turning towards lineage and family becoming increasingly important (Crouch, 2002: 31).

3.1.4.3   Women and Heraldry

It is not unusual for heraldic devices to follow the female line rather than the male (Crouch, 2002: 33). Suggesting that female lineage is of equal interest to male interest. Theoretically women did not hold arms in their own right. However, heiresses did, (taking their fathers arms after their death) (Alexander & Binski, 1987: 44) or they created a meld of both father and husbands arms (Alexander & Binski, 1987: 56).

Of particular interest to the Dallingridge family is the presence of Elizabeth Wardieu's shield on the gatehouse. Elizabeth has taken her father's coat of arms not Dallingridge's the presence of this device on the gatehouse suggests they are putting forward her own personal status (Bedos-Rezak, 2006: 360-1). Bodiam was built on the lands that came from Elizabeth following the death of her father. The placing of her arms highlights her part in the creation of the castle.

3.1.4.4   Heraldry and Architecture

Displays of heraldry in architecture have been used since the middle of the 13th century. These displays have been termed as decorative in the same way they have been used to decorate metalwork, tiles and other wall decorations (Woodcock & Robinson, 1988: 172). However, their description of being only used as decoration has to be questioned. Instead we should question why

these devices were displayed and what the significance was of where they were being displayed and what people (of all classes) would have understood from their positioning. Would the encounter for a peasant have different meaning than that of a noble man?

Particularly in reference to Bodiam, as stated above, it is not the Lord's coat of arms that can be seen from the service entrance (the postern) but his commander (Sir Robert Knollys). Why is this? What does this mean for the people entering from this entrance instead of from the main gate? People have often suggested that the positioning of a local commander meant to tie the two families together. But why were they not displayed together rather than being found at opposite ends of the building. Significantly Knollys' coat of arms is not found in a position of social prominence, being positioned over the postern gate.

At Ecclesiastical sites architecture (among other visual signals) provide cues to important social information about what is expected of them at a particular point and also what they are meant to feel and be thinking about (Woolgar, 2006: 179-180). On clothing heraldic badges highlight allegiance and identity (Woolgar, 2006: 181), devotional practice, family ties and deeds of valour were all associated with deeds of heraldry (Woolgar, 2006: 183)

3.1.4.5   Experiencing Heraldry

By examining knighthood, lineage and association Coss explores this process of encounter for a contemporary, a knight (Coss 2001).

At Bodiam the shields displayed at the Gatehouse detailed not only the Dallingridge coat of arms but also those of his wife and, supposedly, another relative. These links are placed here to emphasis rich ancestral history of Dallingridge and the age of the family they suggest lineage to as well as knighthood and lordship (Coss, 2001: 48). Heraldry is used to project self through associations (Coss, 2001: 58) to stress dominion and a centre for administration (Ailes, 2001: 85). Through the display of heraldry of these particular families Dallingridge was making a statement about his importance and how he wished to be perceived by his contemporaries. He was also making up for the lack of old building by emphasising the age of his ancestors and providing links to his lineage (Johnson, 2002: 29).

This links with the presence of his old leader Sir Robert Knollys arms and tourney shield on the postern tower showed his continuing loyalty and allegiance with his old leader under whom he excelled in France (Thackray 1991: 31; Curzon 1925: 61) and with whom he could still draw relationships.

At Tattershall links between the castle and the local church can be found through the heraldry adorning both buildings. At Bodiam the same is true; the coat of arms of the Dalligridge's can be found at both buildings (Simpson, 1931: 82). Neither Edward nor his son John were buried in the church in Bodiam: they were buried at the nearby Robertsbridge Abbey presumably with some form of heraldry adorning their tombs. Found at these places their meaning was evidently stating "this is mine" giving the Dallingridge's a personal identity with not only their own home, but also a building of some significance in the locale (Johnson, 2002: 61).

This display of ostentation at Bodiam has been designed to emphasis the status of the builder and highlight the age of the family and its importance (Thackray 1991: 31). Encountering it at the final approach to the building implies it was for those he would consider of his class to behold and would highlight his rank as well as how he would like to be perceived. The inclusion of his tourney helmet shows the world that Sir Edward is of the necessary status to compete in tournaments. His choice of the unicorn, a symbol of purity and virtue and linked with Christ, was rarely used before this period and possibly a suggestion of his strength being linked through Christ against his foes (Thackray 1991: 31). The presence of Sir Robert Knollys' arms and tourney shield show his continuing loyalty and allegiance with his old leader under whom he excelled in France (Thackray 1991: 31; Curzon 1925: 61).

3.1.5   The setting

By building in a new area Dallingridge had the choice of a new position and a clean canvas with which to work (Clark 1884: 241) allowing the site to be completely transformed by the builder. Originally theorised as a strategic move (Tipping 1921: 242; Sands 1903: 115), it was most likely to do with the access to the river (Coulson 1992: 86) in combination with a natural pooling of water on the site (Coulson 1992: 87). This allowed for the easy creation of the moat by excavating this area, and retaining the water by building an earthwork to

the east and raising the level of the land to the south (Clark 1884: 241). Goodall suggests that the location was chosen as a concession to John of Gaunt following a disagreement that resulted in Dallingridge's imprisonment. The site of Bodiam was selected as a location for principle residence instead of the family seat of Fletching which was considered too close to Gaunt's estates (Goodall 2011: 314).

Not only did Dallingridge choose to build, he also chose to completely transform the landscape surrounding the location. As well as the features discussed above, the moat is fed by a stream running down a series of earthworks to create ponds and pools of water to the east and by a number of springs in the moat itself (Curzon 1925: 52). There are also ponds to the west which are now seen as a marshy valley with the remnants of walkways on either side (Taylor et al. 1990: 155). To the east a pond is used as drainage for the moat. There may also have been a number of other pools of water found to the south of this eastern pond, but this area has been used as a deposit for the dredging of the moat and the topography may have been much altered. The last water feature, directly south of the castle and now known as the tiltyard, could be the remains of the mill pond; to the west of this over a flat-topped bank another low lying area has been interpreted as the location of the medieval harbour (Taylor et al. 1990: 155) (Figure 61).
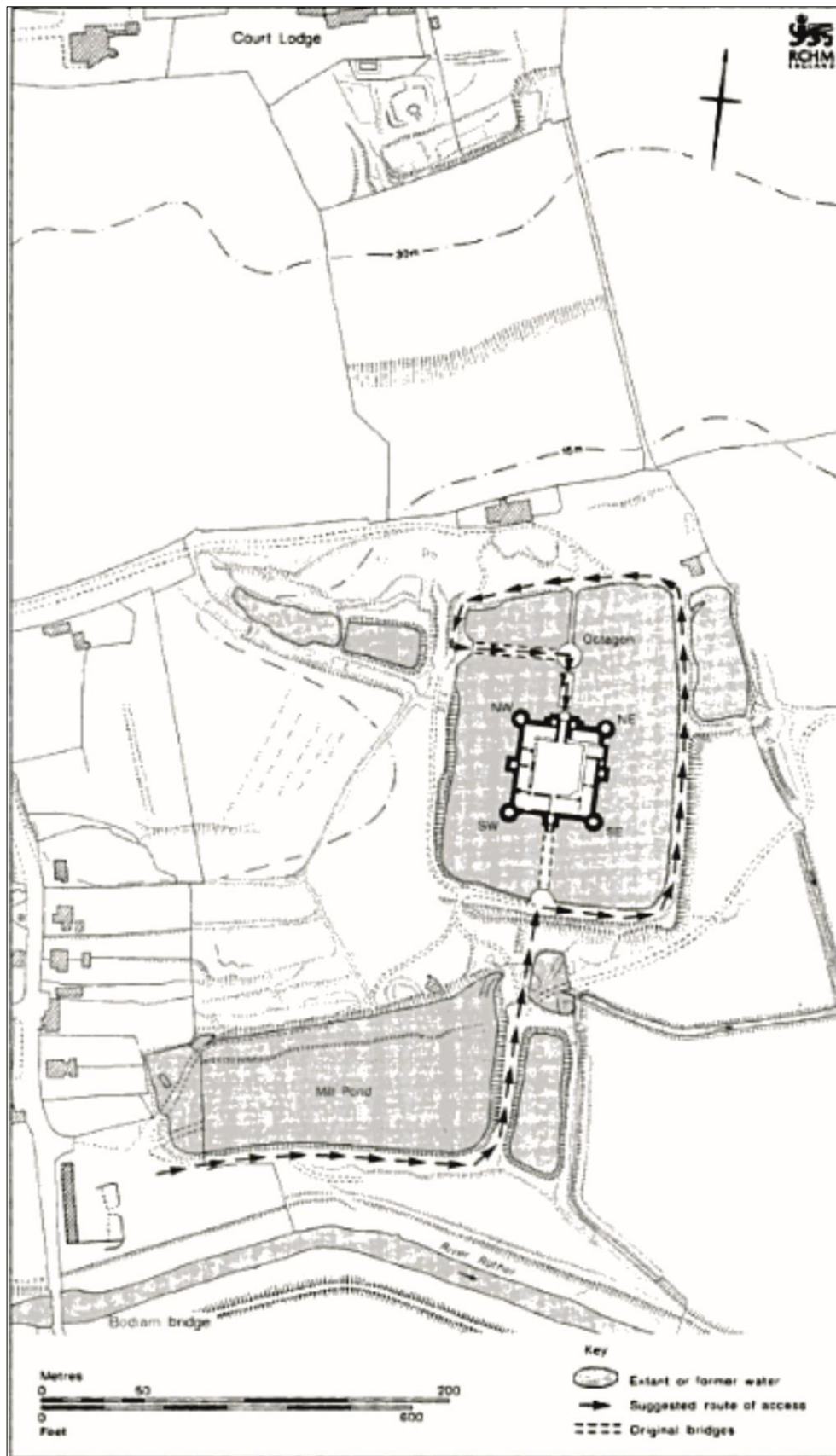
Figure 61: Approach to Bodiam detailed by Everson (Everson 1996a). Approach is dictated by the series of pools of water

To the north of the castle and further up the hill are a series of earthworks traditionally called the Gun Garden or viewing platform. It is here that a number of sources suggest that an assault on the castle was based (discussed in more detail in section 3.1.2) (Lower 1857: 302; Timbs & Gunn 1872: 367). Lower and Timbs & Gunn suggest that these earthworks were used as gun embrasures (O'Neil 1960: 107; Sands 1903: 132; Simpson 1931: 96). Excavation on this terrace in 1961 undertaken by the Battle and District Archaeology Society suggested that these earthworks were actually the remains of a medieval building (English Heritage 2007), potentially the old manor house that Dallingridge chose to replace; or that the whole feature was instead used as a viewing platform to look over the castle either during construction (Thackray 1991: 11-2) or after, as it shows the castle in its full glory (Johnson 2002: 26; Taylor et al. 1990: 157; Everson 1996a: 70). This fits with Steane's theory that building positions were selected to highlight builders importance (Steane 2001; Emery 2007) .

All of the earthworks are the remains of elaborate gardens and water features designed to set the castle in a carefully composed landscape. This designed landscape appears to have been produced to enhance the appearance of the castle as well as to carefully control access and to display the castle from its best aspects. These features are usually associated with features of much later buildings, but Bodiam lacks post-medieval development and was not occupied in later years (Everson 1996b). Everson continues to suggest that this series of earthworks and sheets of water were designed with the intention of manipulating the route of the visitor towards the castle, providing an elaborate setting and enhancing the visual appearance of the castle (Everson 1996a). It also suggests the possibility that this region was used as a pleasance or a garden (Taylor et al. 1990: 157).

Bodiam has been long considered as a designed landscape. However, it can also be construed as an economic landscape. As discussed in section 3.1.2 Dallingridge acquired a license to hold a market and air close to his castle moving it closer to the building. The position of the mill is still debated with various areas to the south of the castle suggested as possible locations (Whittick 1993). However, with the move of the castle to this location close to the river, water connections with Rye were possible along the Rother. This raised the possibility of bringing building resources to the site via the port;

and also provided a means of communication and trade to the new position of the castle (James et al. 2008: 14). Finally, results of the Elite Landscapes in Southeastern England Project have highlighted, through geophysical survey, a series of features to the west of the castle. The magnetometer results (which are good at detecting burnt material such as ovens, kilns and hearths) show a series of features which we hypothesize as an area of industrial working (see Figure 62 and Figure 63) (Barker et al, 2012).

Figure 62: Grayscale image of the magnetometer survey results from the area to the west of the castle (Barker et al. 2012). See Figure 63 for the interpretation
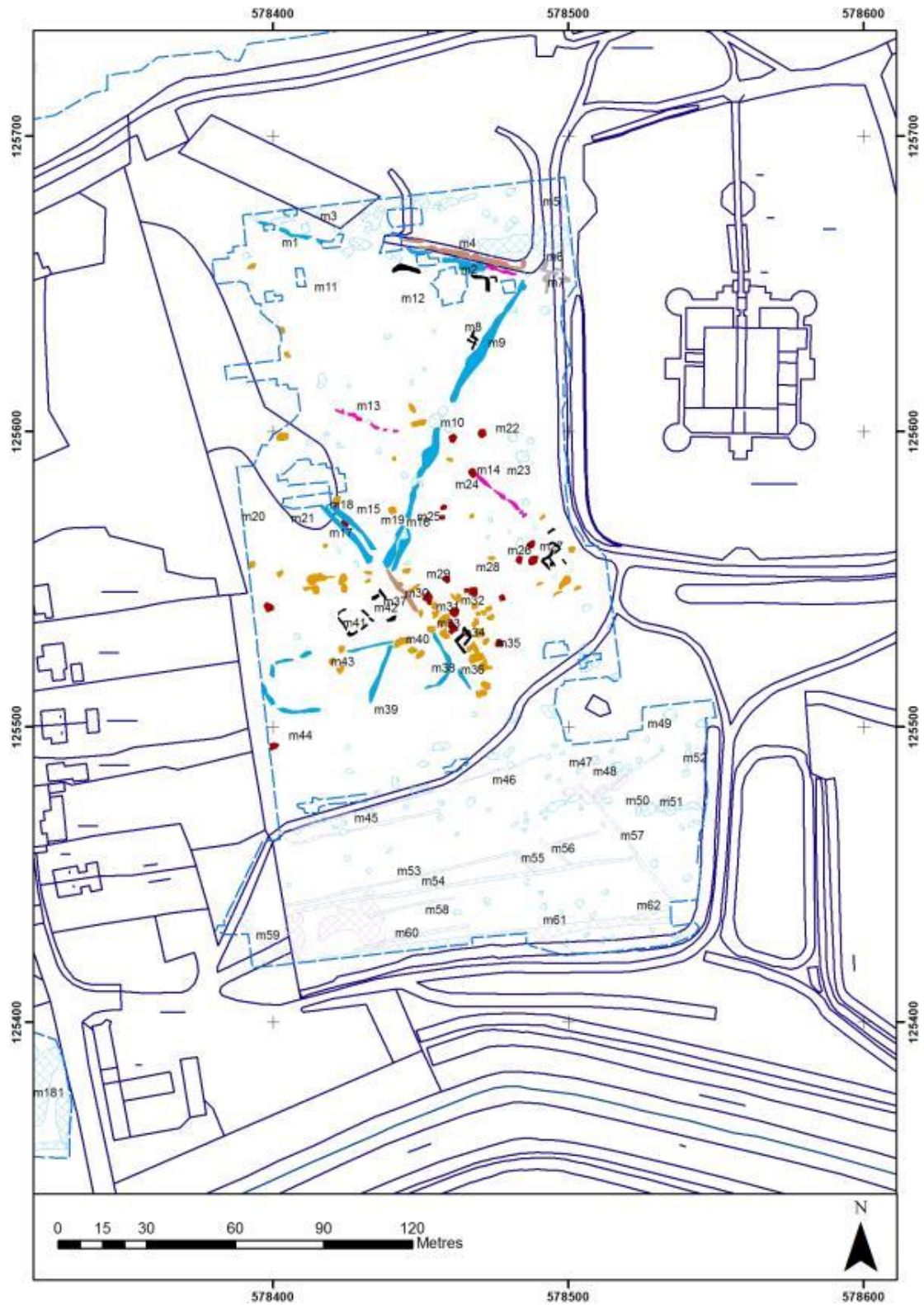
Figure 63: Interpretation of the magnetometer survey (Figure 62) the coloured lines represent anomalies in the results. For discussion see Barker et al (2012)

3.2   Work already undertaken on the site

The building has been the focus of study by architects (Goodall 2011), art historians (Hohler 1985), archaeologists (Johnson 2002), historians (Coulson, 1992) (Saul 1995), oral historians (Woodman 2012) and heritage workers (Thackray 1991). It is described as the most written-about castle in the whole of England and Wales (Johnson 2002: 19).

Much of the literature concerning Bodiam, especially the early writings, discussed its structure and style in comparison with other buildings of the periods leading up to and after its construction. These tend to compare it to contemporary buildings in different areas such as Bolton (Toy 1953: 212), Westenhanger, Saltwood, Scotney (Platt 1982: 113) and Leeds (Tipping 1921: 242). They equally argue that Dallingridge had been influenced by buildings on the continent in his design (Savery 1868: 355; Sands 1903: 1222). They are trying to write Bodiam into a typology, which as I discussed in section 1.2.1 is problematic.

These early writings also discussed the military role Bodiam had to play, working from the Licence to Crenellate (See Appendix A) suggesting it was built to defend against French invasion (Braun 2008: 106; Williams 1974: 10; Lower 1860: 227; O'Neil 1960: 49; Simpson 1931: 84; Platt 2007: 87). The internal appearance of the building and further study has suggested that the building is in fact a house fortified, not a castle with a major military role (O'Neil 1960: 16; Mackenzie 1896: 64-6; Simpson 1931: 85; Faulkner 1963: 230; Platt 1982: 119; Brown 1970: 144). Faulkner's (1963) analysis of the domestic arrangements within the building suggests that much of the planned building work was related to the internal layout (Figure 23: page 50)(Faulkner 1963: 230). Indeed the main entrance of the building does give the impression of military strength. These writers discuss the towers and wall walks lined with machilations surrounded by a moat, two drawbridges limiting access to the building and forcing the visitor to cross directly in front of the castle gun loops. Then on arrival at the gatehouse the visitor hast to pass through two portcullises.

Curzon, who purchased the building in 1917, began the first encompassing study of the castle. He worked largely towards its restoration and, as stated

above, it is to him that much of the work has been attributed in saving the building. He undertook the first formal survey of the building and research into its past. He published his record of all his investigations including an accurate description of the building as it stood in his time, the history of the building and its owners and the work he undertook for conservation purposes (Curzon 1925: xiii-xiv). His book gives a comprehensive overview of the building and its history but he pays little attention to the experience of living in the building during the medieval period.

Simpson was the first to critique the idea of Bodiam as a military structure; although his argument is largely discredited today he suggested that, as well as being an externally defendable structure, it is the internal design that was intended to defend against the enemy within: mercenary troops. Bodiam was built during a period when lords needed to provide quarters for professional soldiers to protect them from the results of private quarrels. This housing of a garrison not only required the provision of quarters for the troops, it also meant that the lord's quarters would need to be more secure to protect from swaying loyalties (Simpson 1946: 152). In the case of Bodiam the housing for the garrison is completely isolated from the rest of the buildings (Simpson 1946: 159).

In the early 1990s Bodiam became the centre of a vigorous academic debate as to its purpose and function (Emery 2006: 317). The Battle for Bodiam or the Defence v's Status debate was the result of two different approaches to the study of the building and the lands surrounding it. Charles Coulson began by arguing that on close examination Bodiam is less defensible than it appears from first glance (Coulson 1992). He undertook a detailed survey of the castle in combination with a study of licences to crenellate. He then examined the standing remains to state categorically that Bodiam would not have been able to withstand substantial attack (Coulson 1992). Instead he concludes that the gaining of a licence to crenellate agrees with their later use to build houses not for protection but for ostentation and display (Williams 1974: 8; O'Neil 1960: 29). This is reflected by the presence of not only Dallingridge's armorial shield, but that of his family and Sir Robert Knollys (Thackray 1991: 31) in a show of heraldic display above both gatehouses. Displays of heraldry in this context show the wish to project an image of oneself on those encountering the

engravings and as a method for recognition of the coats of arms (Coss 2001: 58; Crouch 2002: 29; Woodcock & Robinson 1988: 52).

While Coulson was undertaking this research from a historical background the Royal Commission were undertaking a survey of the grounds surrounding the castle. The results show the earthworks are the remains of elaborate medieval gardens and water features designed to set the castle in a carefully composed landscape garden (Taylor et al. 1990: 157). Everson suggested that these earthworks control the approach to the castle (Everson 1996a: 69). Curzon suggested that the route taken would start in the north-west corner where one would skirt around the series of ponds leading into the moat (Curzon 1925: 114). Instead Everson suggests that the design of the landscape intended visitors to approach from the west and south of the tiltyard (Figure 61: page 139). If approaching from the north to this point the castle would not yet have been visible. On reaching the tiltyard the castle would be seen across a body of water but the moat would not yet be visible. The visitor would then progress along the edge of the tiltyard towards the castle along a flat-topped bank separating the tiltyard from the suggested 'harbour'. As the visitor ascends, the moat would suddenly come into view enlarging the castle dramatically. The gatehouse visible from the tiltyard would then be acknowledged as the postern and the important visitor would set off to the right around the edge of the moat, surrounded on both sides by water and overlooked by the principal apartments and chapel. On reaching the northern edge of the moat the distinguished guest would have to pass in front of the gate house to reach the bridge across the moat on the north-western corner, situated again between the moat and the series of ponds (Everson 1996a: 69; Johnson 2002: 26).

The two arguments, Everson's landscape survey and Coulson's study of License to Crenellate, taken together highlight this important stage of building in which it was no longer the martial aspects of the castle that were important but the statement that Sir Edward Dallingridge was making to the rest of the world.

3.3   Use of Space

In chapter 1 I discussed how different disciplines have approached the use of space in buildings. Analysis of the internal space at Bodiam, as previously discussed, has been limited to studies of the external appearance and setting

of the building. To date most of the studies have been limited to applying a range of techniques (detailed above) to reassess the floor plan.

Above I stated that Simpson discusses the building in reference to his ideas on bastard feudalism through the enforced division of space, in the building, by the owner (1946: 159-60). Faulkner also explored the interior of Bodiam as a residence through the structure of the layout (further discussed in section 1.2.3). He demonstrated that the internal layout was planned before Bodiam's construction and not designed to fit the completed exterior which had always been assumed about the building of castles (Faulkner 1975: 150-1). He also highlights the internal layout as being of similar design to the other examples: he analyses Goodrich, Bolton and compares them to Chepstow, Corfe, Caerphilly and Beaumaris (Faulkner 1963) Figure 23: page 50 shows his planning analysis of Bodiam.

Beyond these two studies of the use of space at Bodiam few people have touched on the questions surrounding the interior. Pevsner briefly discusses the layout in his Buildings of England (Nairn & Pevsner 1965) while the Trust guidebooks give a good walking tour and discussion of the space (Thackray 1991). Emery in his impressive study of Greater Medieval Houses touches on the layout but mainly introduces the wider debate surrounding the castle (Emery 2006) and Coulson while addressing the building's defensibility comments on varying aspects of the internal layout that are relevant (Coulson 1992). Most recently Goodall presents a reconstruction of the interior of the building but failed to include much discussion on what it showed (Figure 64)(Goodall 2011).
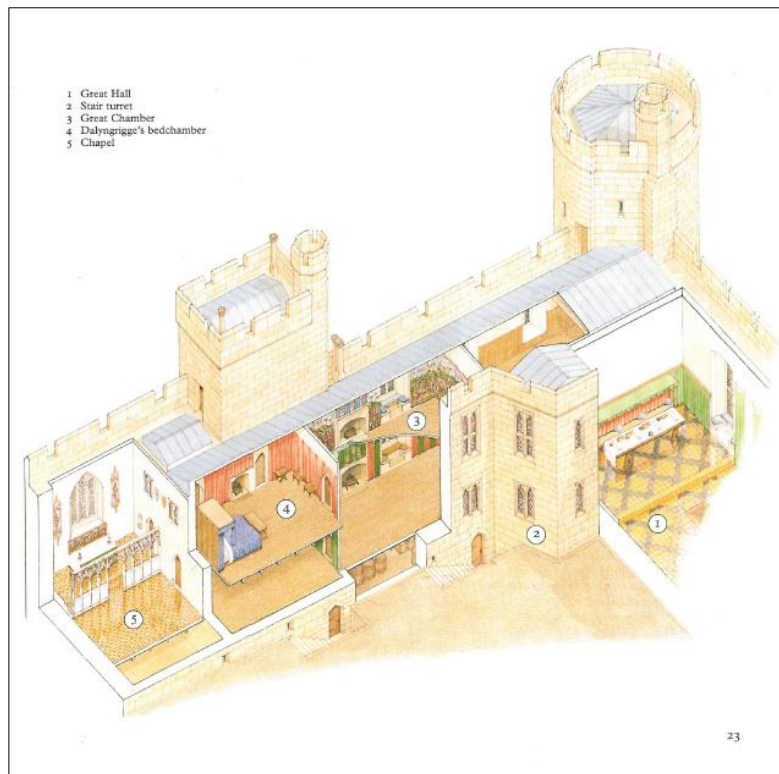
Figure 64: Bodiam Castle guidebook's visualisation of the eastern range, it is also found in Goodall's The English Castle (Goodall 2011: 23)

3.4 The visualisation project

The debate concerning the intended use of Bodiam Castle has stalled. It can be argued that it was a martial building, the centre of a designed landscape or a symbol of power to those visiting. However, what Dallingridge intended with its construction is not something that we will ever know and no more work on the building will answer (Johnson, 2012: P. Comm). Beyond Bodiam Castle, discussed in chapter 1, the study of late medieval buildings has yet to embrace its interdisciplinarity and engage with concepts borrowed from different disciplines.

This thesis intends to move beyond the cultural historic analysis and place Bodiam Castle at the centre of a study applying theories of materiality to the building as an artefact of medieval society. The building, as with any other artefact, existed as a plan in the mind of Edward Dallingridge who commissioned the build and Henry Yevele who built it, whether the result of its construction was as intended or not, it was "*a plan… 'realized' in stone*" (Ingold 1993: 170) and is the result of human interaction and intention. This

intentionality of construction allows the building to be studied as one would study a pot, handaxe or brooch, it can be considered a social agent, as having a social identity (Hoskins 2006: 74) or producing an effect in us (Hoskins 2006: 76). This identity through the physical construction of the building, as well as how it has been decorated and furnished, mediates social interaction undertaken within the building. Through Bodiam's construction, the social context that the owner (Edward Dallingridge) wished to construct is realised (Olsen 2003: 100). This argument is too simplistic. Through human agency, (i.e. the wishes of Edward Dallingridge) an element of the buildings creation was bound up with social and economic abstracts of the medieval period (Barrett & Ko 2009). To do this, the individuality of the spaces as well as their commonality needs to be explored with contemporary buildings (Hoskins 2006: 74). I will look at the building through its involvement with its surroundings and those engaging with it (Ingold 2007: 15). Through this study we can also begin to examine the changing development of this plan, through Bodiam's construction we can observe how his plan evolved and his aims or intentions in the construction changed.

I use these ideas to move the study of the building away from examining it as a plan drawing, or an analysis of the architecture or historical documents associated with it. Instead it will take all these elements and study them in relation to each other (Hodder 2008: 30) taking the building and the objects that fill it as one and the same and study the relationships between them. Central to this intention is exploring the use of space within this building. Most of the literature (Johnson et al. 2001; Sands 1903; Saul 1995; Savery 1868; Turner 1986; Blaauw 1861; Braun 1936; Brown 1970; Clark 1884; Creighton 2005; Creighton & Liddiard 2008; Grose 1791; Harvey 1978; Hohler 1985; Kenyon 1981; Liddiard 2005; Mackenzie 1896; Morris 2003; O'Neil 1960; Platt 1982; Platt 2007; Stocker 1992; Thompson 1912; Timbs & Gunn 1872; Tipping 1921; Toy 1953; Turner & Parker 1859) relating to Bodiam explores the exterior and overall appearance of the building. Instead I will examine the interior of the building which only a couple of papers touch on (Fairclough 1992; Johnson 2002; Faulkner 1963; Simpson 1946) and explore how the use of space within the building is inherent in its construction. I use visualisation to realise these ideas.

I selected Bodiam Castle as a case study. It has been selected not only due to its appropriate setting but also because of its position in the middle of the academic debate detailed above. Choosing a building that is already at the centre of scholarship regarding late medieval buildings provides a well-known case study to move investigation forward by applying new techniques to an old subject.

This thesis has been completed alongside the wider *Elite Landscapes in Southeast England* project. This has involved surveying the building and the area surrounding Bodiam Castle. The nature of this work has encouraged a visual method for exploring the space. As so much work has been undertaken exploring the building itself I especially want to place that alongside the work researching medieval interiors and landscape. Visualisation is the perfect tool for this, allowing a range of different datasets to be observed together. The recording of the building ensures that all clues from the masonry are carefully explored. Then combined with detailed research into the furnishings, fittings and decorations of domestic rooms the use of the rooms can be interpreted visually. The very nature of this creation process can allow for multiple views of the spaces to be produced.

In chapter 2 I discussed different methods for presenting uncertainty in visualisations of the past. Presenting multiple interpretations has been a popular suggestion by digital specialists (Lozny 2011: vii; Koerner & Russell 2010: 327; Fawcett et al. 2008). Through this method multiple interpretations of the past can be presented though a series of images detailing the development of the simulation. However, this ideal has yet to be fully realised. I demonstrate that this technique can be applied as more than a mechanism for interpretation and engagement but also as a method for exploring space. These images can be used as a method for fostering discussion about the use of space allowing the subjective nature of the creation process to be questioned at every step, encouraging further engagement with the building from the public. The intention is to explore how to engage with the building and respond to it through the use of visualisation to try and understand its lived experience. Instead of presenting a series of images in creation or completed images I bring together the final images produced through the 3D model alongside elements of the research which created it (furniture, manuscripts, art).

I have isolated a small but complicated area of the building to work on, the eastern elevation: focusing on the private apartments (see Figure 65 and Figure 66). The apartments will not only be furnished appropriately, they will be decorated according to the period and populated in the same manner. It will look at how the building fulfils the "*spatial grammar of expectation*" (Johnson 2002: 20) that contemporary buildings portray but equally how Bodiam differs from the expected norms associated with such buildings. In essence it will explore how the spaces are both individual and part of a conforming dataset by looking at the building as an artefact of medieval society.

Presenting multiple images in this way is a phenomenon which has been developed in social media over the last few years. The most popular realisations of this are shown by the internet service and company Pinterest. It allows users to create and catalogue collections of visual bookmarks. Catalogues are chosen by the user and the visual bookmarks can be added via upload, searching the internet, other people's boards or through other media content (Pinterest 2014). I am going to explore the subjective reaction from a series of participants to assess which images they feel best contribute to an understanding of the lived experience of a medieval building, this could be a 3d image or one of the source images.

All of the decisions concerning materials, structure, furnishings inform our understanding of the space and the parts of my work that are discarded are as important as those used. Throughout this project I highlight and discuss these issues with uncertainty and subjectivity (discussed in Chapter 2) that are unavoidable when using digital technologies: I propose them as a method for engagement and not as an overarching issue. Engaging with the evidence and discussing the suvjective nature of the role provides an inherent critique to the visualisations rather than a problem. To record these thought processes and create a forum for discussion I have produced a blog throughout my interpretative process which can be accessed online at (catrionacooper.wordpress.com). The posts from this blog can be seen in Appendix C.

Figure 65: East and Southern Elevations showing Great Hall and Apartments.
Photo taken from the north-west wall walk.
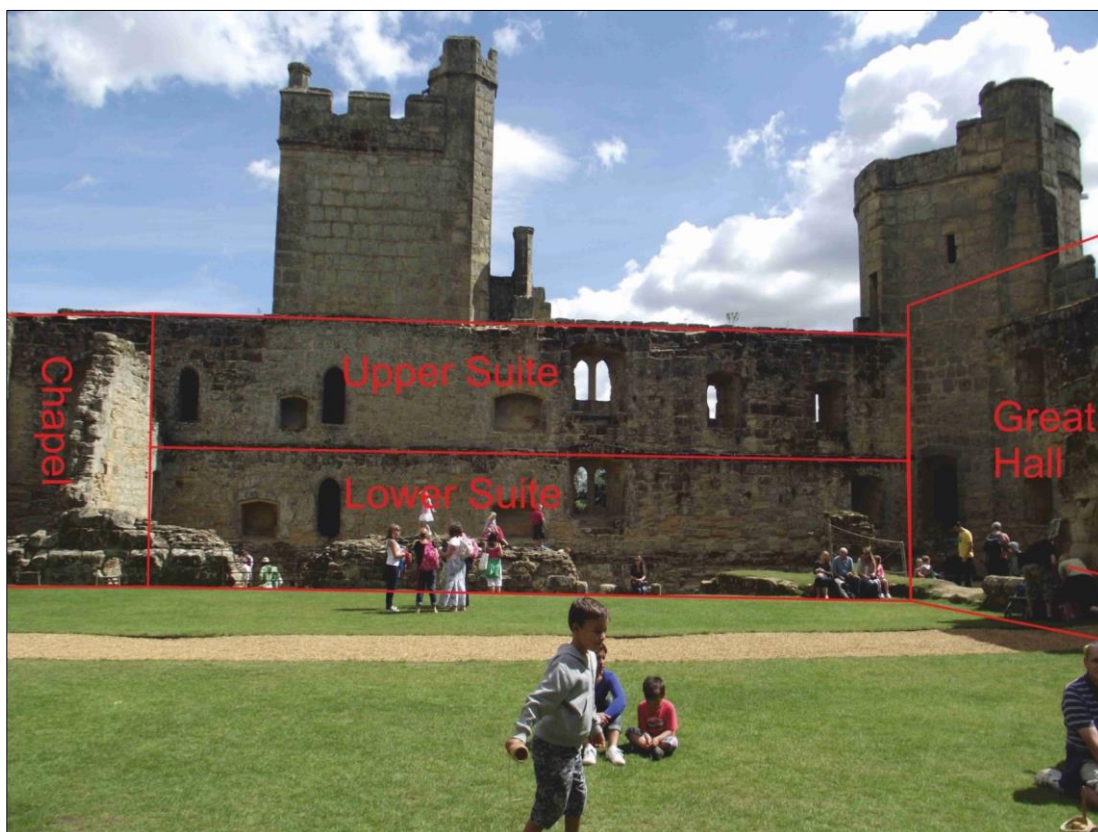
Figure 66: East range showing where each suite and rooms would have been.

Chapter 4:   The visualisation project

In Chapter 3 I introduced Bodiam Castle and in the final section (3.4) I discussed how I intended to explore the building using visualisation. This chapter details my work at Bodiam as a case study for applying digital modelling to medieval buildings. I begin by highlighting the aims and defining my intentions for this project. The methodology section discusses the building survey, the research surrounding the modelling of the apartments and finally how I went about the modelling and scene creation. I then discuss the construction of the mood boards, the topics that were selected and which images. The mood boards are then assessed in section 4.4 before discussing the conclusion of the project.

4.1   Aims of Visualisation

The visualisation project will apply visualisation media as a mechanism for exploring lived experience at Bodiam Castle. Lived Experience has been defined in my glossary as a way of thinking about being. It looks at how we understand the place around us, how we engage and respond to it, how memory is inherent to our perception. Critical is the idea that experience is so personal it is "socially and historically specific" (Hamilakis, 2011: 208) therefore it is based on personal and group memories.

Visualisation is more than a presentation method (see chapter 2) it is a technique with which we can bring together aspects of that place which no longer exist to allow us to look upon one interpretation of how the place looked and allow us to respond to it. The technique is a method for undertaking research and the entire creation is a process of interpretation of a site.

The aim of the visualisation project is to learn more about the experience of living in Bodiam Castle in the Middle Ages. To do this I am going to produce a digital model of the eastern elevation of the castle: the private apartments (Figure 5: page 12). Digital models of ruinous buildings cannot show how the building looked in the past: too much is lost overtime. Instead this model

shows my interpretation of the standing remains, research from documentary sources and an understanding of medieval furnishings and fittings.

The nature of this project is collaborative and as such the use of these images is not just academic, they will be given to the National Trust for use in public interpretation. By engaging with how they are consumed by the viewer I can provide the Trust with material suitable for their use. The nature of the final images needs to be considered carefully. I suggest that the model alone is not enough to truly inform about the nature of the lived experience of the past. Instead, it is suggested that a level of context is required. The normal method implemented is to provide images alongside a text about the research or metadata related to the modelling process (see 2.5.2). However, they also need to invoke a response to the site. Whether this is an engagement with the medieval life of the building: to invoke a memory of a personal past or a deeper understanding of medieval life, all of which contribute to the lived experience of a place. My method presents the final renders alongside a number of images which have informed the models creations to produce mood boards themed about elements of medieval life.

Interpretation of these mood boards are then undertaken by a group of individuals who assess which images they feel represent a number of concepts relating to medieval life. Assessing the final renders of the model alongside the material which inspired its creation allows me to consider how successful a digital model is at engaging with the lived experience of Bodiam.

These images were given to individuals who were asked to do one of three things. Either:

- To tag which 5 images they feel best represent the emotion or concept of the album;
- From all of the images tag 5 images with the concepts provided (the same as the first groups albums);
- Choose a number of their own concepts and tag the images with these.

I want to explore whether the digital visualisation features in all the groups of images that represent different concepts or whether other images in combination provide a greater response.

The results of this shed light on how we consume different types of image and whether standalone visualisations are more positively consumed than groups of images that make them up.

4.2   Methodology

The methodology in essence is simple, create a digital model of the building then present this alongside the elements which have influenced its creation through a series of albums on flickr. These mood boards are themed around different concepts which explore the lived experience of Bodiam. Central to this methodology is the idea that the interpretation of the site is not based solely on the survey or research, but the entire process of modelling and decision making. Therefore this chapter will reflect on the whole process of image creation from the background research right through to the selection of each frame of the model to be assessed.

4.2.1   Survey

Creating accurate models of buildings requires having access to the space in order to collect information about the size of the space or alternatively access to survey data that has already been collected. If there is limited access to the site basic dimensions can be used, but the more detailed the data collected the more accurate the model will be. The most popular technique for this data collection is laser scan data, as it collects huge amounts of spatial information very quickly which can then be examined at ones leisure away from site.

We did not use this methodology. The nature of the project at Bodiam meant that we had the time to spend at the site looking at the masonry and recording every element we felt was important to the overall understanding of the building. Instead we have undertaken an intensive building survey using a Leica reflectorless total station connected to a laptop using TheoLt to download the data straight into AutoCAD (Figure 67). Setting up the equipment in this way allowed us to visualise our recordings in real time. This allowed us to add to the survey as elements appeared due to changing lighting conditions or closer examination, it also allowed us to correct mistakes in the recording and check nothing has been missed. The work was conducted primarily by myself and Penny Copeland of University of Southampton, with additional help

from James Miles of the University of Southampton and under the direction of Prof. Matthew Johnson of Northwestern University.

Figure 67: Total Station Connected to Laptop. Survey work being undertaken by Southampton students Ben Culpin and Tom Young in August 2012.

The work was undertaken over a three year period. Spreading the work over three different seasons has meant that the building has been examined in a range of lighting, at different times of day and during different seasons. Working in this way has led to a unique understanding of the space, allowing the close examination of building phases, highlighting the post-medieval reconstruction and some understanding of the nature of the building's initial construction phases: as detailed in Chapter 3. An understanding of the original building works can inform the visualisations towards some of Dallingridge's original intentions and how they developed through the creation of the castle.

Prior to this project the only survey data available was a ground-floor plan of the building (Figure 49: page 124) this is discussed briefly in Section 3.1.3 and in more detail in Cooper, Copeland, Johnson (2013). The first season (Spring 2010) we created an up-to-date floor plan of the ground floor of the castle. The results of which can be seen in Figure 50: page 126 (Barker et al. 2010) Figure

68 shows the original plan overlain with the results of our survey: as you can see they do not align.
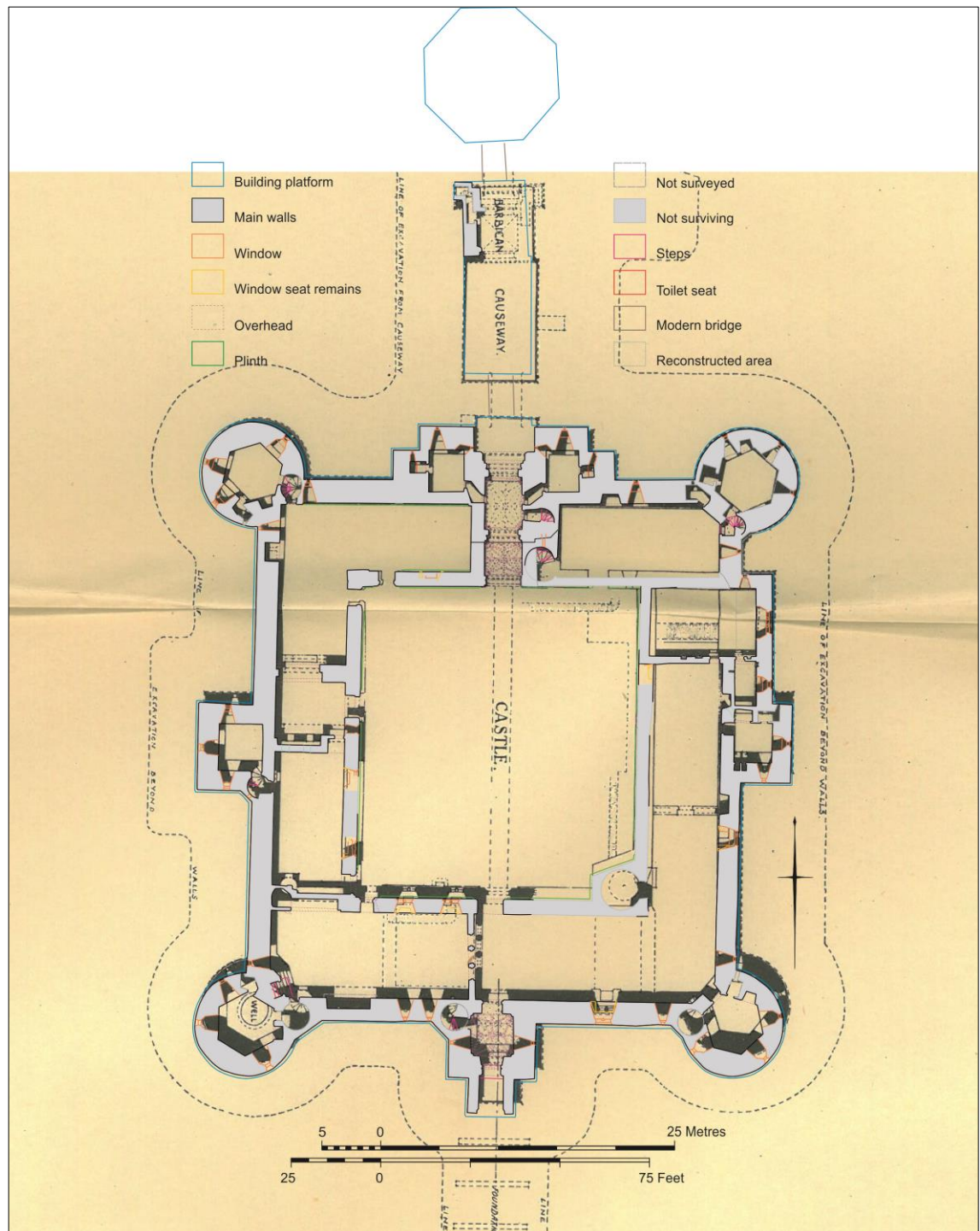
Figure 68: The results of our survey of Bodiam Castle layered over the plan produced by Tavenor Perry (Curzon 1925). As you can see it is impossible to line them up as the shape of some of the spaces produced by Tavenor Perry.

Undertaking the detailed survey has highlighted how complex the building is. Floor levels are not regular across the space, and access routes are not as clear as they first appear to be. The eastern elevation (Figure 5: page 12) which forms part of the medieval plan (see 3.1.3 and Figure 69) is surprisingly challenging for these reasons. This meant that it was targeted for the next season of work, the aim for the second season was to produce an elevation of the eastern side of the building (Barker et al. 2010). The resulting drawing can be seen in Figure 44: page 120. This, in combination with the ground floor plan would give me most of the survey data I would need to create my model.

The third season, which took place in summer 2012 was to fill in the gaps and create complete a full collection of floor plans (Figure 51: page 127 and Figure 52: page 128) for the entire building with a secondary aim of finishing as many elevations as possible. An additional, longer, season gave us time to really think about the construction of the building. We began to really understand the building works and differences between the medieval fabric and later developments, as discussed in section 3.1.3.

Building platform

Main walls

Window

Window seat remains

Overhead

Plinth

Not surveyed

Not surviving

Steps

Toilet seat

Modern bridge

Reconstructed area

Chapel

Private Apartments

Kitchen

Services

Great Hall

5   0   25 Metres

25   0   75 Feet
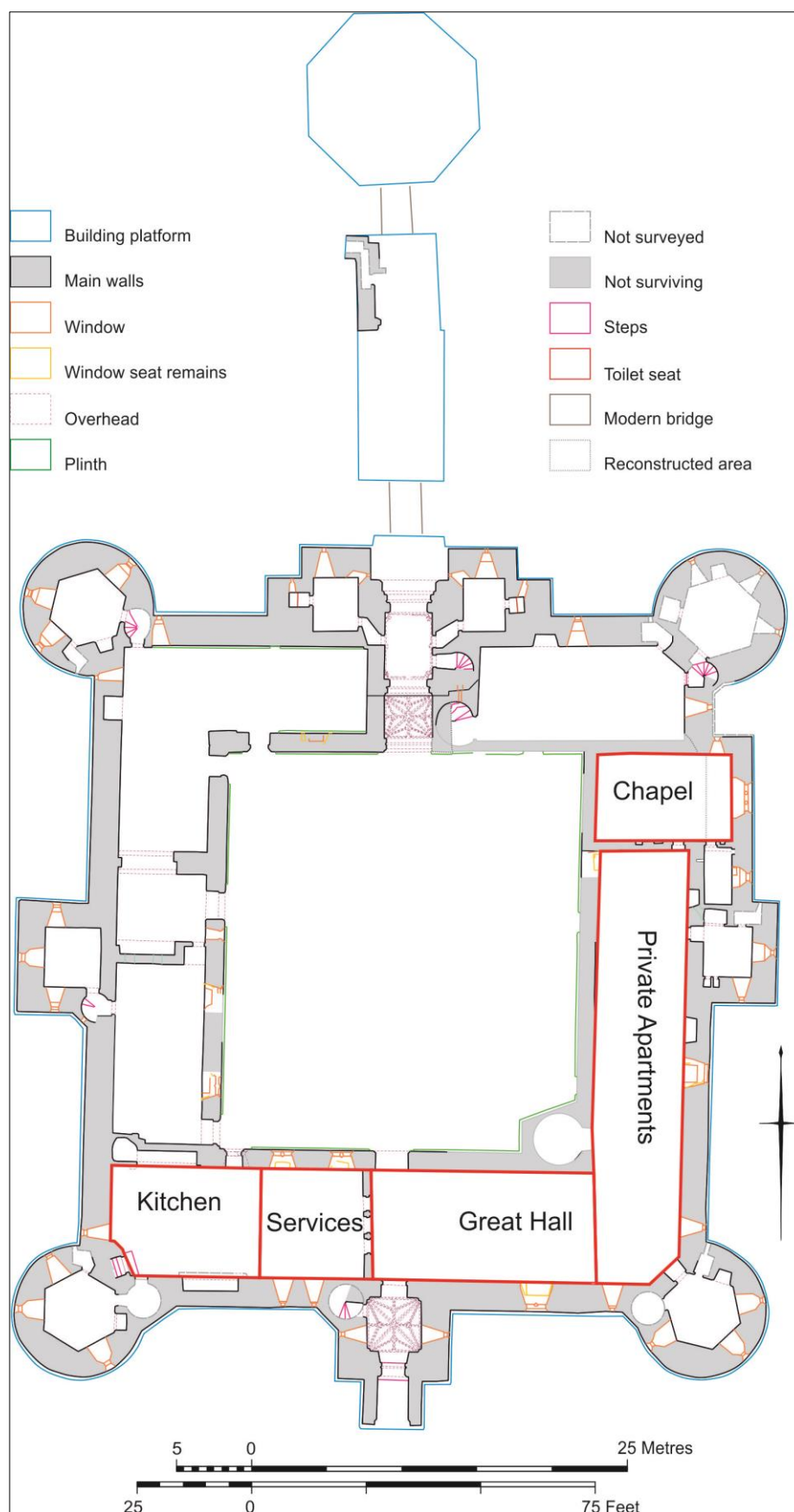
Figure 69: Floor plan of Bodiam with the aspects of the medieval plan overlaid

4.2.2 Research

Chapter 3 detailed the work that has been undertaken at Bodiam Castle to this date. Modelling this area of the building requires an understanding of the space involved, and an assessment of the other visualisations of that area of the building. This shows how mine differ before considering the elements which furnish the modelled space.

4.2.2.1 Work on the eastern elevation

These apartments consist of two suites of rooms running from the end of the great hall along to the edge of the chapel (Figure 5: page 12). Like much of the building the exact use of these rooms is disputed. The debate concerns who had the main use of the apartments and how they were used. As Pevsner questioned "If this [the upper suite] was the owner's private suite… what was the purpose of the suite below?" (Nairn & Pevsner 1965: 421). One suggestion holds that the upper apartment is Dallingridge's and the lower that of his steward's (Faulkner 1963: 234; Thackray 1991: 43), while a second view suggests the upper apartment is Elizabeth's (his wife) and Dallingridge is accommodated below (Gilchrist 1999: 124).

Above the basements on a level just above that of the great hall is the lower of two suites of apartments. Goodhall suggests that this level is in fact a parlour which has a private entrance into the chapel (Goodall 2011: 316) see Figure 64: 148. Faulkner observes that the upper chamber is undivided and that in essence the two suites are not connected beyond being situated in the same area of the building (Faulkner 1963: 232-3).

The use of this area of the building has been further discussed by Gilchrist who explores feminine spaces in medieval buildings (1999). In the placing of one space over the other she suggests this means that the lord's rooms is situated below and the lady's apartment above. This is because the depth of a lady's rooms is linked to ideas of high-status women's segregation and seclusion and as a rule women's apartments are the deepest or most enclosed rooms in a building (Gilchrist 1999: 124). She also suggests that lady's apartments would need an adjoining room for maidservants and a nursery (Gilchrist 1999: 124) which could be suitably accommodated at Bodiam within the adjoining tower rooms. Two windows overlook the chapel from these apartments. This

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type of squint, private pew or gallery seems to have been provided for in most private chapels (Gilchrist 1999: 123) and allowed women to undertake their devotions without being overlooked (Gilchrist 1999: 136-7).

Alternatively the upper of the two suites could have been the lord's apartments with the lady's apartment situated below (Thackray 1991: 42). The upper apartment features a grand fireplace, the largest in the building, and the only one with a decorated opening. The supposition is this must be the lord's apartment as it is not imitated in the lower rooms (Thackray 1991: 43). The presence of only one staircase (leading out of the Great Hall) the lower rooms being the chambers of the constable of the castle or for providing guests of rank comfortable chambers nearby makes more sense than the lady of the house (Faulker 1963: 234).

4.2.2.2   Other Visualisations

While other work has had little focus on the internal aspects of Bodiam what there is has focussed on the layout of rooms across the building. Digital work has looked at the Great Hall (Watterson 2010) and Kitchen (Whittaker 2011) by University of Southampton students.

A number of other visualisations have been produced of Bodiam Castle and the private apartments (see Figure 70, Figure 71, Figure 72, Figure 73, Figure 74, Figure 75 and Figure 76). Appendix E shows these images, where they have come from and a critique of them. There are two major criticisms of most of the images and why I feel they do not engage the viewer with the lived experience of the place:

- The images are designed to give an overall understanding of the building or just a small surrounding area. This means that the camera angle is usually from above from a position a human cannot access in the past.
- The images are not populated with people or furniture. Making them less places that people lived in and more a space to be viewed as a Heritage property.

These are things I aim to address with the model I produce.
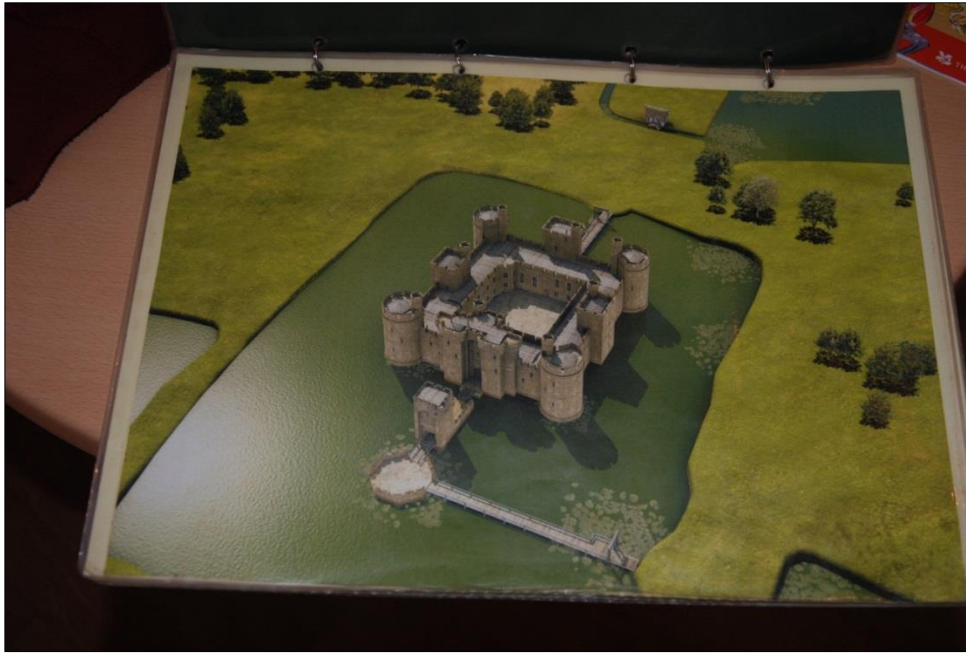
Figure 70: Bodiam Castle reconstruction produced as part of the introductory video to the castle produced by Rendermedia CGI (2014). This is a still used by the costumed interpreters to engage with visitors and school groups. Photo taken of an A3 print out the interpreters were using during my visit in the 2012 field season.

Figure 71: Another still used by costumed interpreters. This one rebuilds the internal courtyard and is taken from the north west corner of the courtyard

looking south east. Of interest is the lack of entrance to the eastern cellars and the regular placing of windows on the internal elevation.

Figure 72: Trust visualisation of the apartments in the eastern elevation. The suite has been divided by a screen but furnished very sparsely. The timber framed ceiling is not open as one would expect in a space of this type. There is also a lack of textiles which one would expect.
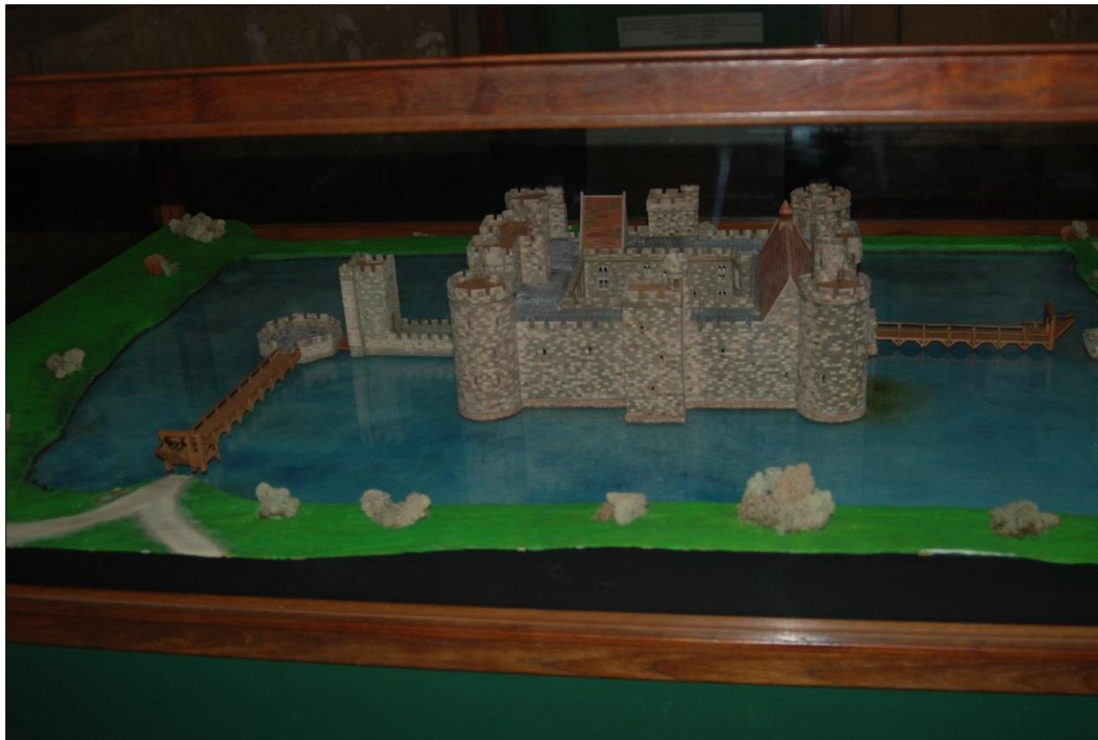
Figure 73: Model of Bodiam Castle found in the education (north-east) tower.

Figure 74: Furnished Room at Bodiam Castle also found in the north-east tower. Access is only provided for school groups on educational visits.
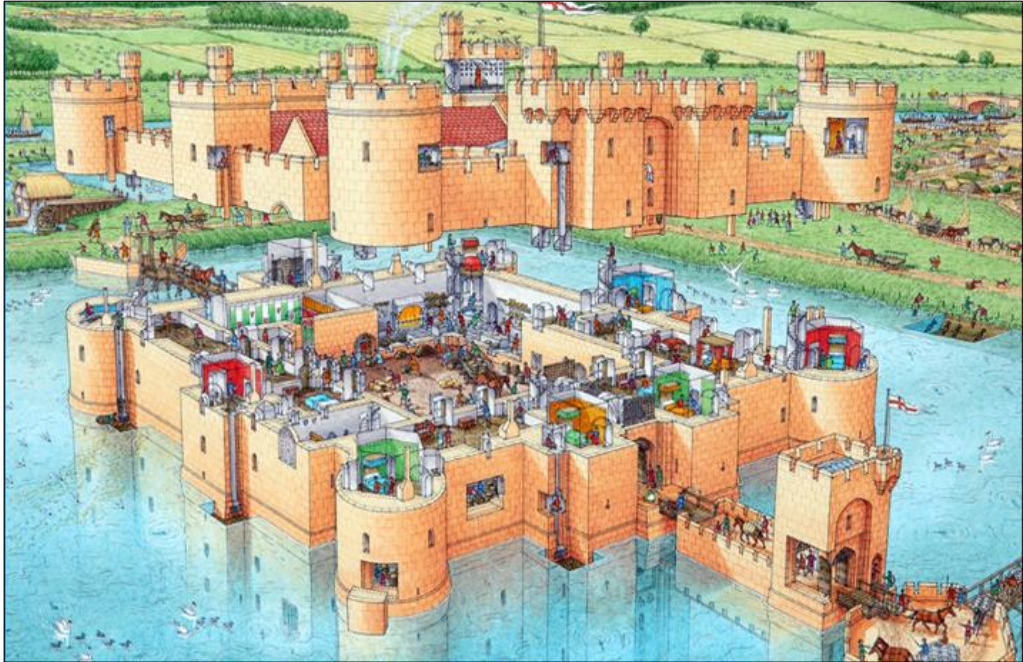
Figure 75: Stephen Biesty's Cutaway Bodiam Castle (Biesty 2004)
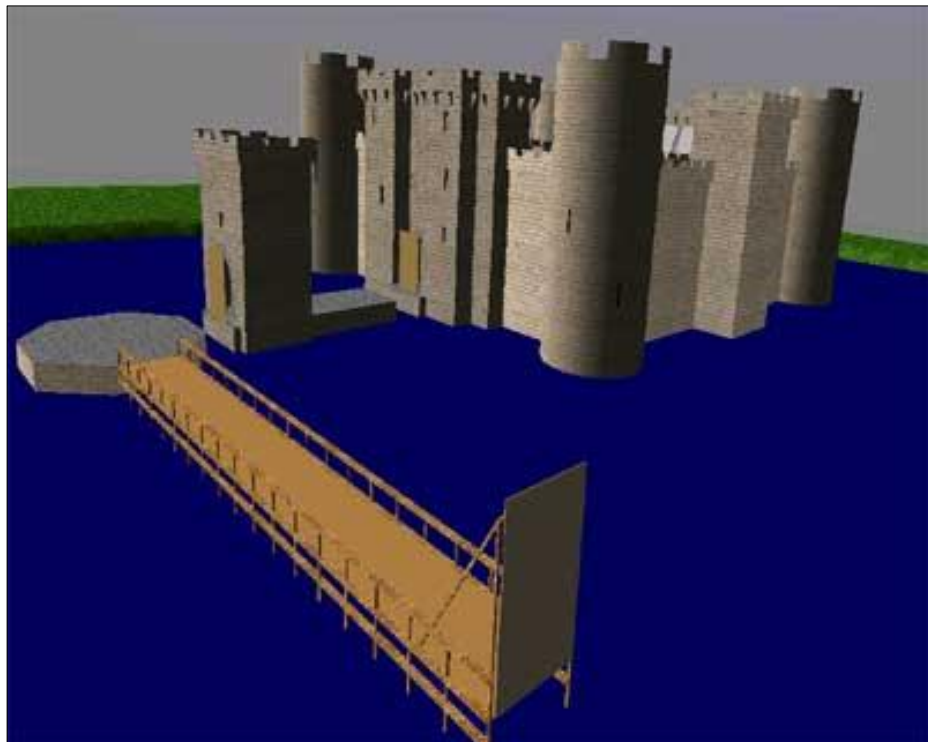
Figure 76: TimeRef.com's Bodiam Castle (Needham 2012)

4.2.2.3   Room structure

The length of the suites and uneven layout of external windows makes us question whether the suite was divided into a series of rooms. Johnson suggests that the elevation was divided into three spaces: the first acting as a waiting room or entrance chamber, the second an audience room and finally a private bed chamber (see Figure 77). The stonework has no evidence for this division of space which leads Woolgar to question whether the suite was in fact divided (Woolgar, 2012: P.Comm). However, the time I have spent in the building makes me agree with Johnson, the space is longer than the Great Hall, which would normally be the largest single space in a manor house. This would mean without division the suites would appear large in comparison. It would also be difficult to heat; another consideration which much be addressed when examining living chambers. By further dividing the space the seclusion of the upper apartments is increased with additional barriers acting as further filtering systems, a trait particular to female apartments of the upper classes (Jaritz 2006). My final reasoning explores the stonework. The fireplaces and windows are not evenly spread according to the perpendicular fashion the rest of the building displays. By this I mean that the layout of fireplaces and windows does not reflect the ordered symmetrical divide expected and seen at places like Westminster and Kenilworth (see Figure 14: page 27 & Figure 78). However, if the space is divided into three, as in Figure 77 this creates three separate areas. Therefore the overall aesthetic of the space would change not creating such an unbalanced feel to the elevation. However, I am unsure whether the same would be true of the lower suite. Here the lower suite has fewer windows, I suggest that there is a potential that the space is only divided into two not three (see Figure 79) or that the lower divide is further south.

Such screens that divide rooms without leaving evidence in the stonework are usually of plank and muntin construction and examples can be found from screens passages. Plank and muntin screens consist of vertical "studs" grooved to accept boards of thinner wood in between. These are then held together with a sill above. Examples of these can be seen in St Cross Hospital, Winchester (Figure 80), and a period joinery website (Figure 81), Fiddleford Manor, Dorset (Figure 82) and Haddon Hall, Derbyshire (Figure 83).
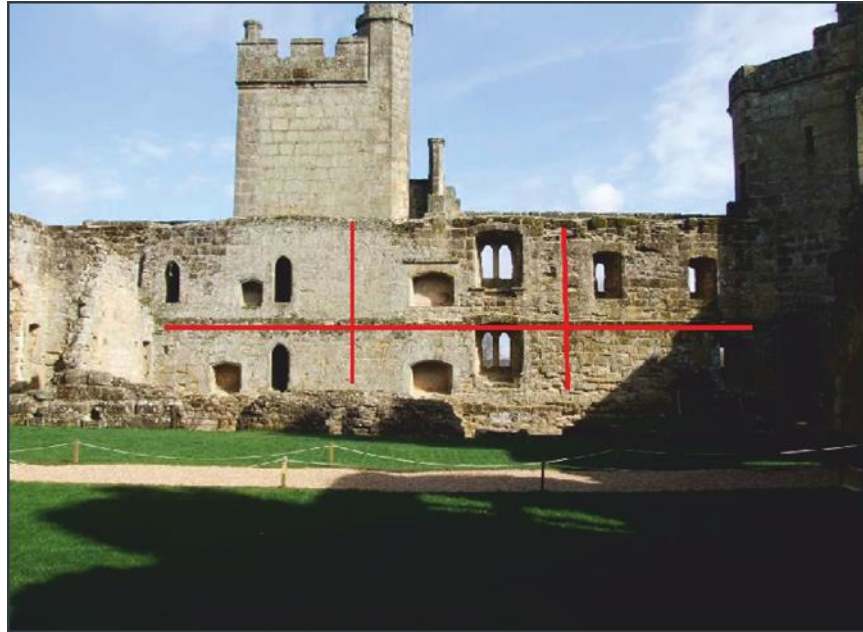
Figure 77: Division of rooms in the private apartments (Johnson, 2012: P.Comm)

Figure 78: John of Gaunt's Great Hall at Kenilworth Castle. This is another example of domestic perpendicular architecture. You can see the repeating pattern of windows and at basement level which is also seen on the floor above. The sculpting around the windows is centred on vertical lines with many vertical panels.
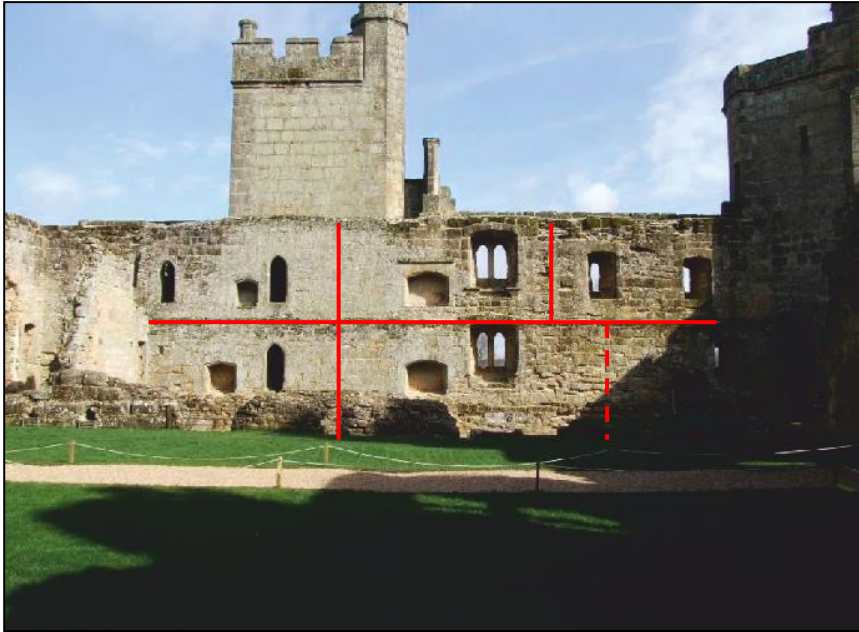
Figure 79: My suggested division of space for the suites of rooms at Bodiam

Figure 80: Screens Passage at St Cross Hospital, Winchester.

Figure 81: Oak plank and mutin screen, Bury, Somerset (Wright 2012)

Figure 82: Plank and muntin screen at Fiddleford Manor, Dorset (Tiller 2012)

Figure 83: Screen at Haddon Hall (Andy 2011)

4.2.2.4   Roofs and floors

Some aspects of the roofing and flooring can be seen clearly in the masonry. For example in Figure 84 a ledge can be seen where the position of the floor can be seen. This is created by setting back the ground floor from the basement level and the first floor from the ground floor. The ledge can then be used to place floor beams on Figure 85 illustrates the different parts of a timber framed building, at Bodiam the ledge would act in the same way as the wall plate in supporting the beams or rafters of the floor above the ceiling. The ceiling is comprised of small cross beams covered by wooden planks; tie beams are only needed to cross larger expanses. This can be seen at Dover Castle (Figure 86 and at Wilmington Priory Figure 87).

Large open timbered roofs are common across the UK, they have a much more detailed typology than might be assumed. A common assumption is that the style of roofing found in Figure 88 is accurate, however, this dates from the 17th century and is used in Tythe Barns (Harris, 1993: 68). The principle style of roof for this area in this period requires the use of a crown post (examples can be seen in Figure 89 and Figure 90). In these the collar plate runs parallel to each bay down the centre of the ceiling each pair of rafters has a collar which

rests on this crown plate (see Figure 91 and Figure 92 for a visual explanation) (Harris, 1993: 8 & 63).

The nature of timber framing divides the space in a series of bays. Figure 92 shows the creation of a Wealden Plan 2 bay hall (see section 1.1.3), which shows the general structure of a roof, at Bodiam this structure is extended by increasing the number of bays to cover the length of the hall. The gap between these bays does not have to be equal, but rather reflects the lengths of wood available, longer lengths of wood are more expensive. Wilmington Priory Figure 88: page 174 and other spaces are about 5m. The beams form the support for the rest of the roof which consists of horizontal rafters linking the beams together. Roof tiles are then attached to these rafters or thatching is tied on. The stonework at Bodiam suggests tiling rather than thatching and the presence of a number of tiles in the finds report compiled by Kathryn Catlin of Northwestern University (Catlin 2014)(reports that are particularly useful are (Barber 1998; Barber 2007; Stevens 1995; Stevens 1999; Priestly-Bell & Pope 2009; Grant et al. 2009)).

Figure 84: The eastern elevation at Bodiam looking south. Here a ridge can be seen running along the wall edge (above the people sitting on the bench) this is the ridge the floor would have rested on.
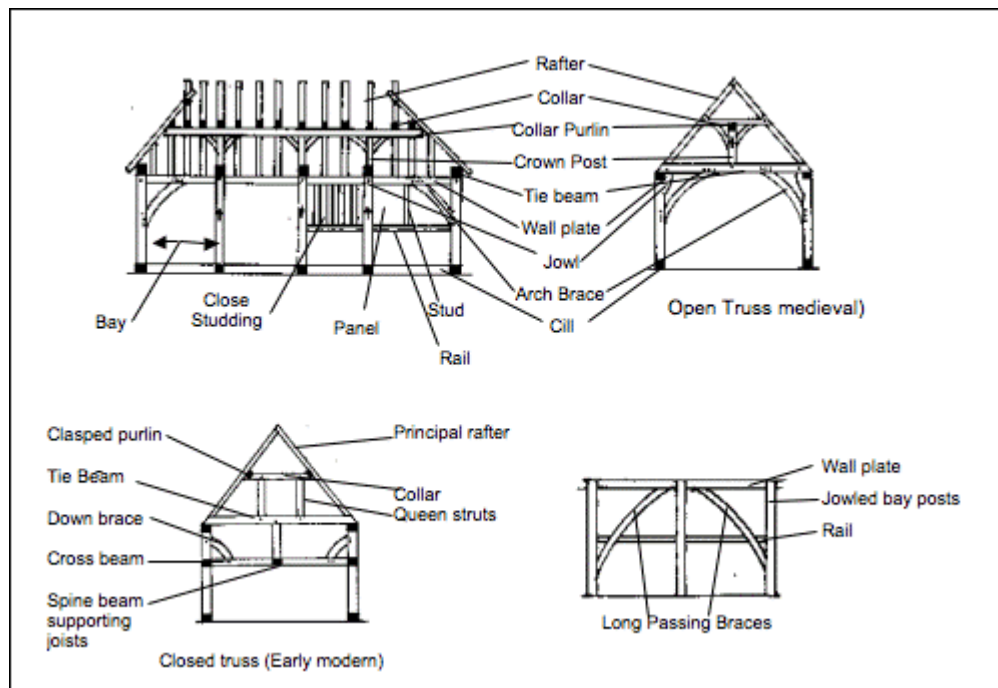
Figure 85: Illustration of the different parts of a timber framed building (DBRG 2009)

Figure 86: Dover Castle Great Hall. This image shows the appearance of the ceiling.

Figure 87: The ceiling at Wilmington Priory, Sussex.

Figure 88: Wilmington Priory Roof without crown post

Figure 89: Wilmington priory Crown Post

Figure 90: Bayleaf Hall Crown Post

CROWN POST ROOFS : BRACING PATTERNS

CROWN POST ROOFS : RANGE OF PROPORTIONS

CROWN POST SECTIONS

CRUCIFORM   REBATED   DOUBLE REBATED

CHAMFERED   OCTAGONAL

PLAIN

CAP

MOULDED CROWN POST

BASE

CROWN POST ROOF ABOVE CHAMBER
(FIFTEENTH CENTURY : N.E. KENT)

Fig. 32. Crown-post roofs.
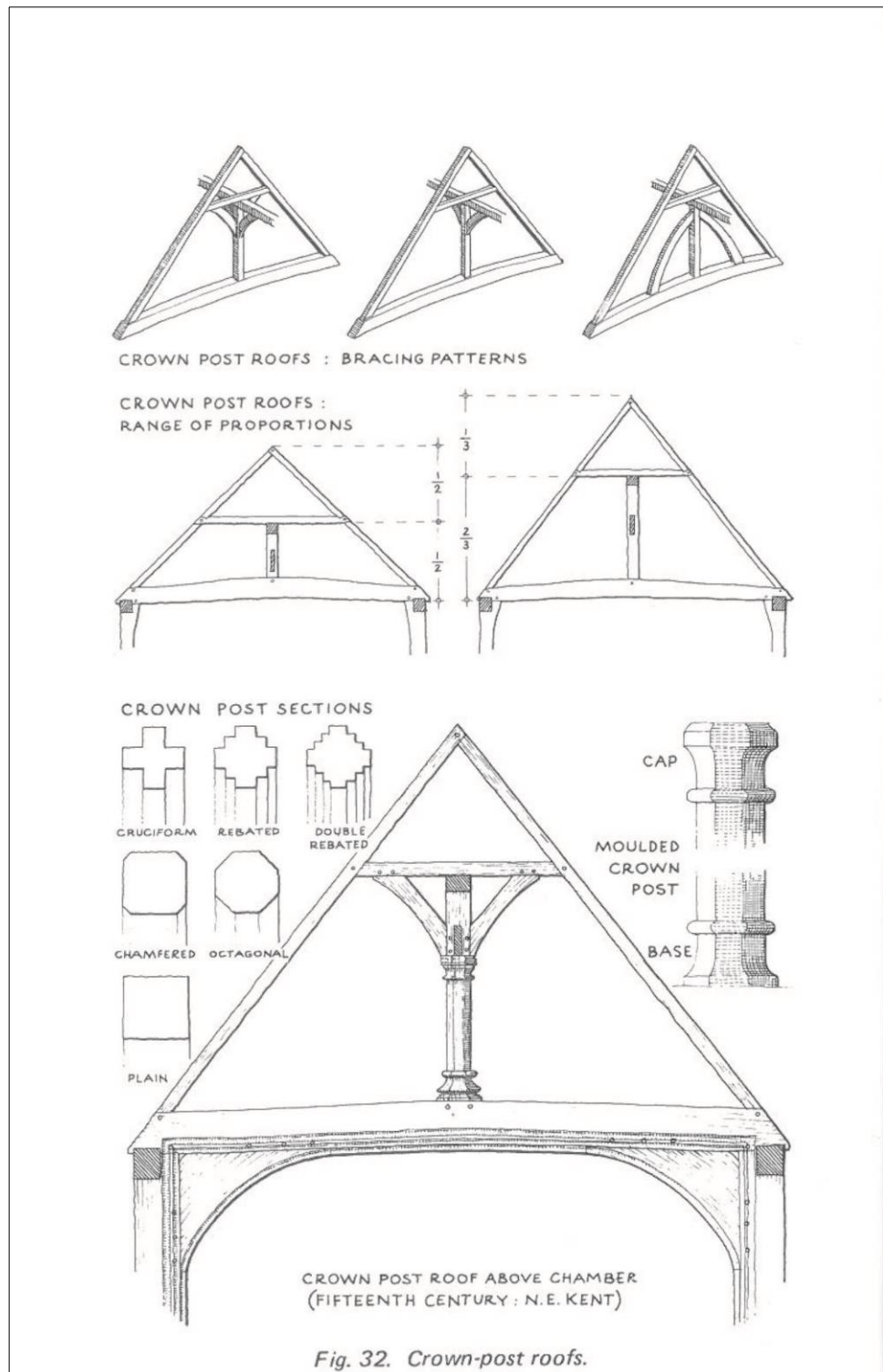
Figure 91: Explanation of how a crown post timber framed roof is constructed
(Harris, 1993: 62)

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19 – Plans (IV)

A) Wealden plan (includes two-bay hall with open truss and cross entry) B) Single-ended Wealden C) Longhouse D) T-plan house a) Flying wall plate b) False tiebeam c) Gable chimney d) Byre

F19
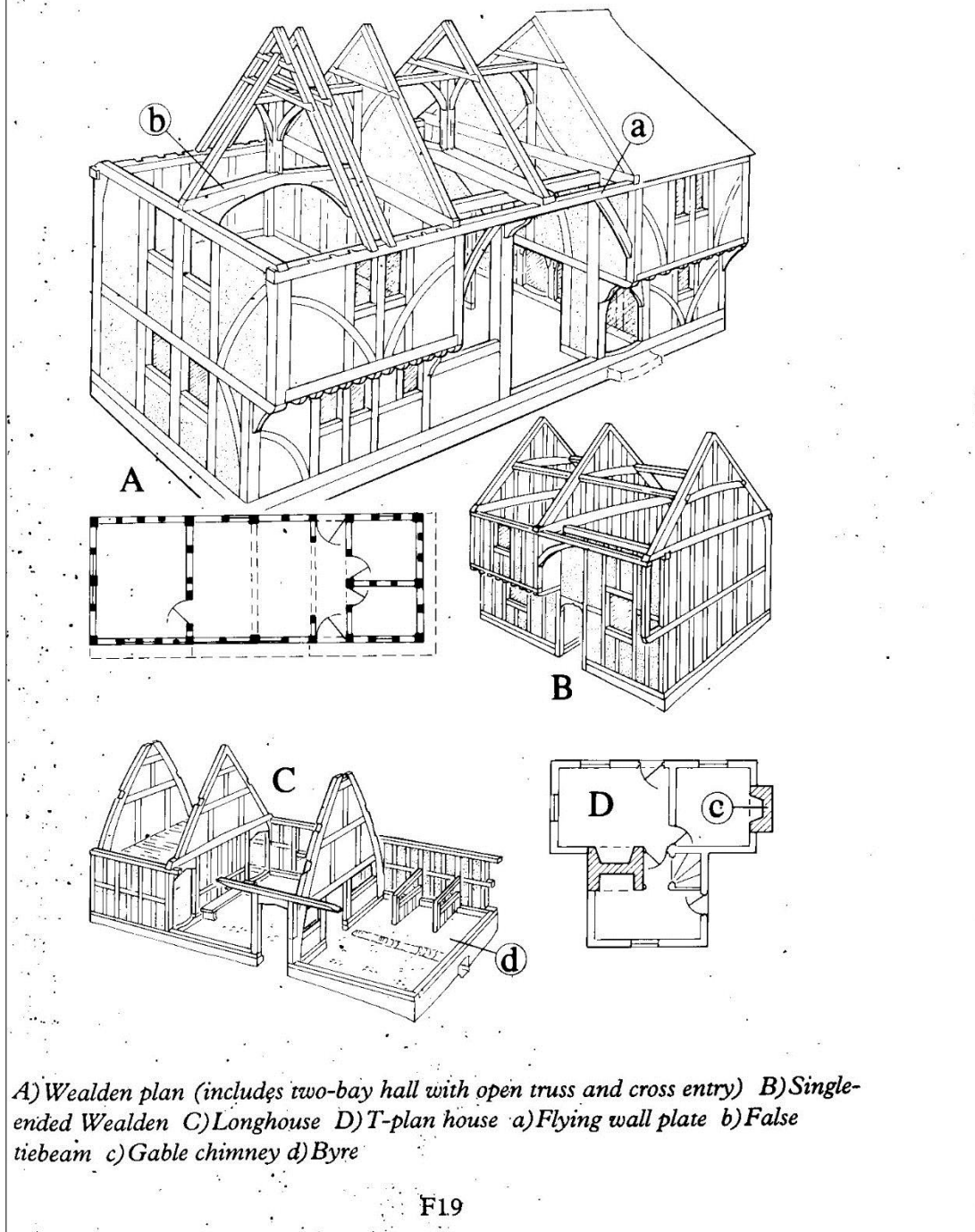
Figure 92: Wealden Plan 2 bay hall (Alcock 1996)

Associated with the style of the beams is also whether they are ornamented or not. At Bodiam the architecture is not as ornamented as buildings of the same period. Ightham (Figure 93 and Figure 94), Wilmington Priory (Figure 95) and Penshurst (Figure 96: Wooden figures carved into the beams at Penshurst

Place) all feature figures or faces carved into beams or doorways. I have chosen not to do this at Bodiam, the lack of any kind of ornamented architecture (discussed in detail in Section 3.1.3) I feel means that this did not feature here and instead the architecture at Bodiam was much more perpendicular: straight lines, chamfers and blocks.
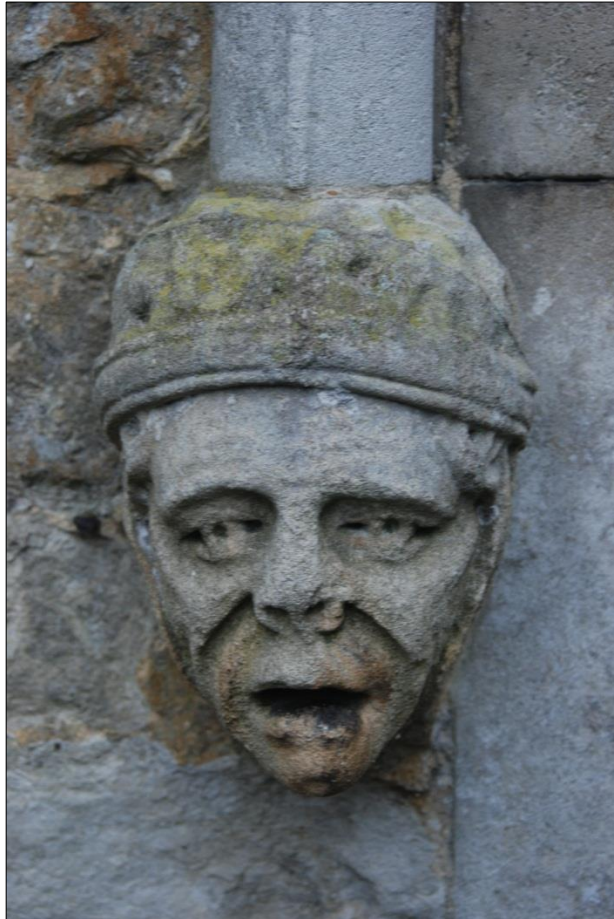
Figure 93: Bosses at the entrance to the Great Hall at Ightham Mote.

Figure 94: Carved figure in the Great Hall at Ightham
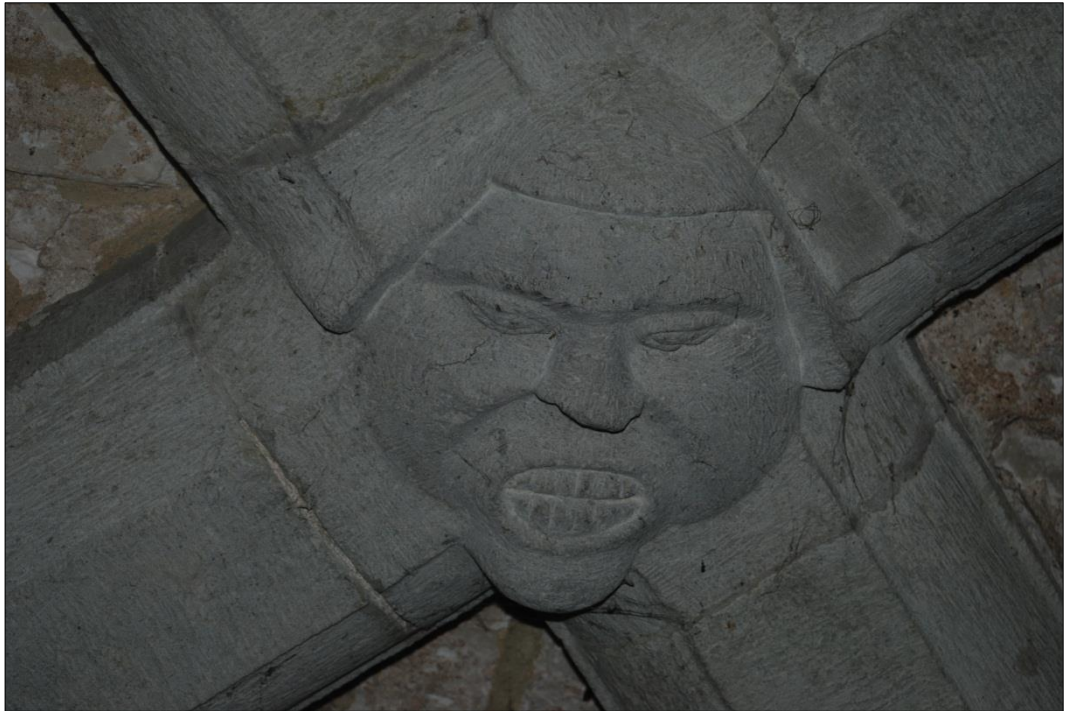
Figure 95: Carved faces in the vaulting at Wilmington Priory
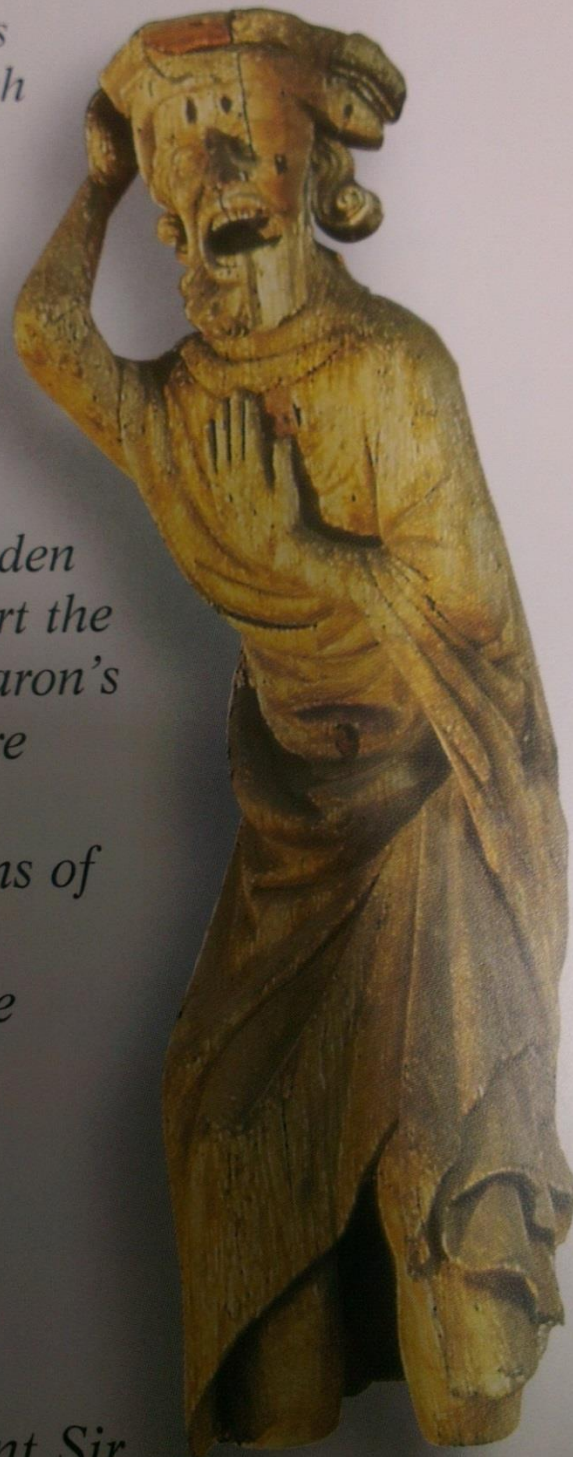
Figure 96: Wooden figures carved into the beams at Penshurst Place (Anon n.d.)

Flooring in the apartments would have been wooden planks. Carpets were not in use in England until the 15ᵗʰ century. There seems to be an underlying belief that floors were strewn with rushes (Beresford, 1974: 108; Evans, 2010; Platt, 1976: 72; Steane, 1985: 208). The only source quoted for this appears to be a quote from Erasmus from the turn of the 16ᵗʰ century about visiting England and it's housing which supports this idea.

"*The doors are, in general, laid with white clay, and are covered with rushes, occasionally renewed, but so imperfectly that the bottom layer is left undisturbed, sometimes for twenty years, harbouring expectoration, vomiting, the leakage of dogs and men, ale droppings, scraps of fish, and other abominations not fit to be mentioned. Whenever the weather changes a vapour is exhaled, which I consider very detrimental to health. I may add that England is not only everywhere surrounded by sea, but is, in many places, swampy and marshy, intersected by salt rivers, to say nothing of salt provisions, in which the common people take so much delight I am confident the island would be much more salubrious if the use of rushes were abandoned, and if the rooms were built in such a way as to be exposed to the sky on two or three sides, and all the windows so built as to be opened or closed at once, and so completely closed as not to admit the foul air through chinks; for as it is beneficial to health to admit the air, so it is equally beneficial at times to exclude it*".
Erasmus via (Lordsandladies.org 2014)

At lower levels of society support for this could come from the archaeological record a number of excavation reports show a small number of seeds from rushes in the environment sampling (Buckland 1974; Greig 1981; Jones 1980). However, the archaeological record seems vaguer particularly at the upper levels of society: though the *Grove Encyclopaedia of Medieval Art and Architecture* discusses the possibility of rush matting (Hourihane, 2012: 440). There do not seem to be any documentary sources for rushes and the iconography does not show any. There are images of rush matting, this would work well with the upper class women's dress which would not be suited to a thick layer of loose rushes. Figure 97 and Figure 98 show examples from manuscripts of the 14ᵗʰ and 15ᵗʰ century which clearly detail rush matting on the floor. It can also be seen in Figure 99, of later date, but also showing the same rush matting. Powis Castle has had a number of rush mats replaced over the years, as seen in Figure 100, possible replacing much older versions?
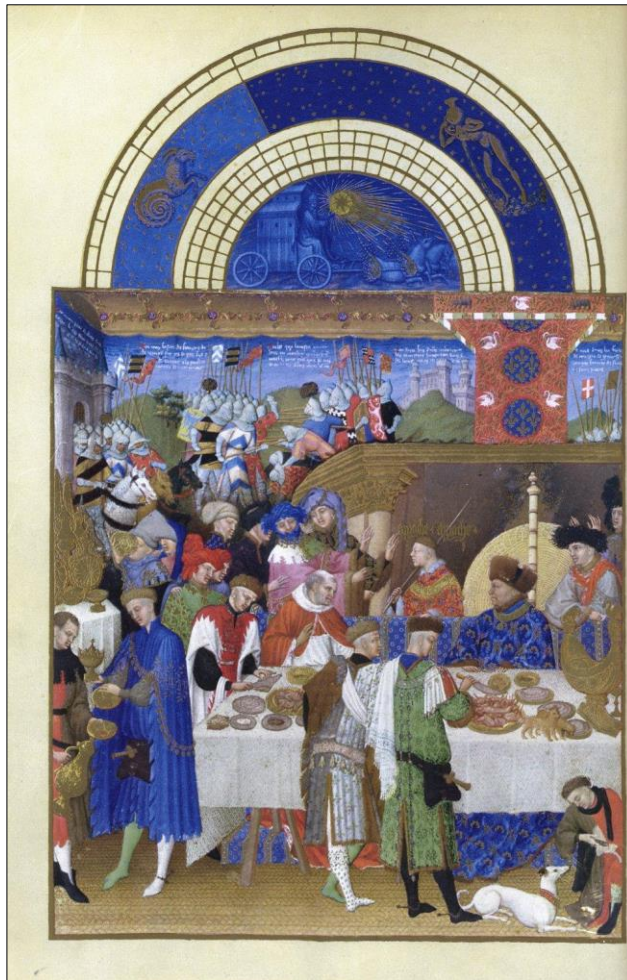
Figure 97: From Jehan, Duc de Berry's Book of Hours *The Très Riches Heures: January*, 1411/12–16, Limbourg Brothers, Musée Condé, Chateau de Chantilly. Rush matting can clearly be seen on the floor. (MS 65, f. lv)(Stein 2009)

Figure 98: From *Roman de la Rose*. Another example of rush matting from the 15ᵗʰ century (MS. Douce 332 fol. Iii recto 174D 001)(LunaImaging 2014b)
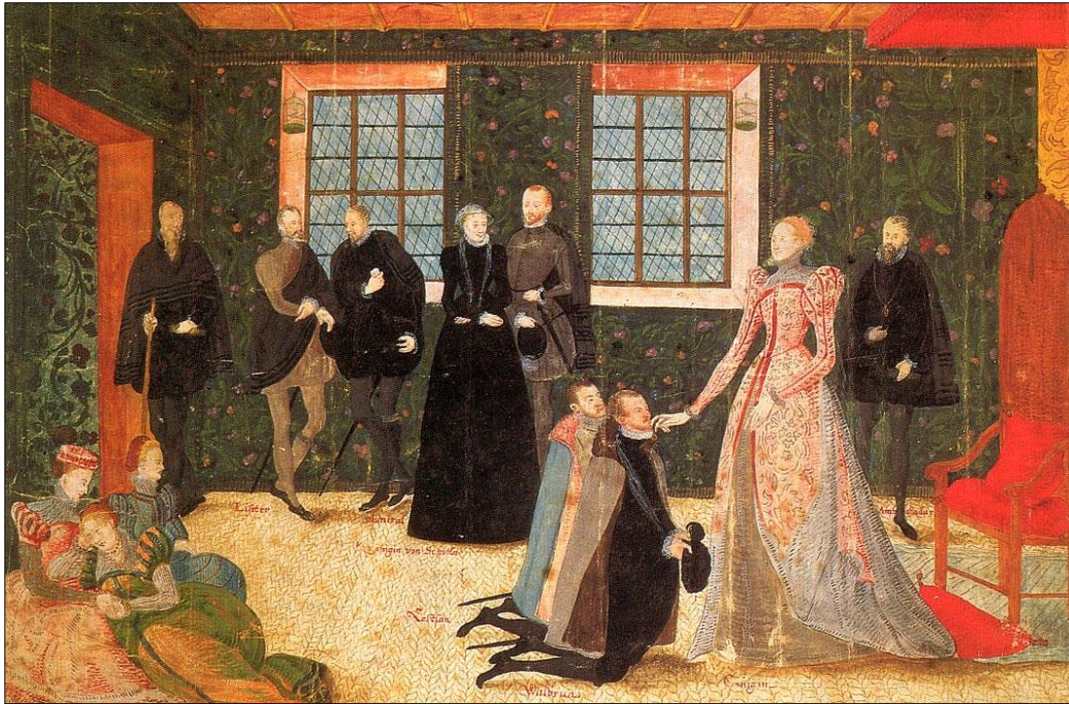
Figure 99: *Queen Elizabeth receiving the Dutch ambassadors*. Painted between 1570-75 the artist is unknown. It is currently at Neue Galerie, Kassel, Germany. (Jokinen 2008)

Figure 100: Replica rush matting from Powis Castle (Ellen-Scarlett 2014)

4.2.2.5   Fittings and Fixtures

Bodiam fell into disrepair between 1560 until it was purchased by Jack Fuller (Curzon 1925), during this time it was stripped of much of its metal, including hinges, window bars and portcullises. Evidence for the location of these can still be seen in the stonework where much of it has been forced out (Figure 101). This is particularly true of window bars all along the private apartments. In some areas individual holes can be seen which made their placement very easy, these results could then be projected onto other windows of the same type (Figure 102). The same is true of doors; the shape of the door, the direction it swings in (see Figure 103 and Figure 104) and how it is attached can easily be seen.

What cannot be seen in the stonework is the nature of hinges or latches as none remain in situ. For shutters and hinges I looked to Great Chalfield (Figure 105) and St Cross Hospital (Figure 106) where they are still found in place. While examples of how they function can be found in excavation reports from York (Ottaway & Rogers 2002).
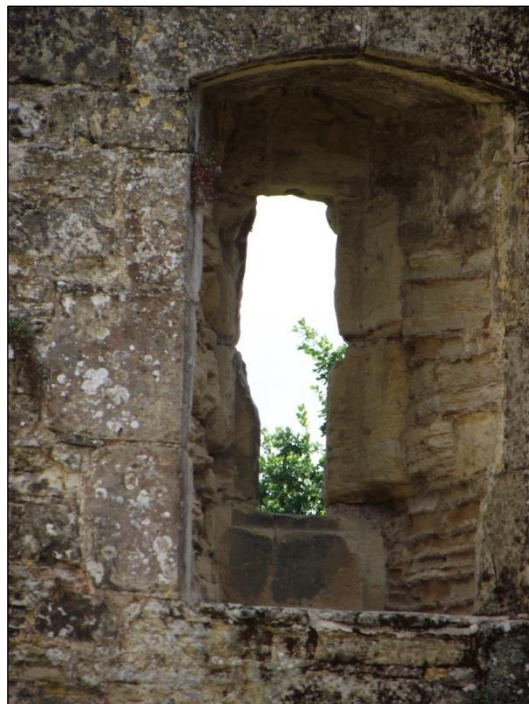
Figure 101: During the abandonment of Bodiam the building was ransacked for metal. This window, from the eastern elevation, shows where the metal bars have been forced out (along with substantial amounts of stone) leaving the window in this state of degradation.

Figure 102: View of the window seats in the private apartments. This photo shows how the bars have been forced out of the windows and the positions of the bars.

Figure 103: Wall at the northern end of the eastern range. The doorway shows which way the door would have pulled open based on the indentation in the stonework.

Figure 104: Northern doorway in more detail (closer view of Figure 103), note detail on recess which shows where the door would have been placed.

Figure 105: Hinges and latches from an original shutter at Great Chalfield, Wiltshire.

Figure 106: Hinge from St Cross Hospital in Winchester

4.2.2.6　Medieval Furniture and objects

The primary resource for medieval furniture is Penelope Eames's book *Medieval Furniture* (Eames, 1977). She provides a catalogue of evidence for furniture from the 12th to 15th century. It is very detailed and highlights the major problem with furnishing sites of this period, that there are a limited number of pieces surviving. This point is also made in the volume *World Furniture* (Hayward 1965) suggesting that instead we must turn to evidence from manuscript illustrations, ivories, mosaics, paintings etc. (Hunt 1965: 20; Ash 1965: 32). In this section I go through each piece of furniture or object that I create and discuss the evidence available. This evidence firstly consists of any remaining medieval pieces, then explore alternate sources such as iconography, documentary sources and finally look at pieces of replica furniture. It is key to note that there is remarkably little furniture remaining from this period, despite the multitude of ecclesiastical furnishings (Alexander & Binski, 1987: 118). This is partially due to the transient nature of various types of furniture, they were designed to be easily moved in and out of spaces and covered with textiles rather than appeal as individual pieces. It is also to

do with the contemporary lack of furnishings: spaces were scantily populated (Ash 1965: 32).

Beds

Jude Jones (2007) undertook an undergraduate dissertation examining sleeping and gender 1350-1750 in which she has created a catalogue of beds between these periods. She discusses the presence of two types of bed the four poster (see Figure 107) and the hung bed (Figure 108). The four poster bed, although first appearing in 1242 did not become popular until the 15th century (Eames, 1977: 75). This has been attributed to the peripatetic nature of medieval elite life. The hung beds provide an elegant bed which can be constructed and taken down easily and taken to the next house, whereas the four poster is not so easily transported (Hunt 1965: 22).

Figure 107: The Great Bed of Ware on display at the British Museum. This is a four poster bed which became popular after the hung beds of the 14th century.
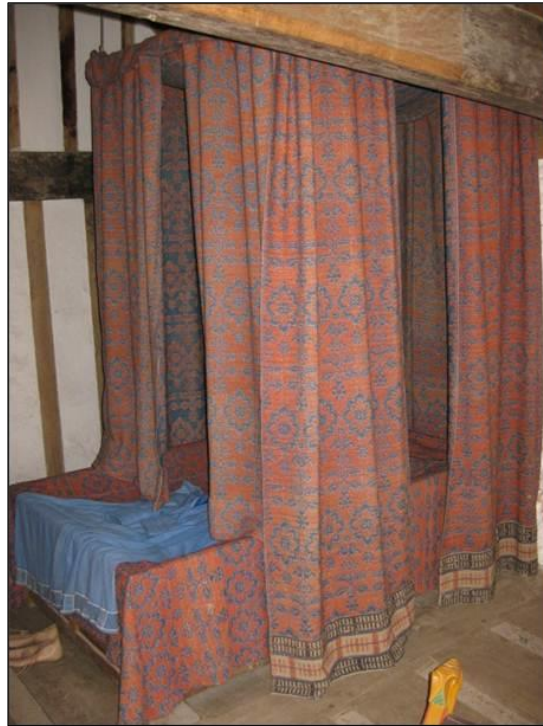
Figure 108: Reconstructed hung bed from the Medieval Merchants House, Southampton

The use of the bed was not totally devoted to nocturnal use. By lifting and tying back the curtains the bed could be used as a living room (Ash 1965: 33). There are no surviving examples of these beds remaining from the late 14th century (Eames, 1977: 75). However, the bed hangings appear frequently in documents from the end of the 13th century onwards. The textiles were very valuable and appear as part of inventories such as John Chelmyswk, Esq of Shropshire (Court. 1999: 34) and John Rogerysson of London (Court. 1999: 42) and the more popular examples of the Inventory of the Duke of Burgundy from 1404, and are found in wills such as The Will of Richard Earl of Arundel in 1392. These support the argument that beds of this type were not just of the upper classes but also the middling and gentry classes (Eames, 1977: 78-83). Appendix F and G show the wills of James Peckham and Thomas Couen and also feature bed hangings. There is also a quotation from Chaucer's *Book of the Duchess* which reveals how highly valued textiles were in this period.

"*I will give him a feather bed of down of pure white doves, arrayed with gold and finely covered in fine black satin from abroad, and many pillows, and every pillowcase of linen from Reynes, to sleep softly he will not need to toss and turn so often. And I will give him everything that belongs to a bedchamber,*

and all his rooms I will have painted with pure gold and arrayed with many matching tapestries." Book of Duchess: ln 269 (EChaucer 2011)

These pieces of evidence discuss the existence of the textiles but do not help much with our understanding of how they appeared. The best resource we have for this is iconography. Paintings by Van der Weyden Figure 109 & Figure 110 (1400-1464), van Eyck Figure 111 (1390-1441) and other illuminations Figure 112 & Figure 113 show hung beds as part of their images.

Figure 109: *The Annunciation* by Rogier van der Weyden. This image is one of the representations of a hung bed from the 14th -15th century (MuseeDuLouvre 2014)

Figure 110: *St John Altarpiece* by Rogier van der Weyden. Another example of a hung bed in the background clearly showing the difference between it and a four poster (such as the Great Bed of Ware seen in Figure 107) (ArtSunlight 2014)

Figure 111: *The Arnolfini Portrait* by Jan van Eyck (TheNationalGallery 2014). Another hung bed can be seen in the background
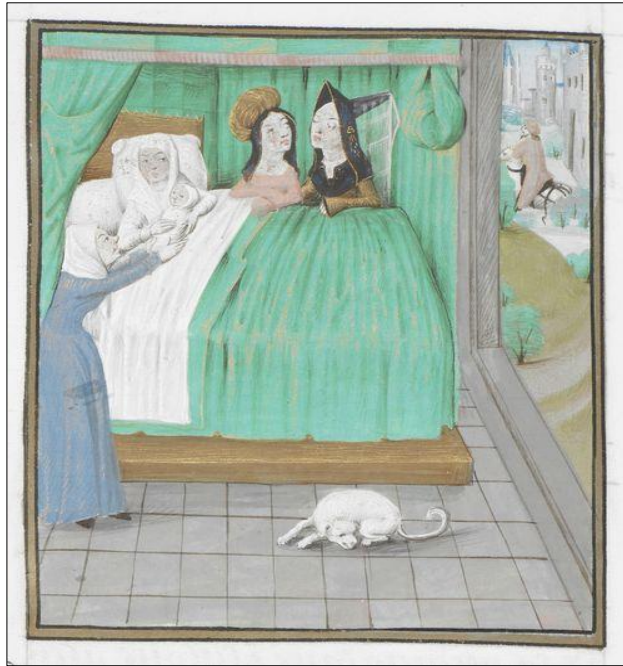
Figure 112 Detail of a miniature of the birth of Alexander the Great, at the beginning of book 5, from the Miroir Historial (translated by Jean de Vignay from Vincent of Beauvais's Speculum Historiale), Netherlands (Bruges), 1479-1480, (British Library, MS Royal 14 E I, vol 1, f.177v-178r) (BritishLibrary 2014f)

Figure 113: *Delilah shearing Samson's Hair*, by the workshop of the Boucicaut Master (Pierpont Morgan Library, MS M 394, f 112) (TheMorganLibrary&Museum 2014)

While no beds remain from this period a number of replicas have been produced. Bayleaf Hall (Figure 114), The Medieval Merchant's House in Southampton (Figure 108: page 194), and Dover Castle (Figure 115) are just three examples of them. As replicas their construction can be carefully examined to see how they are hung from the ceiling, taken apart and put together particularly at the Medieval Merchant's house in Southampton.

Figure 114: Reconstructed bed and chest at the Bayleaf Hall

Figure 115: Bed from Dover Castle, for more information on the creation of the furnishings at Dover Castle see Blog Post "*The Making of the Great Tower at Dover Castle*" on the associated material disk.

Tables

Tables existed in both fixed and moveable types. Trestle tables appear to have been particular common for use in the hall and other spaces. Piers Ploughman writes of the changes occurring at this period with the wealthy moving from dining in the Great Hall to eating in their private chambers

"... the rich nowadays have a habit of eating by themselves in private parlours […] or in a special chamber with a fireplace of its own. So they abandon the main hall, which was made for men to eat their meals in" (Langland 1966b: 115)

Halls and withdrawing chambers were considered as transient spaces and had different uses at different times of day, the ability to easily assemble and put down was essential (Ash 1965b) (Eames, 1977: 217). Chaucer writes it as extremely uncommon for the table in spaces like this to be fixed: the Franklin,

whose passion for eating and entertaining means his table is fixed, is unusual, he states

"*And all day in his hall their stood*

The great fixed table, with the places laid." (Chaucer 1998: 9)

Unlike beds there are a few examples of trestle tables still in existence. The best example are the two tables still found in situ at Penshurst Place (see Figure 16: page 32). There are two known types of base construction for trestle table, splayed leg and spreading base: the Penshurst examples, are of the less common form of base (a single column rising from the spreading base (Eames, 1977: 220). Of the other there are no known remaining examples, but they are far more common in art (Victoria and Albert Museum 1966: 2).

The most famous example of this is the image of Geoffrey Luttrell at dinner in the Luttrell Psalter (Figure 116) the table is of the splayed leg type. Other examples include a range from the illuminated manuscripts including Figure 117, Figure 118 and Figure 119. These also highlight that tables were mostly covered in table cloths, particularly those of English origins (Yarwood 1956: 39).

Figure 116: *Luttrell Psalter* Featuring the Lord at Dinner (Copyright 1989 The British Library Board)

Figure 117: Image of a king and queen dining (British Library, Royal MS 10 E IV, f. 14v) (BritishLibrary 2014a)

Figure 118: Example of a trestle table (British Library, Royal MS 14 E III, f. 76v) (BritishLibrary 2014e)
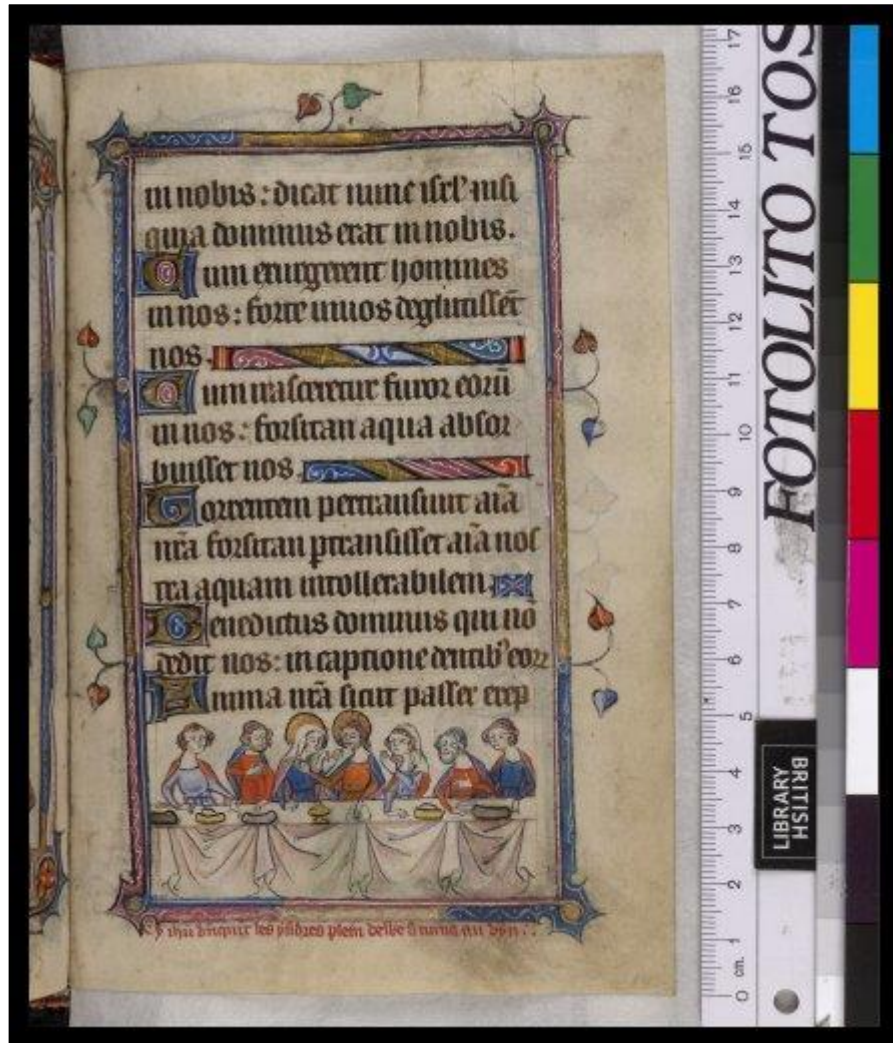
Figure 119: Example of a trestle table in use (British Library, MS Yates Thompson 13, f. 100) (BritishLibrary 2014d)

Tables are not of the same kind of expense as beds and therefore are not found in documentary sources in the same way. Eames discusses a series of orders placed for tables and their presence in inventories but they are less detailed and are instead considered a more general commodity (Eames, 1977: 215-227).

There are a number of replica trestle tables found at heritage properties including Figure 120 and Figure 121 from Dover Castle and the Medieval Merchant's House. Trestle tables are still in use in some form today only changing the fabrics they are made from.

Figure 120: Reconstructed trestle table and chair at the Medieval Merchants House, Southampton

Figure 121: Reconstructed trestle table at Dover Castle in the Bed Chamber

Of other tables the evidence seems to be much more fractured. They appear to exist as smaller side tables and the ones still in existence seem to be more associated with service rooms such as the meat table at Haddon Hall (Eames 1977: 225-7).

Prie-dieu

There are a number of examples of prie-dieu's in the iconography (such as in Figure 122 and Figure 109: page 195). These are small desks not unlike tables or stools for private devotional use. The use of these appears to have been for private prayer. Wealthy ladies would often have access to a private chapel or a space in their private chambers. Margaret Beaufort, mother of Henry VII, can be seen in Figure 123 using one.

Figure 122: Manuscript showing a small private alter (MS. Canon. Liturg. 175, fol. 023v)(LunaImaging 2014a)

Figure 123: Lady Margaret Beaufort at Prayer by Rowland Lockey c. 1500
(Caro1409 2006)

Examples of similar shaped stools can be found in Eames (1977: Plate 63B).
Reconstructed examples such as Figure 124 allow a closer look at how they are
constructed.

Figure 124: Reconstructed medieval stool, similar in construction style to Prei-Dieu's featured in the iconography (Batchelor 2011)

Seating – general comments

Seating, particularly in great halls (and later in withdrawing chambers) was highly controlled. Modern chairs were rare and only provided for those of the highest status. The Great Hall or receiving chamber would only be furnished with one seat reserved for the person of authority in each space (Ash 1965: 33). The type of seat did not indicate the social rank of the household, the number of seats provided indicated who was privileged to be seated.

In chapter 1 I discussed how dining in the great hall was structured according to strict rules of etiquette. This can be seen through a variety of written pieces from the time for example from the general prologue of the Canterbury Tales in reference to a number of their company:

"*A haberdasher and a carpenter,*

A weaver, dyer, tapestry maker-

[…]

And fit to sit on any guildhall dais" (Chaucer 1998: 10)

And this from Piers Ploughman.

"*The great divine, being the guest of honour, was asked to be seated first, and after him Learning and Conscience, and then Patience. But Patience and I had to keep one another company, for they put us by ourselves at a side table.*" (Langland 1966a: 152)

When all were to be seated the position of one's seat was important, those of the highest status were found on the dais mentioned above. The further down the hall one was placed indicated a lowering of status:

"*When they had washed, worthily they went to their seats, the best man ever above, as it best behoved.*" (Neilson 1999: 4)

The act of sitting defined authority through not only the presence of a seat but also the order of sitting.

"*One by one the hundred knights passed into the hall where all the barons of Ireland stood, they entered in silence and sat all in rank together: on their scarlet and purple the gems gleamed.*

When the King had taken his throne, the seneschal arose to prove by witness and by arms that he had slain the dragon and that so Iseult was won. Then Iseult bowed to her father and said: "King, I have here a man who challenges your seneschal for lies and felony. Promise that you will pardon this man all his past deeds, who stands to prove that he and none other slew the dragon, and grant him forgiveness and your peace." The Romance of Tristan and Iseult (Chapter 4, p. 9) (Bedier 2014)

The act of sitting and the type of seat could be very restricted. A king or lord often used their seat as a means to highlight his authority (as in Figure 125). This can be clearly seen in Figure 99: page 186, Queen Elizabeth receiving the Dutch Ambassadors. Here there is only one chair in the room: the Queen's. Her ladies are seated presumably at Elizabeth's request while everyone else stands. This image also details two other elements of the chair that highlight authority:

the foot rest and canopy. Which can also be seen in Sir Gawain and the Green Knight

"*Queen Guinevere full beauteous was set in the midst, placed on the rich dais adorned all about. Fine silk at the sides, a canopy over her of precious cloth of Toulouse and the tapestries of Tars.*" (Neilson 1999: 4).

The importance of these seats of authority can be seen in English language today: the word throne refers not just to the seat of the queen but also to the authority as a whole and can refer to the entire royal family, their estate etc. It can also be seen in the use of "chair" or chair person in committees.

Figure 125: King seated while all stand around (MS 47680, f.33r)(BritishLibrary 2014c)

In chambers chairs were often provided for a visitor (Woolgar 1999: 24). This is demonstrated in writings from the period such as here

"*A chair before the chimney where charcoal burned*" *Ln 875 Sir Gawain and the Green Knight* (Anon n.d.)

The use of the seat is less controlled but can put into perspective the confusion arising in the understanding of seating. It is not the type of seat that is important but its existence in the space.

Great Seat

Seating in the 14th century was used as a method for conveying authority, the placing of seats of privilege symbolised the power of a single authority. In providing only inferior seating to others or no seating at all highlighted their subservient position (Eames, 1977: 181). Medieval examples of these do exist (as do chairs of similar form from much earlier periods). Common and between all styles of seat is the presence of some method of elevation in the seat, allowing the person sat in it to dominate the room. There appears to have been two principle forms of a great seat X-stool and Post and Boarded.

The X seat or stool has examples dating from Ancient Egypt, Roman and Early Medieval times. However, there don't appear any specific to this date. Examples of them can be seen in the replicas Figure 126 and Figure 115: page 200. They also feature in the iconography Figure 113: 198 and Figure 127 shows a woman seated on a stool of this design. Figure 128 shows Christine de Pizan seated on an X-seat writing from the Book of the Queen she was a late medieval author who served as a court writer who was well known and highly regarded. These seem to feature in properties as smaller seats often as the only other seating other than the great chair. Examples can be seen in the Merchants House in Southampton (Figure 126), Dover Castle (Figure 115: page 200) and Figure 129 which shows the layout of an entire room at Dover Castle. They also have much more humble uses which will be discussed below.

Figure 126: Reconstructed stool at Medieval Merchants House

Figure 127: X type stool being used as a Great Chair (Royal MS 19 D II f. 273r)(BritishLibrary 2014g)

Figure 128: *The Book of the Queen* - Christine de Pizan in her study - by Master of the Cite Des Dames in 1410 (British Library, MS Harley 4431, f. 4r)

(BritishLibrary 2013). Of interest is the X-seat and her writing opposite a
window.

Figure 129: Brightly Coloured Decoration at Dover Castle

The X-seat did not provide a medium for expression in developing the design.
The post and boarded seats appear to have been produced in a huge range
from which only a fraction remain. Unlike the unassuming x-seats post and
boarded forms can be seen as the supreme seat of authority, seen today as
thrones, the most famous example being the St Edward's Chair (Figure 130) at
Westminster Abbey which has been used at the coronation of nearly every
English monarch since 1299. To demonstrate some of the range of designs we
can also observe the Hereford Chair, this seat is believed to have been the
coronation seat of King Stephen.

Figure 130: The Coronation Chair, Westminster Cathedral (BBCHistory 2014). This is one of the most famous examples of a Post and Board seat from the medieval period. It has been used as the Coronation Seat for nearly every English monarch since 1299. Originally the chair was painted and gilded according the fashion, much of this has now gone giving it the appearance of plain oak.

Stools

X-type stools are often featured in the iconography as general stools. Figure 113: page 198 shows a woman seated on a stool of this design. They can also be seen in a close up look at Figure 131 and Figure 132. These seem to feature in properties as smaller seats often as the only other seating apart from the great chair. Examples can be seen in Figure 126: page 211 from the Merchants House in Southampton, Figure 115: Page 200 in Dover Castle and Figure 129: page 212 which shows the layout of an entire room at Dover Castle.

Figure 131: Stool in front of fireplace (Griet 2012)

Figure 132: *The birth of John the Baptist* from the Turin-Milan hours c.1420
(MS Museo Civico d'Arte Antica, inv. no. 47 fol. 93v) (Aavindraa 2012).

Another lower status type of a three legged stool also exists. One can be seen in Figure 132 and Figure 133.

Figure 133: Manuscript showing stool in front of a fireplace (MS Koninklijke Bibliotheek fol 1v. 74 g37a. 088v-089r)(KoninklijkeBibliotheek 2014a)

Chests

Medieval households were peripatetic; possessions therefore had to be both portable and secure. By the 14th century although houses were travelling less these considerations were still essential in the production of furnishings and fittings. Chests were the most important pieces of furniture in the household, they provided a means for transporting valuables and could be used as rudimentary furniture acting as seating (Eames, 1977: 108). Compared to other pieces of furniture larger numbers of chests survive today (Victoria and Albert Museum, 1966: 1). Where different types of furniture falls in and out of fashion chests still exist in ecclesiastical contexts and are often still in use (Robinson, 1905: 19). Château de Chillon has a collection of chests some medieval and some reconstructions such as Figure 134 (MuséesCantonaux 2011).

Figure 134: Chest from Château de Chillon (MuséesCantonaux 2011)

As with most medieval furniture they would have been brightly coloured as in the case of Figure 135. Dover Castle (Figure 137) and the Medieval Merchants house (Figure 136) have reconstructed examples.

Figure 135: Italian chest dating from 1345-1354. This example of a chest still shows much of its original colouring © **Victoria and Albert Museum, London.** (V&A 2014c)

Figure 136: Chest from the Medieval Merchants House
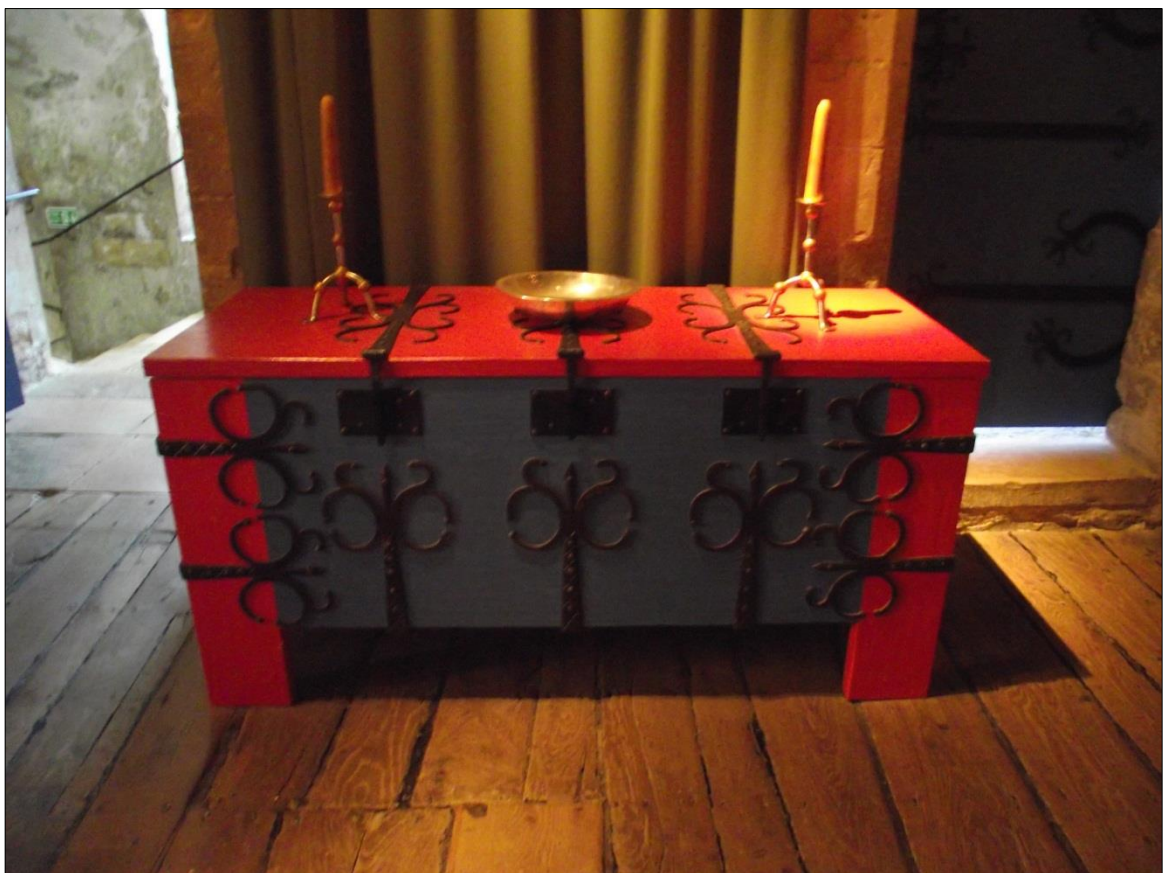
Figure 137: Chest from Dover Castle

The Birth of John the Baptist in the Turin-Milan book of hours (Figure 132: page 214) shows a chest in use. And a close up on the mirror in the *Andolfini Portrait* also shows a chest (Figure 138) in use in a room scene.

Figure 138: Close up of the mirror in the *Andolfini Portrait* (TheNationalGallery 2014)

Armoire/ Buffet/ Cupboard

Chests were not the only form of storage. Other pieces of furniture were used for storage which was not as portable. The medieval names for these seems particularly complex with little description of the defining characteristics of each item (Eames, 1977: 55; Morley, 1999: 73-6).

Eames discusses in detail armories which have been built into walls. However, there are only two examples of these at Bodiam: one in the Sacristy and the other in the Eastern tower (Figure 139). Instead there must have been free standing storage. Buffets, dressoirs and cup boards were used as storage and display i.e. of plate and also for use as a type of side table (Eames 1977). Most

of these structures consist of an open space to display the plate and a closed space for more storage (see Figure 140, Figure 141 and Figure 142). The display of plate was very important as it showed the wealth of the owner and the presence of these pieces of furniture to show off plate is seen frequently in the iconography (a particularly good example is Figure 132: page 214, but this can also be seen in Figure 109: page 195 and Figure 110: page 196 and in Figure 143 a reconstruction from the Weald and Downland Museum) (Ash, 1965: 34).

Figure 140 shows a cupboard which has evidence of paintwork still present on the woodwork. As with the chests discussed above these would have originally been brightly coloured as in Figure 144 and Figure 145.

Figure 139: Built in Armoire in the eastern tower at Bodiam

Figure 140: English Medieval Cupboard c. 1400 © **Victoria and Albert Museum, London** (V&A 2014e)
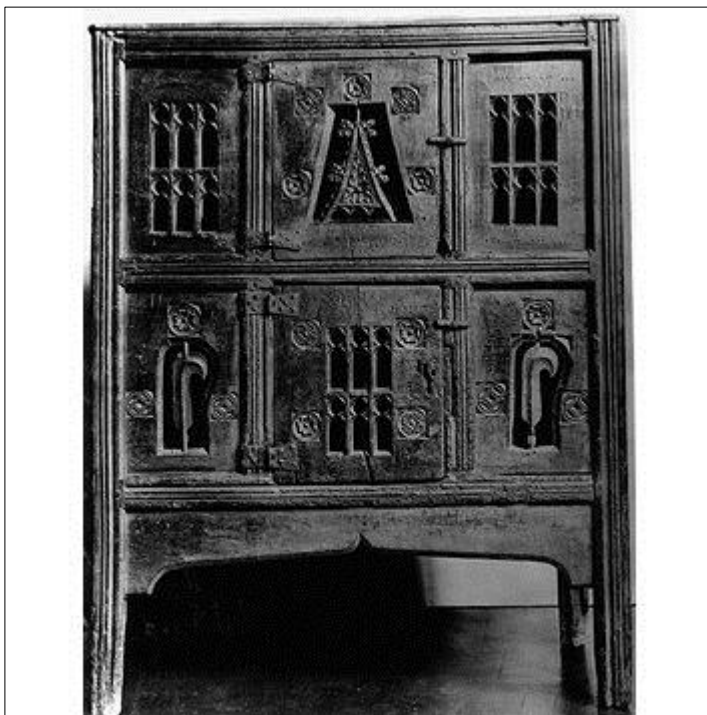
Figure 141: Food cupboard from 1500s © **Victoria and Albert Museum, London** (V&A 2014f)
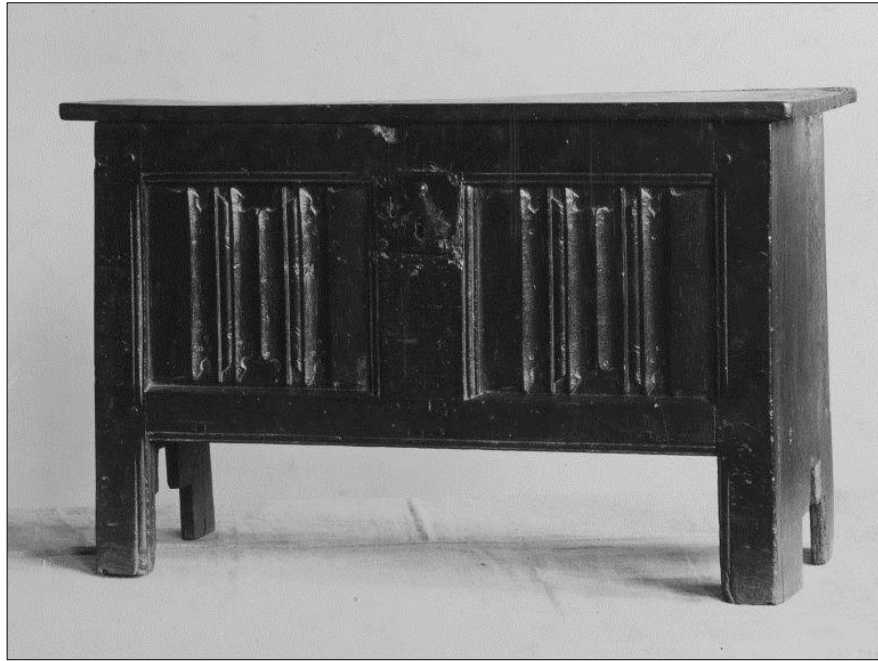
Figure 142: Chest from the 1500s © **Victoria and Albert Museum, London**
(V&A 2014d)

Figure 143: Cupboard in use displaying plate at the Weald and Downland
Museum

Figure 144: Cupboard from the medieval merchants house, Southampton

Figure 145: Cupboard from Dover Castle

Plate

When discussing the evidence for cupboards I highlighted that they were used to display plate. Plate was not only valuable in its own right as worked metal, it could also be used as currency (Allen, 2012: 356). Thus in displaying plate a lord was showing his wealth. The iconography shows this in detail in figures Figure 132: page 214, Figure 109: page 195 and Figure 110: page 196. It features greatly in the documentary records, various items are featured in the wills of James Peckham and Thomas Couen (Appendix F and Appendix G). In addition inventories such as the Ordinance for Edward IV's household discusses the uses and types of plate owned by the royal household (Myers, 1959: 189). The plate for display was different than the plate for real use (Woolgar, 1999: 149) and as with seating, use of different types of plate was controlled according to rank: metal plate, ceramic or other (Eames, 1977: xx).

There is not as much plate remaining in the archaeological record as one would hope given the high status of the pieces and the amount that exists in the documentary record. Unfortunately it was common practice to have domestic plate melted down and remodelled as fashions changed, while ecclesiastical plate was mostly destroyed during the Reformation as it was seized by the crown (Campbell 1987). Some examples of high status plate include the Wenlok Jug (Figure 146), The Lacock Cup and a number of other examples from the V&A and British Museum (see Figure 148 and Figure 149). There is also a good example of a wine cup in Blair and Ramsay's English Medieval Industries (Campbell 2001: 157). Of lower status a few metal plates exist such as Figure 150 or ceramic vessels such as the Siegburg Jugs in the Museum of London's Collection (MuseumofLondon 2014). Reconstructions also exist such as Figure 151. Both of these vessels are of the same type of fabric that was found during excavation at Bodiam (see Appendix D).

Figure 146: The Wenlok Jug a 15th century Bronze Jug (GazMan7 2006)

Figure 147: The Lacock Cup from the British Museum © Trustees of the British Museum (TheBritishMuseum 2014b)

Figure 148: Silver Chalice from the British Museum © Trustees of the British Museum (TheBritishMuseum 2014a)

Figure 149: 14th century bowl © **Victoria and Albert Museum, London** (V&A 2014a)

Figure 150: Medieval pewter plate. Image courtesy of The Portable Antiquities Scheme/ The Trustees of the British Museum (TheBritishMuseum 2011b)

Figure 151: Replica of a Rye Jug (Newboult & Newboult 2014)

Candles

In section 4.2.3.3 I will discuss how I will model lighting for the scene. Evidence for the use of candles can be clearly seen in inventories and ordinances throughout the medieval period made of either wax or tallow (Topham 1787: xxxviii). Wax candles were expensive and generally reserved for the church, king or nobles (Gemmill & Mayhew 2006: 54). Even in the kings household ends of candles were to be returned to the chandlery to be remade (Myers 1959: 261). Even the use of tallow candles was strictly monitored. The ordinance of George, Duke of Clarence highlights that in only two locations candles were allowed to burn throughout the night (Woolgar 2006: 154). While the ordinance of 1478 highlights the quantity of candles each department of the household was allocated (Myers 1959: 227). Each member of the household were also entitled to a number of candles (Woolgar 1999: 31).

Tallow candles are not regularly shaped and are not pure in colour (Figure 152). Unlike wax candles they produce an unpleasant smell when burnt which is why beeswax candles were so highly valued. There seem to have been a range of qualities of tallow candles valued according to the colour of light they produced (Myers 1959: 227).

Figure 152: Tallow Candle making (OldandInteresting.com 2009)

Evidence for candles holders can be found in the material record. Figure 153 shows a 14th century bronze candle holder. The shape seems fairly typical of candle holders from the period. Figure 154, Figure 155 and Figure 156 show various pieces of holders which all have a similar style.

Figure 153: 14ᵗʰ century candlestick © **Victoria and Albert Museum, London**
(V&A 2014b)

Figure 154: Medieval Candle Holder (TheBritishMuseum 2011a)

Figure 155: Medieval Candle holder (TheBritishMuseum 2013)

Figure 156: Base of a medieval candlestick (TheBritishMuseum 2012)

Hangings

Interior decoration in buildings of the 14th century included large quantities of textiles (Woolgar 1999: 73). They were another way of showing the wealth of the owner, brightly coloured fabrics were expensive the use of wall hangings allowed them to be displayed throughout the household (Robinson, 1905: 9).

Wall hangings feature in most reconstructed houses such as Figure 115: page 200, Figure 120: page 204 and Figure 157. These images really highlight the bright colours used and quantities of the hangings.

Figure 157: The King's Room in the Tower of London (Gagnon 2008)

Evidence for hangings appears both in the iconography and documentary evidence. Appendix F and Appendix G are wills which explicitly discuss fabrics to be bequeathed to members of the creators families. While contemporary writing discusses the importance of textiles. For example the following quote highlights the importance of textiles in the 14th century.

"*I will give him a feather bed of down of pure white doves, arrayed with gold and finely covered in fine black satin from abroad, and many pillows, and*

every pillowcase of linen from Reynes, to sleep softly he will not need to toss and turn so often. And I will give him everything that belongs to a bedchamber, and all his rooms I will have painted with pure gold and arrayed with many matching tapestries." Book of the Duchess (EChaucer 2011)

Figure 113: page 198, Figure 116: page 201, Figure 123: page 206, Figure 128: page 211 and Figure 133: page 215 all show examples of wall hangings present in domestic scenes. The themes of these hangings range but often feature heraldry; this is particularly clear in (Figure 158) a close up the *Luttrell Psalter*. Here Geoffery Luttrell is pictured dining in front of a wall hanging which shows a repeating pattern of marlets, Geoffery Luttrell's coat of arms.

Figure 158: Close up for the *Luttrell Psalter* featuring the lord at dinner, the wider image can be seen in Figure 116: Luttrell Psalter Featuring the Lord at Dinner (Copyright 1989 The British Library Board)

Cushions

Complementary to the wall hangings and textiles associated with bedding cushions were often bequeathed alongside tapestries and wall hangings in the same colours (Pritchard 2003: 359). Window seats required cushions to make them comfortable (Hunt, 1965: 22).

Manuscripts show people sitting on cushions (Monk 2014: 24) and their presence on benches and other areas of seating. These can be seen in images already used such as Figure 109: page 195, Figure 111: page 197 and Figure 132: page 214.

4.2.3 Modelling

I used Autodesk 3DS MAX to create a model of the apartments. 3DS max is a three dimensional modelling, animation and rendering software that can be used by both artists and designers for the creation of games, visual effects, motion graphics and architectural visualisations (Autodesk 2012). In archaeology it provides the perfect tool for creating virtual simulations especially as it is directly compatible with AutoCAD and therefore survey data can easily be imported.

To make my decision process as transparent as possible I discuss each choice I made in the construction of the model and link it back to the research I have discussed above.

4.2.3.1 Wall geometry

The modelling process began by importing the survey data from the AutoCAD model we created during the fieldwork into Autodesk 3DS MAX (Figure 159).
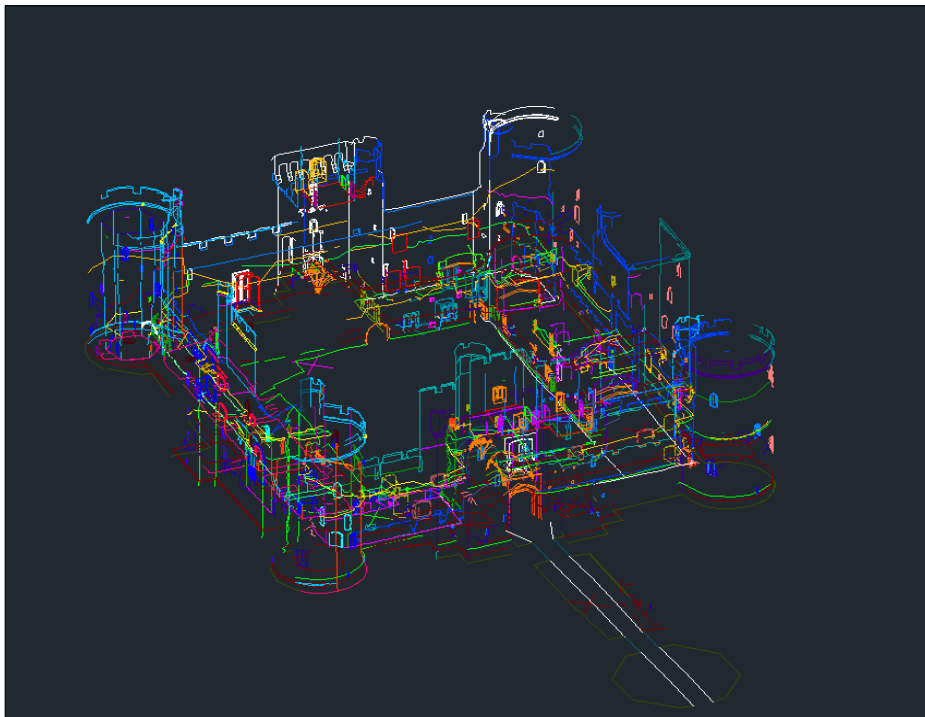
Figure 159: The survey data just imported into 3DS max from AutoCAD

I then cut the data down to just featuring the area of the building I am interested in (see Figure 160). By using the survey data I can ensure the model is at the right scale and the features appear in the right place. However, the

survey data is of the building as it stands today. I am not attempting to model the ruin of Bodiam as it stands today, I am creating a model of medieval Bodiam. The survey data includes all the areas of ruined stonework found on the current building and this had to be corrected. The survey data is thus used as a guide. It provides accurate dimensions of the rooms, floor levels and positions for windows, doors and fireplaces where there are standing remains. On the courtyard wall I have had to create the elevation and infer what I think about the space based on my research (discussed above). The areas of particular degradation are the western and upper floor of the northern wall. The upper floor of the northern wall can be created through conjecture, the lower parts of the frame are the same as the other windows overlooking the courtyard, it is also of a similar size and shape as the adjoining window. Therefore creating this window and placing it here makes sense. However, the western wall is significantly less complete.
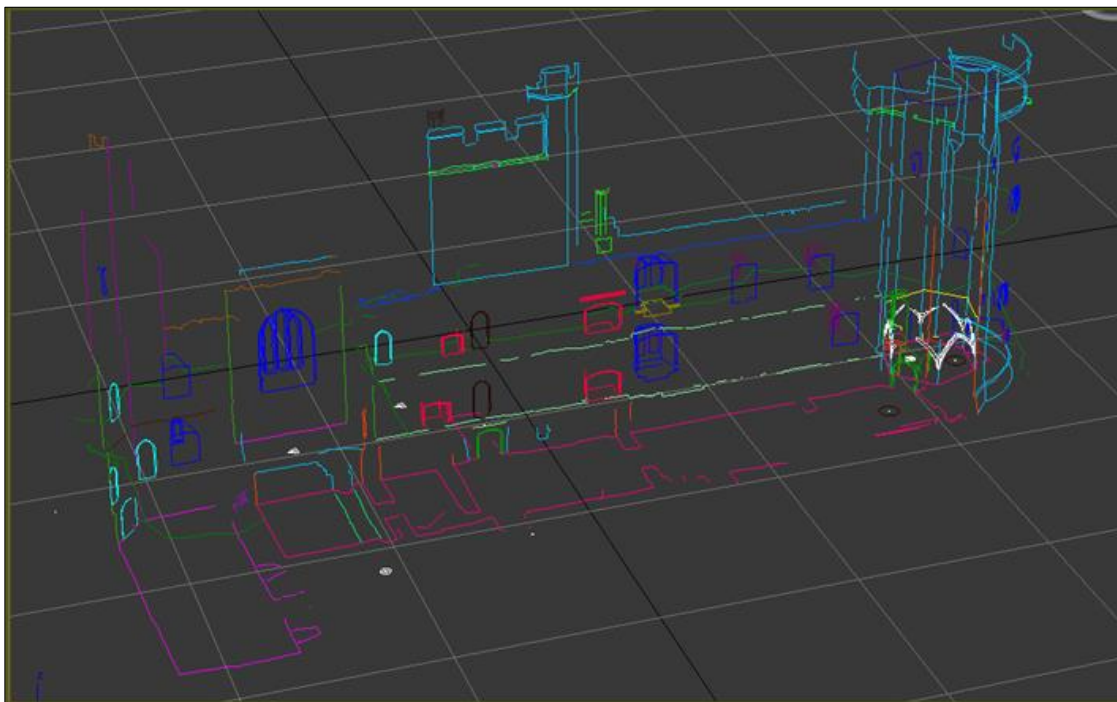
Figure 160: Cropped Survey Data in 3ds Max

This was also my first experience of using 3DS max and I had to experiment with the best technique for producing the model. The more I did this the more I understood the construction of the building as it made me look more closely at the survey data trying to make the model follow it as accurately as possible. The first of these experiments involved:

- Creating the entire elevation in one go and cutting out a series of shapes to create windows (Figure 161)
- Using the same method of cutting out shapes to generate windows on a floor-by-floor basis (Figure 162)

However, although creating the model in separate levels appeared to work effectively, issues arose when I tried to cut out the shapes from the elevation that I encountered difficulties. The shapes of each of the windows, doors and fireplaces are very complex, they have a number of curved surfaces which are not represented easily through the flat edges of 3ds max, and this meant that cutting them out of the overall elevation destroyed its geometry. On first glance this would not seem concerning however, it would have caused problems when trying to render the model as light would shine through cracks and textures will not apply cleanly to the surfaces. A better approach was to model the windows from curves, starting from the most complex part of the window, generally the inside edge or curve, and work out to from this. This generates the internal walls from the edge of the final curve. These could then be extended to create blocks which can be joined to create the overall elevation (Figure 163). When completed this creates a smooth image that lighting reflects from smoothly.
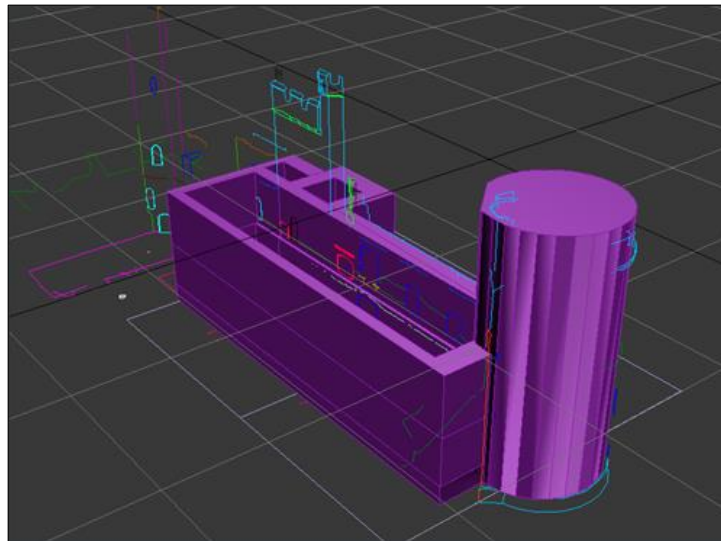
Figure 161: Modelling entire elevation
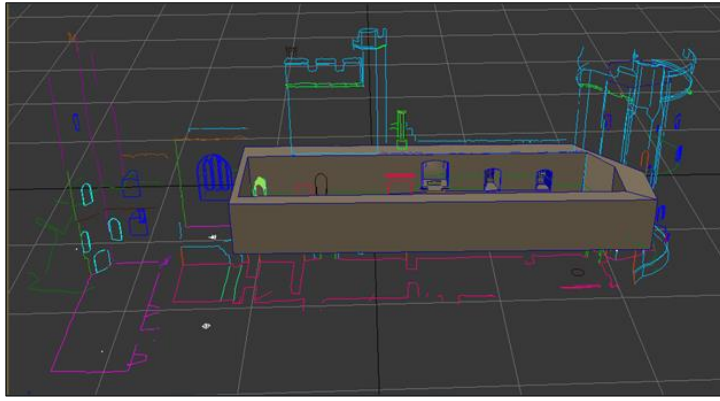
Figure 162: Modelling Individual floors
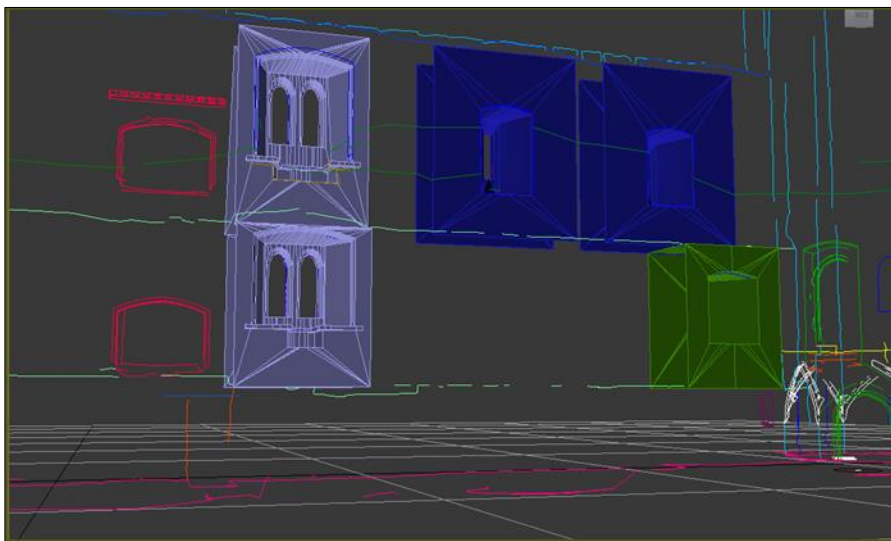
Figure 163: Creating each window in a block to stitch together to create elevation

Bodiam's windows are particularly complex. They are decorated with curves and chamfers which are particularly challenging to model. In this case the survey data alone was not enough to understand their shape and instead a number of photographs were also needed to show different angles of the windows (Figure 164 and Figure 101: page 187). Placing the window bars relied on this methodology as the degradation of the window frame was so extreme that photos were much clearer at showing their placement and distribution.

Figure 164: One view of the window seat in the eastern elevation. The position of the window bars can clearly be seen in the masonry

4.2.3.2   Roof

I discussed in section 4.2.2.4 how there is a complex typology of roof types. The first roof I modelled was incorrect (see Figure 165 and Figure 166). Following discussion with medieval experts (Prof. Matthew Johnson and Prof. Chris Woolgar) I realised I needed to amend the timber framing style. Therefore instead I remodelled it to produce a roof with a crown post. Bays have been spaced at about 5m intervals dividing the space to align with the window seats already modelled.

Figure 165: Early render of my model of Bodiam Castle showing the first attempt at creating the roof, seen from the exterior (south).

Figure 166: Interior of first attempt at the roof, from the south.

We looked again at these structures and decided that the tie beams were a little too straight. If you look at (Figure 167) from 20 Swan Street, Kingsclere you can see the tie beams curves up towards the crown post (this is called a "cranked" tie beam). Figure 168 shows this put into practise in the final model.

Figure 167: Example of a cranked tie beam from 20 Swan Street, Kingsclere (photo courtesy of Penny Copeland)

Figure 168: Render of the beams curving up slighting towards the cross beams with tiles covering the rafters.

Although the beams look very effective as they are, to ensure the lighting appears correctly they also need to be covered with tiles. I created simple boxes and then repeated them individually to create a more authentic look than an overall covering (this can be seen above in Figure 168 and in Figure 169).

Figure 169: Render of the model from outside the building

4.2.3.3 Lighting

3DS max allows lighting systems to be built in. These allow sunlight and daylight to be added to a scene according to location. Location is set based on latitude, longitude and direction (north can be set). Implementing this type of lighting system allows a scene to be lit from the correct angles and allows movement over time meaning that they are physically plausible and allow accurate rendering of daylight scenes.

I undertook a basic lighting assessment allowing me to see how the lighting conditions changes over the course of the day. I used an override material so I could observe how light responded with the geometry before materials were added to observe it. The results of this lighting assessment can be viewed on the associated material disk where all 100 images can be scrolled through. Below (Figure 170) a few of the images are reproduced to show the changing conditions. From this I selected a time of day which I believe showed the details of the space well in the light, I chose frame 99 and 80 for my renders as these showed the light coming in through the windows (see Figure 171 and Figure 172). The following renders are best viewed on a computer screen via the provided associated materials disk. In printed format they appear dark but lightening them would affect the accuracy of the lighting assessment discussed here.

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Figure 170: Lighting assessment of the modelled private apartments of Bodiam Castle. The top left image is for lighting conditions of 21st June at 6am with the bottom right being 21st June 6pm

Figure 171: Frame 80 from the lighting assessment. I have selected this time of day for some of my final renders as the pattern of light streaming through the windows will look effective when more furniture is placed.

Figure 172: Frame 99 from the lighting assessment. I have selected this time of day for some of my final renders as the shadows of the stools appear well.

The next stage was to correct the lighting from a fire in the fireplace. In 3DS max the visual appearance of the fire (flames, smoke etc.) is rendered separately to the lighting (this is discussed in section 4.2.3.5). Instead the lighting has to be created using a volumetric light which then needs adjusting to appear correctly. Volumetric lights allow effects such as scattering of light, by fog or smoke, in the scene. A volumetric light appears in the lighting assessment in the fireplace, but it needs correcting without the outdoor lighting to make sure it is projecting the correct colour and strength. This is done by observing photos of light and carefully adjusting the fire light in each render until it appears correctly. Images such as Figure 18: page 33 of the Bayleaf Hall are helpful, a wood burning fire in a building of the same period, however photos are often filtered to exaggerate lighting.

The final lighting was from a number of candles. The corners of the room were still very shaded so I placed candles in these areas. The lighting for these was again volumetric lights. I used the images produced by Devlin, Chalmers and Brown of a lighting study of medieval Southampton to gauge how the lighting

should appear (Devlin et al. 2002). The result without daylight can be seen in Figure 173.

Figure 173: Lighting of the scene from fire and candle light

4.2.3.4   Screens

Having divided the space as I have discussed above I began to consider how best to order the spaces. In Chapter 3 I discussed the complexity over the ownership of the space and in section 4.2.1 and 4.2.2 I discussed what my research has uncovered. I am going to focus on the upper apartment as the use of the lower one is complicated.

I divided the space with a screen placed close to the centre of the eastern tower as in Figure 174. The placing of the screen allowed me to focus on the audience chamber and bed chamber.

Figure 174: Location of screen on the eastern elevation

The screen was constructed based on this images discussed in section 4.2.2.3. I created it based on a series of panels linked together. I inserted a door shaped gap on the left hand side. The decision to place this on the courtyard side of the room is in imitation to the doorways on the western elevation as in Figure 175. The alignment of these doorways creates the effect of a Baroque enfilade. A render of the screen before a material has been applied can be seen Figure 176.
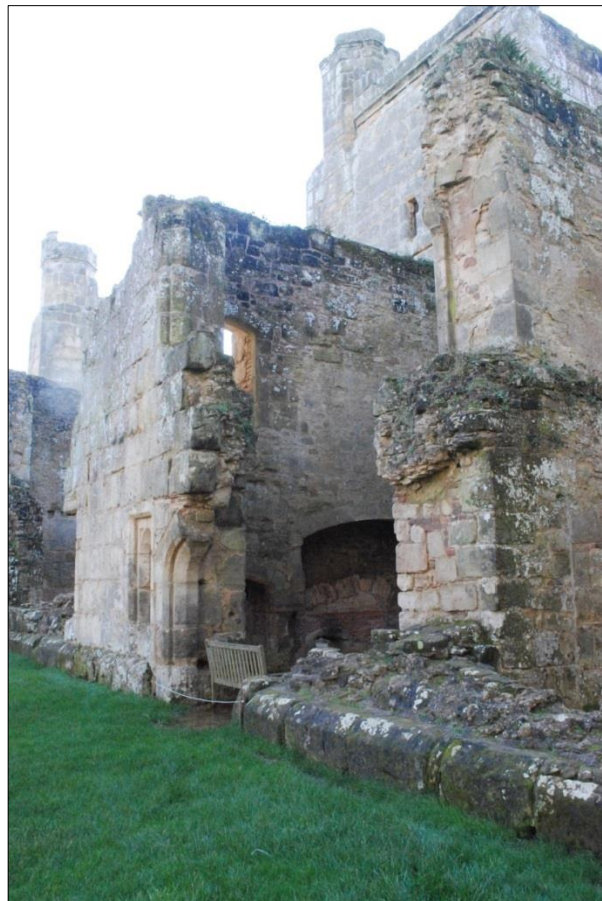
Figure 175: View looking down the western range from the north to the south. Two doorways can be seen linking the rooms together on the upper floor
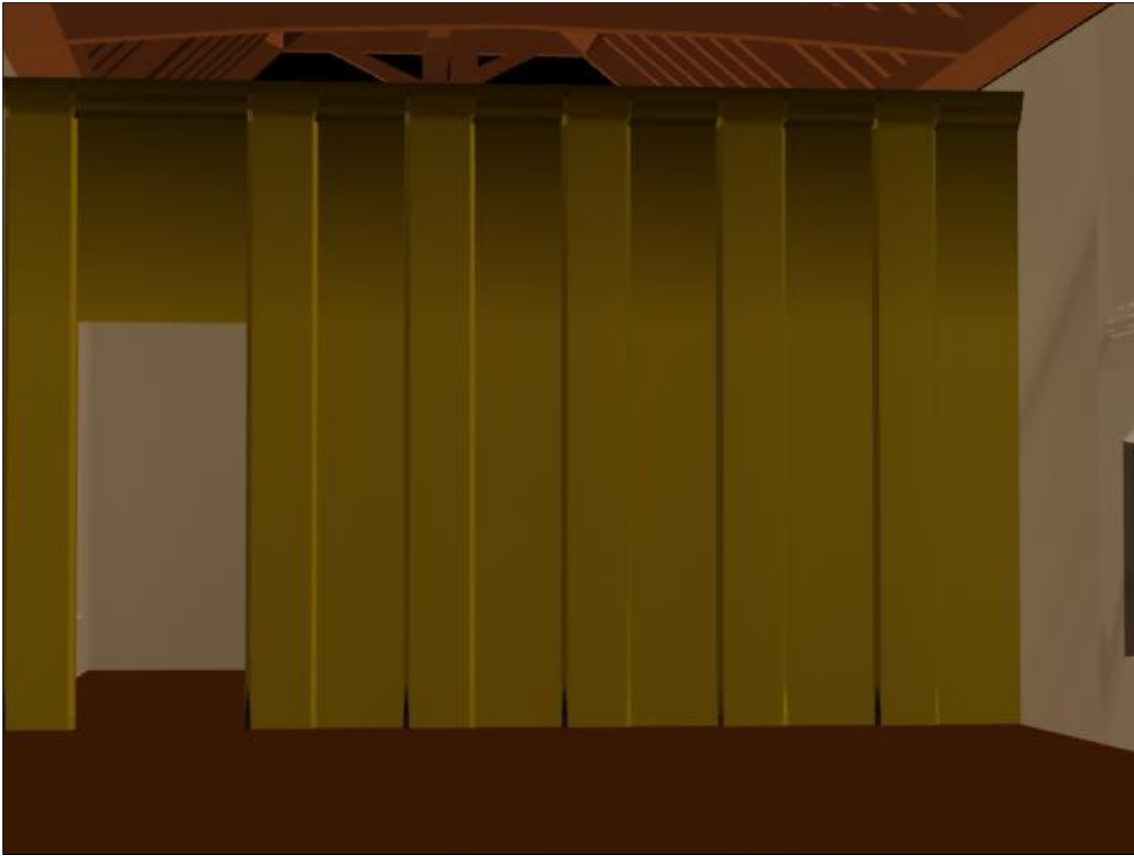
Figure 176: Render of the screen

4.2.3.5   Fire

As discussed in section 4.2.3.3 modelling firelight has to be undertaken independently of modelling the actual fire. To create the visual tendrils of fire in the scene I used the Fire gizmo. Unfortunately when using the mental ray renderer, which I am using because of its daylight systems, the fire does not appear (Figure 177). The two systems are not compatible. Instead I had to render out the fire as an element using the "render elements" option then compile the image in Adobe Photoshop. This produces two images (Figure 177 and Figure 178).

Figure 177: Render of the fire gizmo using mental ray renderer

Figure 178: Fire rendered out as an element

The main image is saved as a .bmp and the fire saved as a .tga. When imported both images need to have the alpha channel enabled and the mode set to 32bit colour. Then the .tga has to be added to the rest of the scene by duplicating the layer into the .bmp file and adding a linear dodge modifier. Figure 179 is the result of compiling the above two images.

Figure 179: An example of a compiled render

4.2.3.6   Doors and fittings

When creating the lighting analysis it became apparent that the doorways
needed filling in even if they would not feature in the final render. The doors
were created out of simple splines for the wooden door and black metal for the
hinges and latches (Figure 180). I did not place shutters on the windows as I
was lighting the scene based on daylight and none of the windows would be
featured directly in the renders. The exception to this is the window seat in the
eastern elevation; however, there is no evidence in the stonework that shutters
would be necessary. Looking at Figure 181 (window seat) in comparison to a
window further along (Figure 182), it lacks degraded fabric to the right of
window.

Figure 180: Render of a door way with door placed and hinges

Figure 181: Window seat built into the eastern elevation in the upper apartment. Photo taken from the west looking east, there is no evidence in the brick work for the removal of shutters.

Figure 182: Window on the eastern elevation. You can see clearly two hollows to the right of the image where fixtures held the window shutter in place.

4.2.3.7   Room layout

The layout of the rooms was not as straightforward as I had originally thought. In Chapter 3 I discuss the similarity between the two suites. However, the door through to the chapel in the lower suite changes how fluid the space is. The door allows movement between the chapel through the room and into the hall. The lower suite also provides access to the south-east tower. Because of this confusion I have chosen to focus on the upper suite.

Furnishing medieval spaces is complex. The modern mind-set has an ingrained belief of what a furnished room looks like and it is hard to move away from

this idea when furnishing a medieval space. Early belief was that medieval spaces were scantily furnished and that this was the nature of furnishing in this period (Ash 1965: 32).

However, this is possibly based on how many medieval heritage properties have been displayed and the lack of existing period furniture. Visiting spaces such as Old Soar Manor (Figure 183), Great Hall in St Cross Hospital, Winchester (Figure 184), or the Great Hall at Penshurst (Figure 16: page 32) supports this idea.

Figure 183: The solar block of Old Soar Manor. It is not presented as a furnished property.

Figure 184: Hall at St Cross Hospital, Winchester

Iconographic sources do not agree with the empty spaces. Instead it suggests the opposite. Rooms appear brightly coloured, full of furnishings and textiles as the examples discussed above in section 4.2.2.6. These can also inform the layout of each of the rooms.

Starting with the audience/ withdrawing chamber. In Pier's Ploughman there is a discussion of the move of lords to dining alone in their own chambers.

"For when the lord and lady eat elsewhere every day of the week, their hall is a sorry, deserted place. And the rich nowadays have a habit of eating by themselves in private parlours – for the sake of the poor, I suppose – or in a special chamber with a fireplace of its own." (Langland 1966b: 115)

In writing this as a piece of advice it suggests that lords and ladies were already beginning to eat in their own private spaces. Therefore it is being used as a type of private hall and I drew on images which focussed on these types of areas. The classic example being an image found in the *Luttrell Psalter* of the Lord at dinner (Figure 116: page 201).

I had already placed two stools in front of the fire to provide me with an element to observe changing lighting conditions in the lighting assessment discussed above. I kept these in place for the final model as is seen in Figure 133: page 215 and Figure 131: page 214.

Figure 185: Modelled stools

Figure 186: Showing stool in front of a fireplace (The Hague MS KB 76 F 14 fol. 5r)(KoninklijkeBibliotheek 2014b)

I chose to place a trestle table with a large chair behind as in Figure 116. It is also found at the Medieval Merchant's House in Southampton (Figure 120: 204) and at Dover Castle it features as an aspect of the private chambers (Figure

121: page 204). The chair was created as a single object with a cushion. The colouring was selected based on the colours of Dallingridge's coat of arms (Or, on a cross engrailed gules, a cross billetty) of red and yellow (Figure 187).
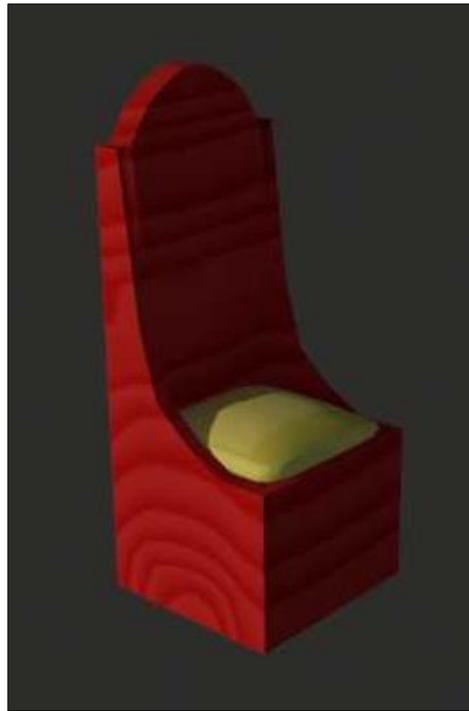
Figure 187: Render of the Great Chair

The table was modelled of three separate elements, the two splayed legs and the covering board (Figure 188). It was then covered with a table cloth (Figure 189).

Figure 188: Model of the trestle table
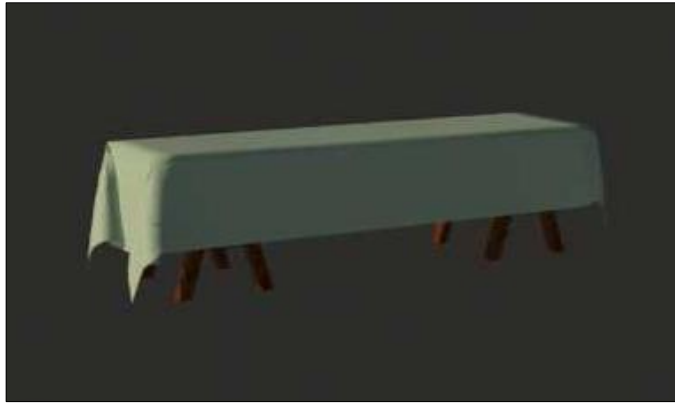
Figure 189: Model of the trestle table covered with a table cloth

Of the reconstructions I have discussed most of them are displayed as rooms waiting to be used. These have an unnatural feel of cleanliness about them. One method to work around this would be to populate the scene. Unfortunately modelling people introduces difficulty from the phenomena known as the uncanny valley (discussed in section 2.2.2). I did not have time to experiment with this. Instead I opted to try and present the scene as a room in use. To do this I did not lay the table as if it was about to be used, instead laying it as if it had just been used. Placing the plates, cups, jug (Figure 190) and candles carefully scattered across it. When modelling the candles I extended the length of the candles for each model, and changed the amount of wax that had melted in each instance to create a partially used affect (see Figure 191). I also created two napkins which I placed as if they had just been discarded on the table (Figure 192).

Figure 190: Models of each piece of plate

Figure 191: Model of the candlestick.

Figure 192: The laid table combining Figure 187, Figure 189, Figure 190 and Figure 191

The space within the room was fairly limited based on the position of the screen and fireplace. I placed a buffet (Figure 193) to the right of the table in the corner as there were not many other appropriately sized spaces. This corner was also particularly dark so I added two candles (the light from which can be seen in the lighting assessment Figure 170). The placing of candles

would also add an interesting affect to the light bouncing off the reflective plate (Figure 194).
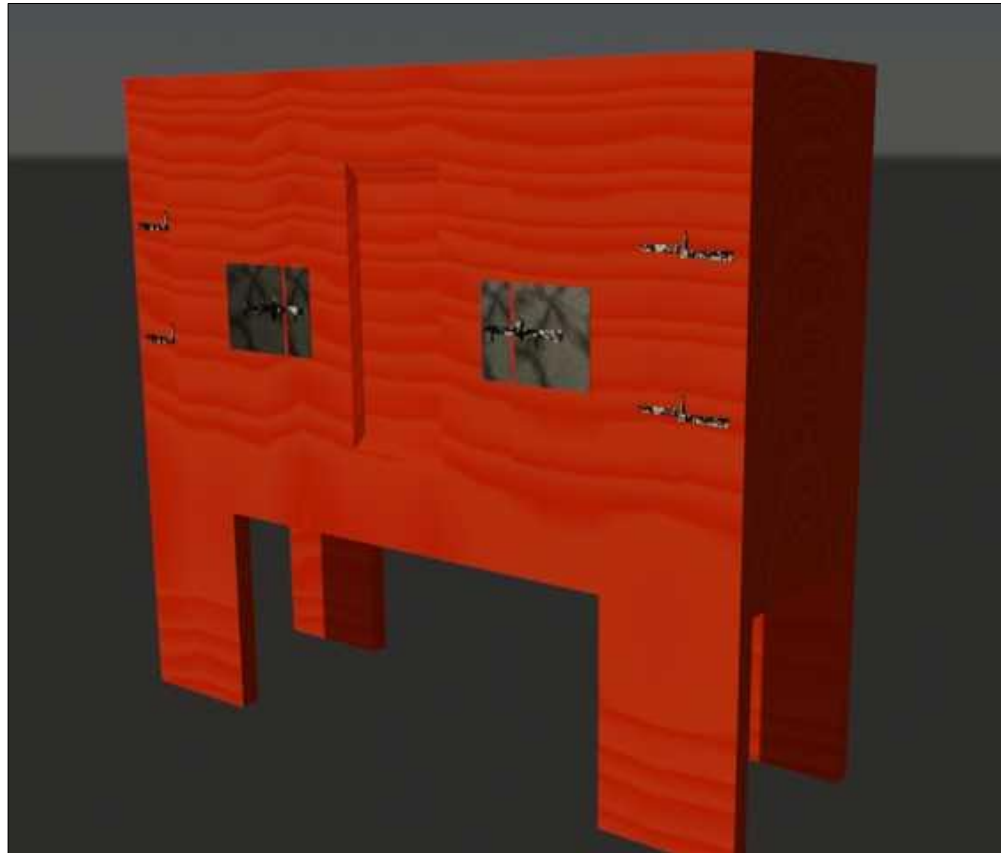
Figure 193: Model of a buffet
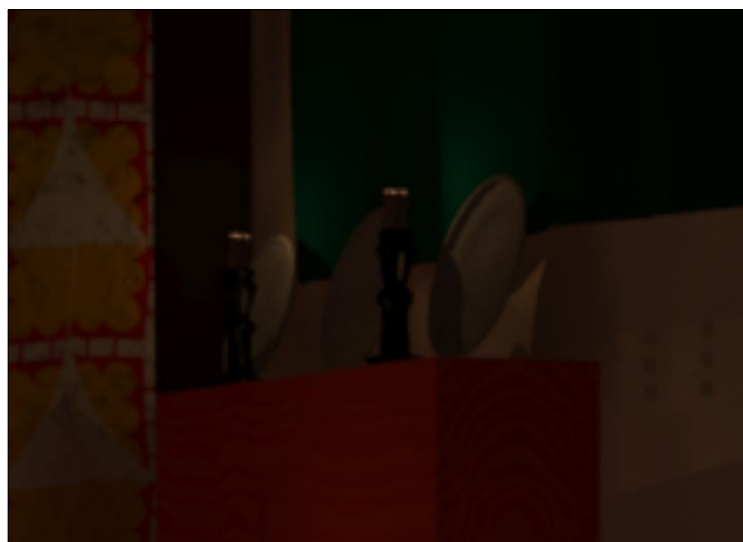
Figure 194: Lighting reflecting off plates on the buffet

Chests were placed in many rooms as extra storage but they could also be used as extra seating and dining space. The left side of the room seemed very

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empty. I placed a chest here to make the space feel more used but also because I wanted to take the suggestion of an enfilade away from the image.

The window seat would also be the focus of some of the images. The position of the floor in relation to the base of the window seat is too far for an easy step up. Therefore I placed a small fabric covered step below the frame Figure 195. The seats themselves were then covered in cushions (Figure 196). You will notice from the render there is also a book placed on one of the cushions. Looking at windows in Figure 128: page 211 and Figure 132: page 214 there are figures leaning up to the light to read. If you look at Figure 197 (a close up of Figure 132: page 214) this is particularly clear. To create it I used references such as Figure 198.
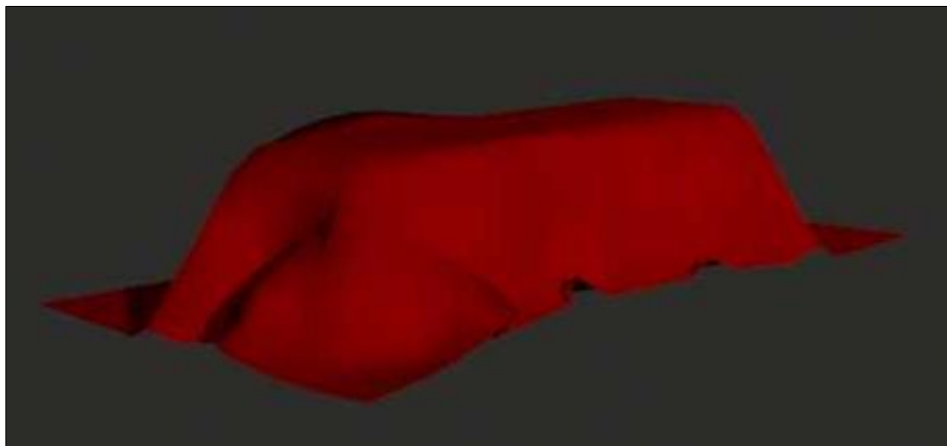
Figure 195: Window seat step
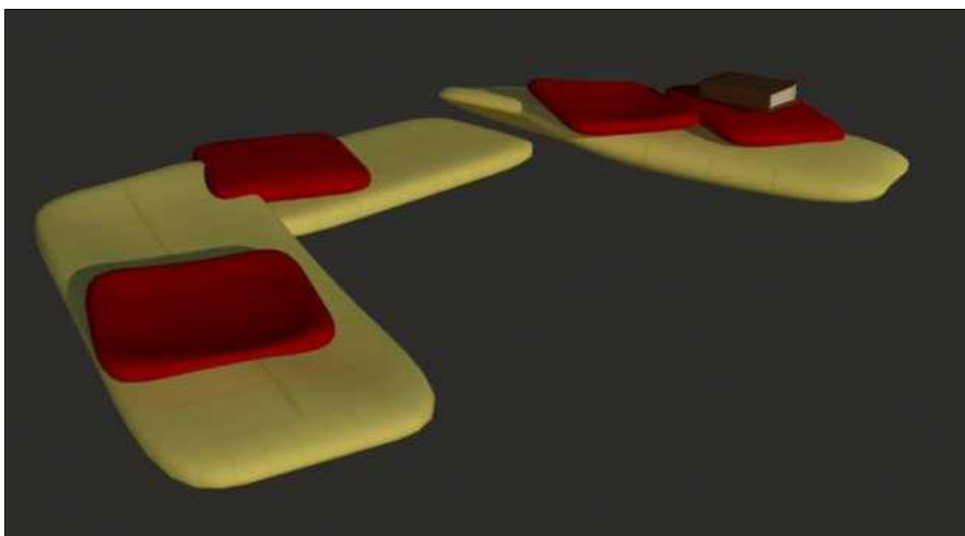
Figure 196: Window seat cushions

Figure 197: Close up of the background of Figure 132. Here the detail of the adjoining room can be seen. Or particular interest is the old man holding is book up to the window for light to read. (MS Museo Civico d'Arte Antica, inv. no. 47 fol. 93v) (Aavindraa 2012)
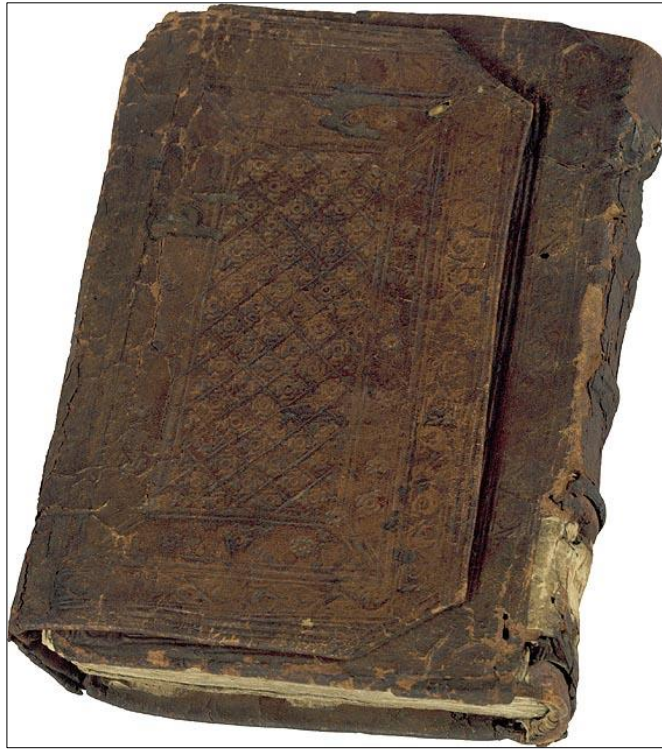
Figure 198: *Commonplace Book* of Johannes Wintzler. Germany, 1519–1527. Copyright: Division of Rare and Manuscript Collections, Cornell University Library (Cornell University Library 2002).

I placed a second buffet on the other side of the window seat with a larger plate and another candle. In some of the final images I added a couple of glasses to the window seat. Here I was trying to capture the lived in feel of some of the paintings such as Figure 132: page 214.

I discussed the decoration of the building through section 4.2.2. The beams and built in features all conform to the perpendicular style. I then chose to use hangings to add individuality. Most depictions of great halls or receiving rooms show the great chair situated in front of a hanging, (often depicting something related to the family). Although iconography depicts what the owner wishes to portray I feel that this is a good theme for the images. Therefore for this wall hanging I used a repeating pattern of Dallingridge's shield. I also placed a hanging to the left of this one over the doorway showing a unicorn (Dallingridge's tourney helmet). The final hanging I choose not to adorn with a pattern instead just having it a bright colour of green. Following are a series of the final renders I used in the mood boards.

Figure 199: Final render of the audience chamber

Figure 200: Final render showing a close up of the buffet

Figure 201: Final render focussing on the fireplace

Figure 202: Final render looking back front behind the table

Figure 203: Final render of the window seat

Behind the screen I started with modelling the bed and placed it against the back wall. The first set up hangings I used were pattered with a repeating pattern of marlets on a black background (Figure 204). The pattern is the Raynden coat of arms, as Dallingridge inherited the estates of Raynden on the death of his brother the use of the coat of arms seemed appropriate as textiles would have also been bequeathed. These colours were very dark and when rendering the side of the room against the tower very little could be seen. Instead I changed the material to be plain red fabric (Figure 205). A colour which seems to be common in bed hangings in paintings (Figure 109: page 195, Figure 110: page 196, Figure 111: page 197 and Figure 132: 214). I used the marlet texture for a wall hanging in the bed chamber.
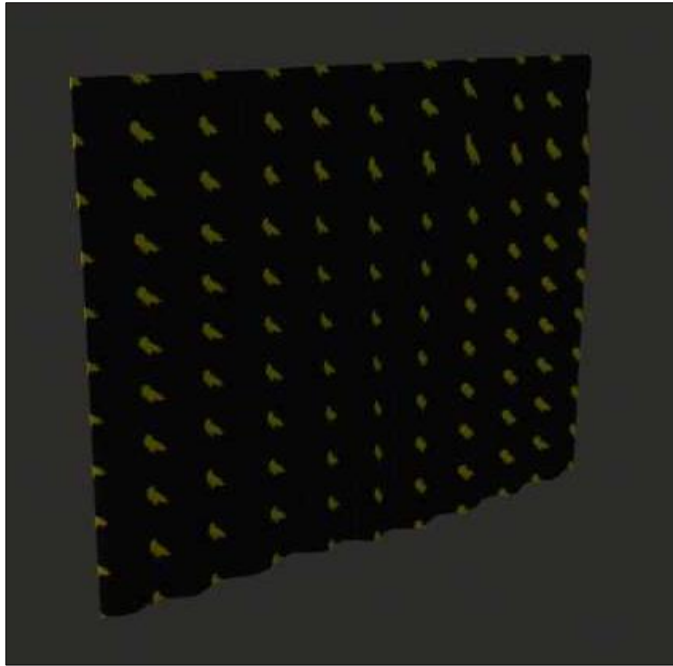
Figure 204: Pattern used in first render of the bed

Figure 205: Render of the bed with red hangings

In front of the bed was placed a chest. I used red and yellow colouring again here. I also added a simplified version of the Dallingridge coat of arms. In a number of the images I also placed a jug on top of this chest.

Figure 206: Chest

Again I drew upon the iconography discussed above to furnish the rest of the scene. I placed a chest covered with a cloth and cushions against the wall near the bed (Figure 207). On the other side of the room I added a three legged stool (Figure 208) close to the fire and a second buffet very similar to the one used in the audience chamber. I also added a pair of pattens (Figure 209). Pattens are a type of overshoe which became popular in the 14th century. They were to protect shoes from general muck of outside and began to appear as shoes become more decorated (Grew & de Neergaard 2001: 4-5). The final element might seem slightly strange but they appear in a number of images from the period (Figure 111: page 197 and Figure 132: page 214). Possibly they have been included in the paintings to show the owners were moving with the new fashions of the times.
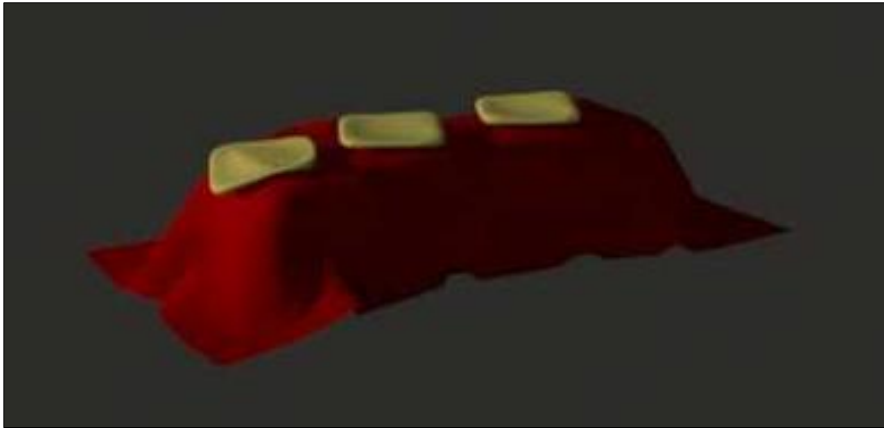
Figure 207: Chest next to bed

Figure 208: 3 legged stool

Figure 209: A pair of pattens

Figure 210: Bedroom final render

Within the bedroom I have moved furniture about much more between different renders than I have with the audience chamber. I was trying to explore different elements which might portray the use of the room. I discussed in sections 1.1.1, 3.1.3 and 4.2.2.3 the presence of the window overlooking the chapel as particularly feminine. Directly below this window I added a prie-dieu (Figure 211) and placed a couple of candles on top of it (Figure 212).

Figure 211: Prie-dieu

Figure 212: Rendered feminine space

Feminine space is often discussed in relation to children and birth, this is quite apparent in the iconography with most images of women being involved with some task surrounding child birth. The easiest way to represent this in the image was to place a cradle in the scene (Figure 213 and Figure 214).

Figure 213: Cradle

Figure 214: Rendered scene with cradle

Masculine space was much harder to define (as I will discuss in more detail in the next section). I modelled a shield (Figure 215) and placed this in against the wall in this room (Figure 216).

Figure 215: Shield

Figure 216: Masculine space

4.3   Mood board creation

Producing the 3d model followed a well-defined methodology. The next step was to select images that bring out the experience of life the visualisations are trying to access.

I began by selecting 20 concepts about different elements of late medieval life (see below). Some of these themes are connected with the use of Bodiam Castle specifically (Business and Status) while others are looking at using visuals to try and invoke an idea of the multisensory experience of the past (touch, scent, reverberation). I then selected about ten images to represent each concept. These images were a mixture of renders, photographs of the site, photographs of period furniture, photographs of reconstructed domestic interiors and images from medieval manuscripts. Many of these sources were used as references when creating the model.

Eating	Warmth	Children/ Birth	Scent	Seasonality
Comfort	Prized Possessions	Status	Sound	Death
Memory	Feminine Space	Business	Touch	Reverberation
Reading	Masculine Space	Defence and Security	Family History/ Heraldry	Sleeping

Stock photographs are used commercially to make consumers react in a particular way. I have the same aim. There are a number of online databases of images which can be sorted by theme (i.e. GettyImages 2014). I consulted a number of online stock image databases to see the type of images or common themes that are used to represent particular ideas (Frosh 2001).

The final images I selected are found in the associated materials in a folder entitled "Visualisation Project". This contains a folder for each mood board which holds the photos and a metadata document which states where the images came from.

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Eating

I discussed in Chapter 1 how the Great Household spent the majority of their time involved with the creation and consumption of meals. Stock images generally show people eating or food. As I did not render populated images I had to focus around the task of eating.
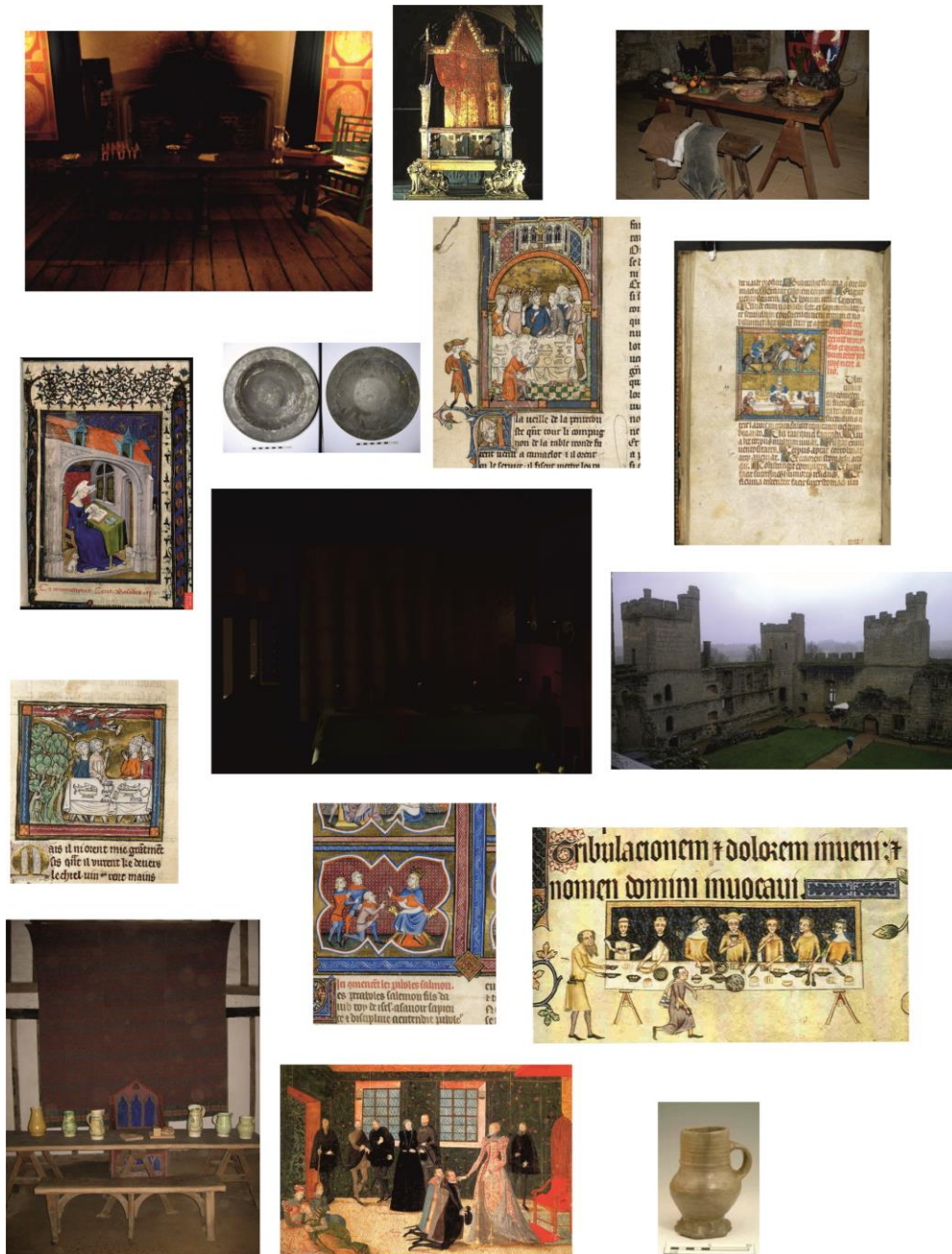
Figure 217: Eating mood board (see associated materials for sources of images)

Comfort

Looking at the interior of Bodiam today, particularly if visiting on a cold wet day, it is hard to imagine it being a comfortable space. I brought together images of furnished space: such as Dover Castle with manuscripts of household scenes. These I felt elicited a feeling of warmth and comfort similar to those used in stock photography.
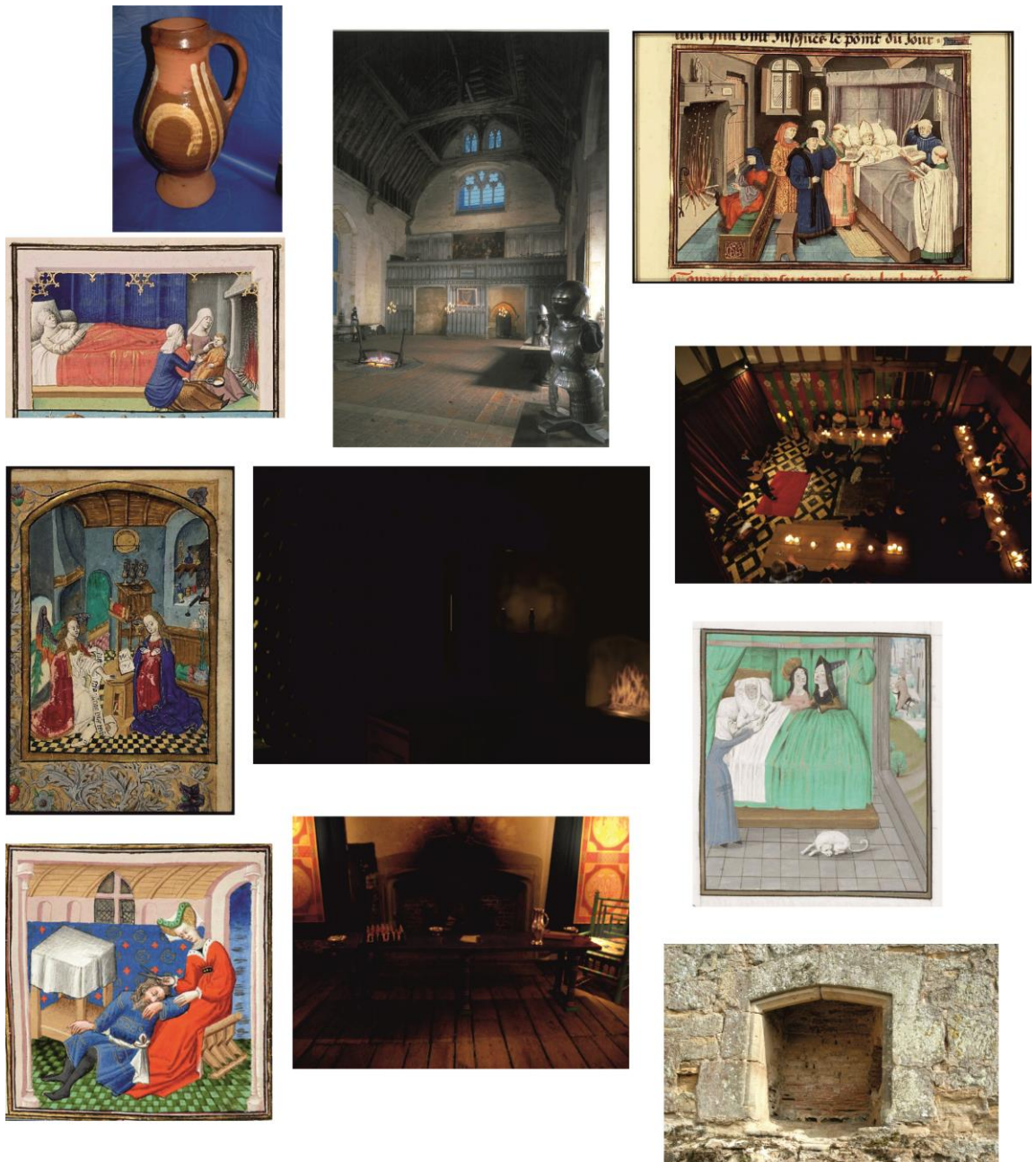
Figure 218: Comfort mood board (see associated materials for sources of images)

Memory

Memory was a much more difficult concept to grasp. Stock images were not a great deal of help as they predominantly feature people taking photos. There are not many images of images in the process of creation (e.g. paintings of artists painting). Instead I tried to use images of heraldic displays as heraldry is being used to help them be remembered. I also used images of heritage places and spaces. The final image: a photography of group of people dressed for a 1940s event was selected as it was encouraging memories of a specific past era.
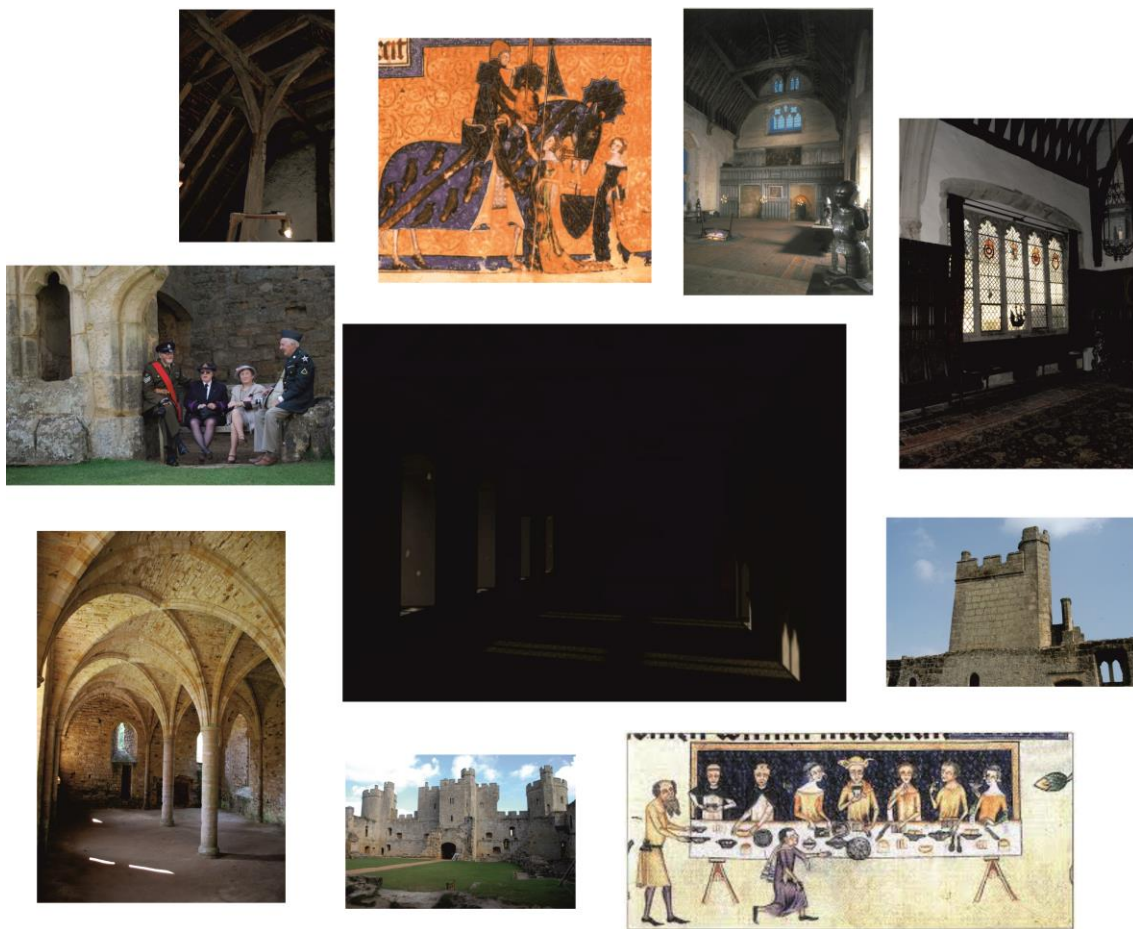
Figure 219: Memory mood board (see associated materials for sources of images)

Reading

Putting together images around the idea of reading was very straightforward. Medieval manuscripts include many images of people reading as well as the survival of medieval documents made this group of images easy to collate.
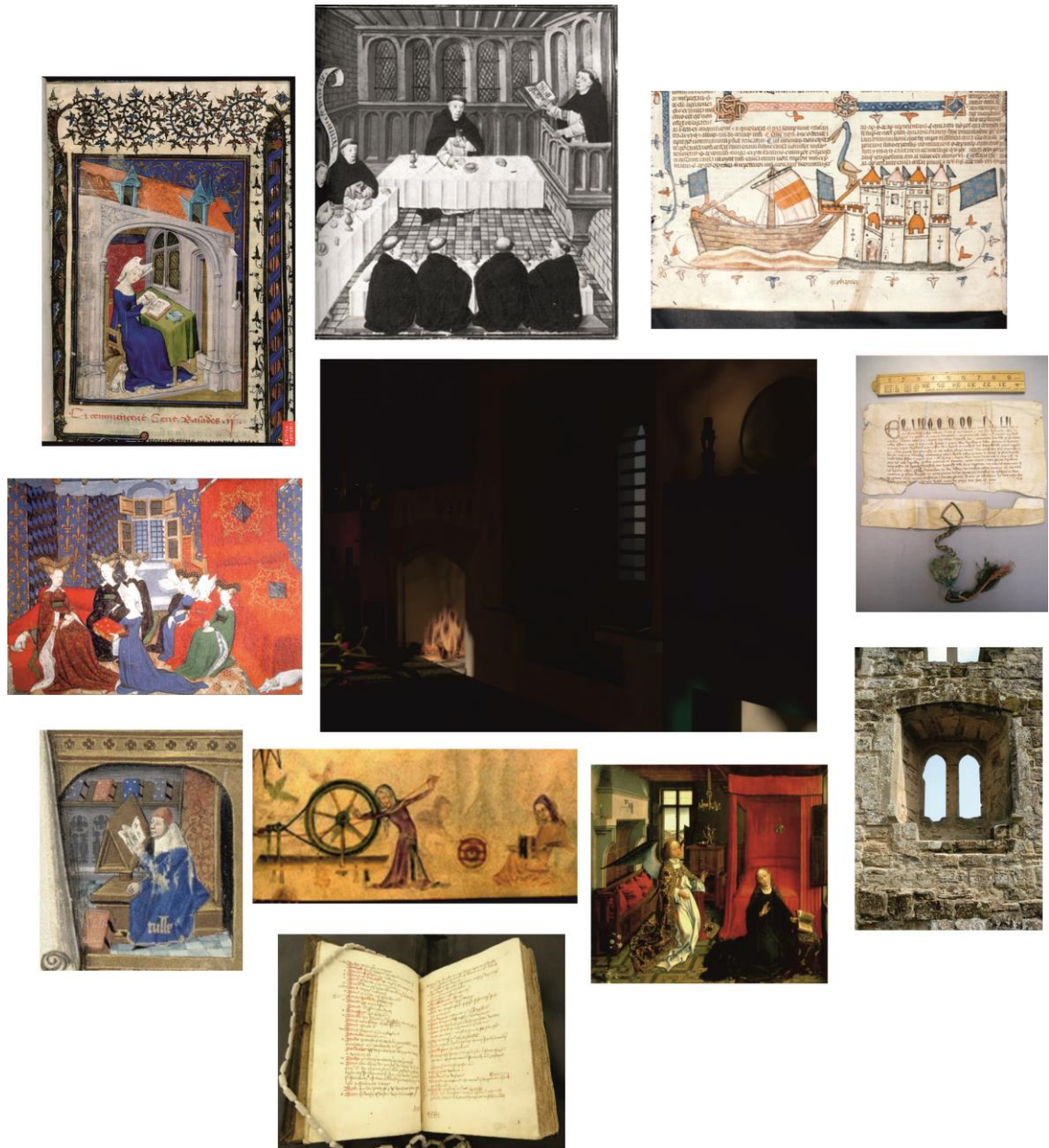
Figure 220: Reading mood board (see associated materials for sources of images)

Warmth

Stock images of warmth were more varied than I was expecting. Here I used images containing lots of textiles or fires.
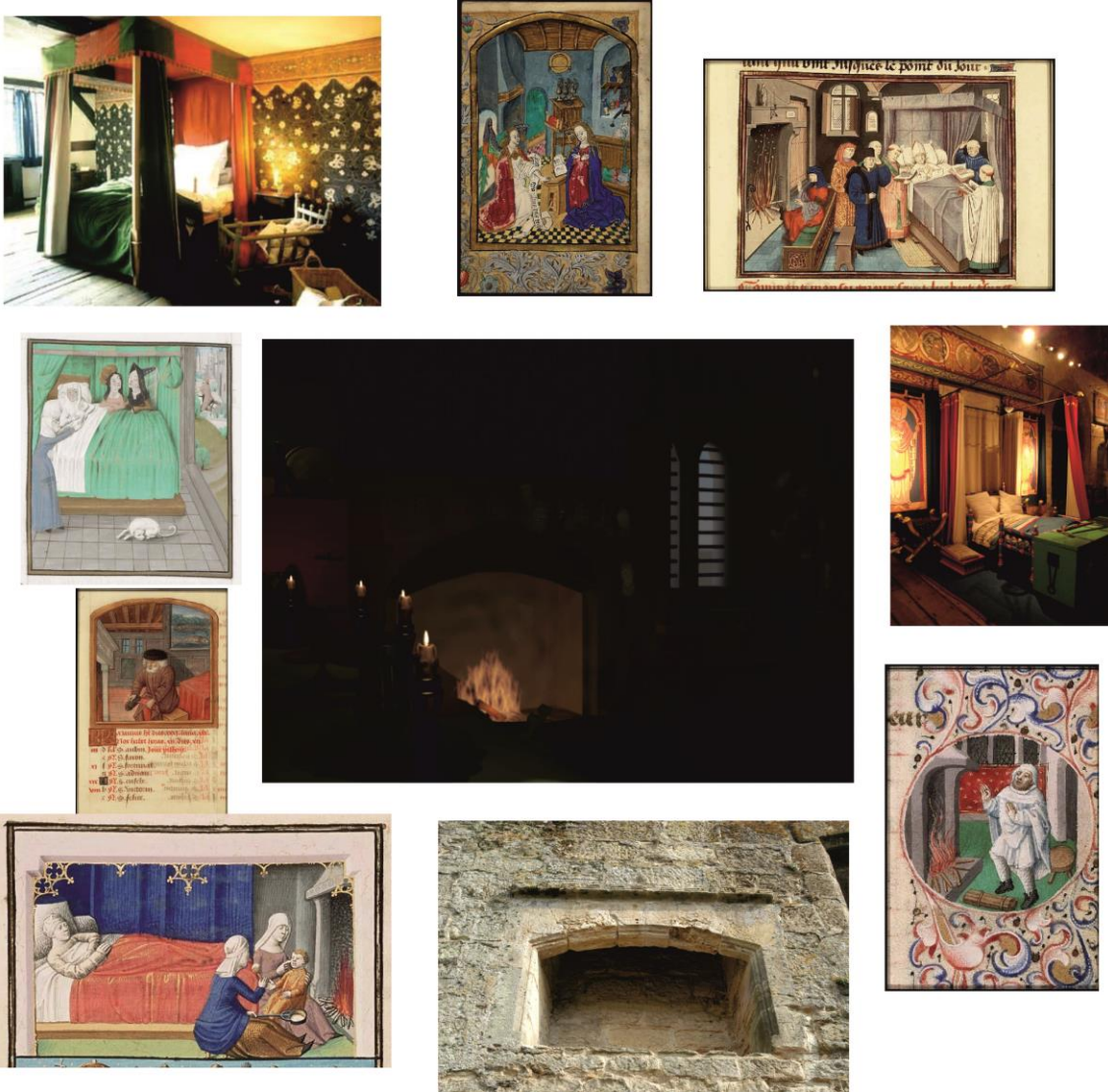
Figure 221: Warmth mood board (see associated materials for sources of images)

Prized Possessions

The importance of possessions can be seen in the types of furniture which were predominant in the medieval period. Pieces used for storage, transport and display of possessions. Therefore I selected images which were used in this way or displayed. I also used an image of a license to crenellate, Coulson argues that the possession of a license to crenelated as a symbol of status was more important than what it decreed (Coulson 1992), therefore the document itself would be considered prized.
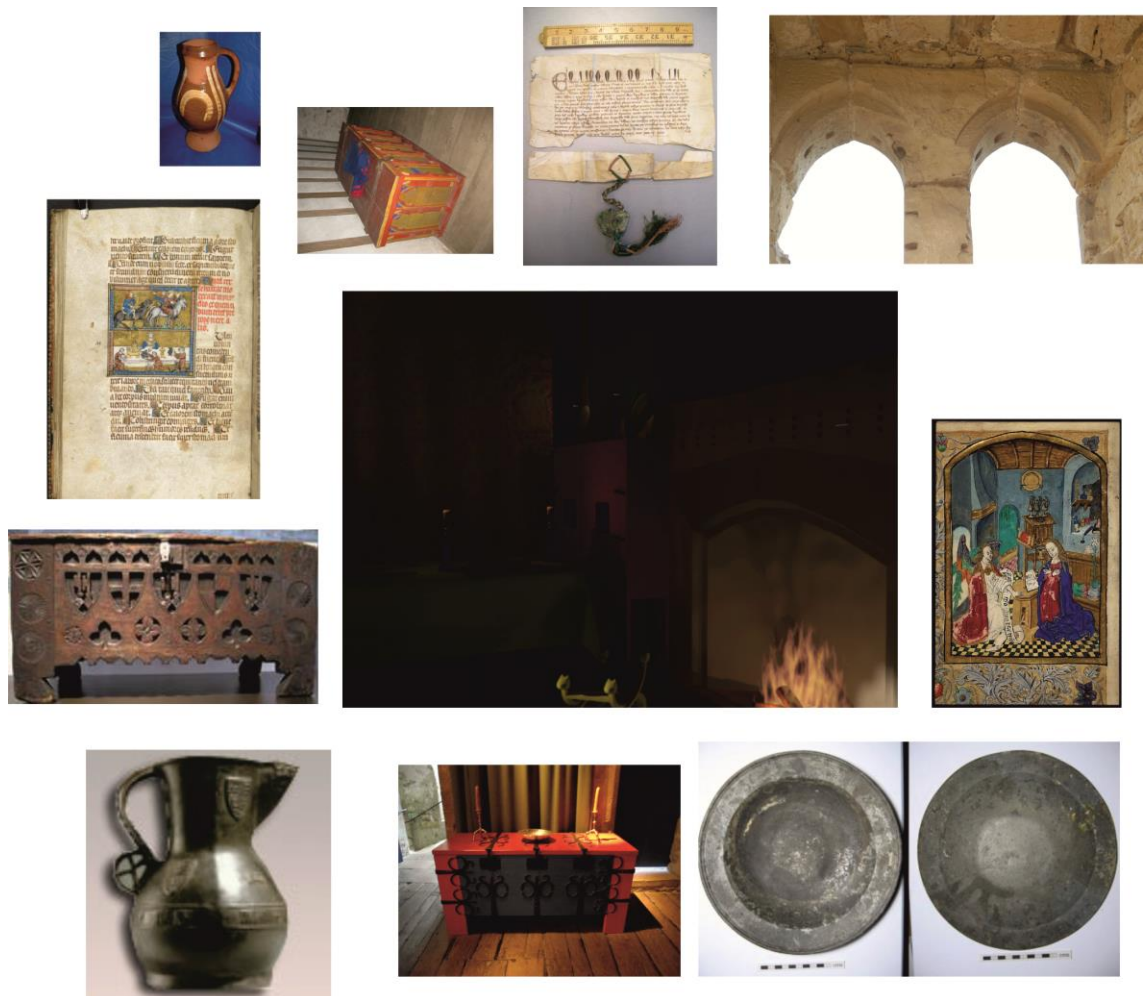
Figure 222: Prized Possessions mood board (see associated materials for sources of images)

Feminine Space

In the conclusion to Chapter 1 (section 1.3) I discussed the study of feminine spaces. There are a number of images of women: most of these are dominated by the theme of child birth. Therefore the renders I used were chosen to show this.
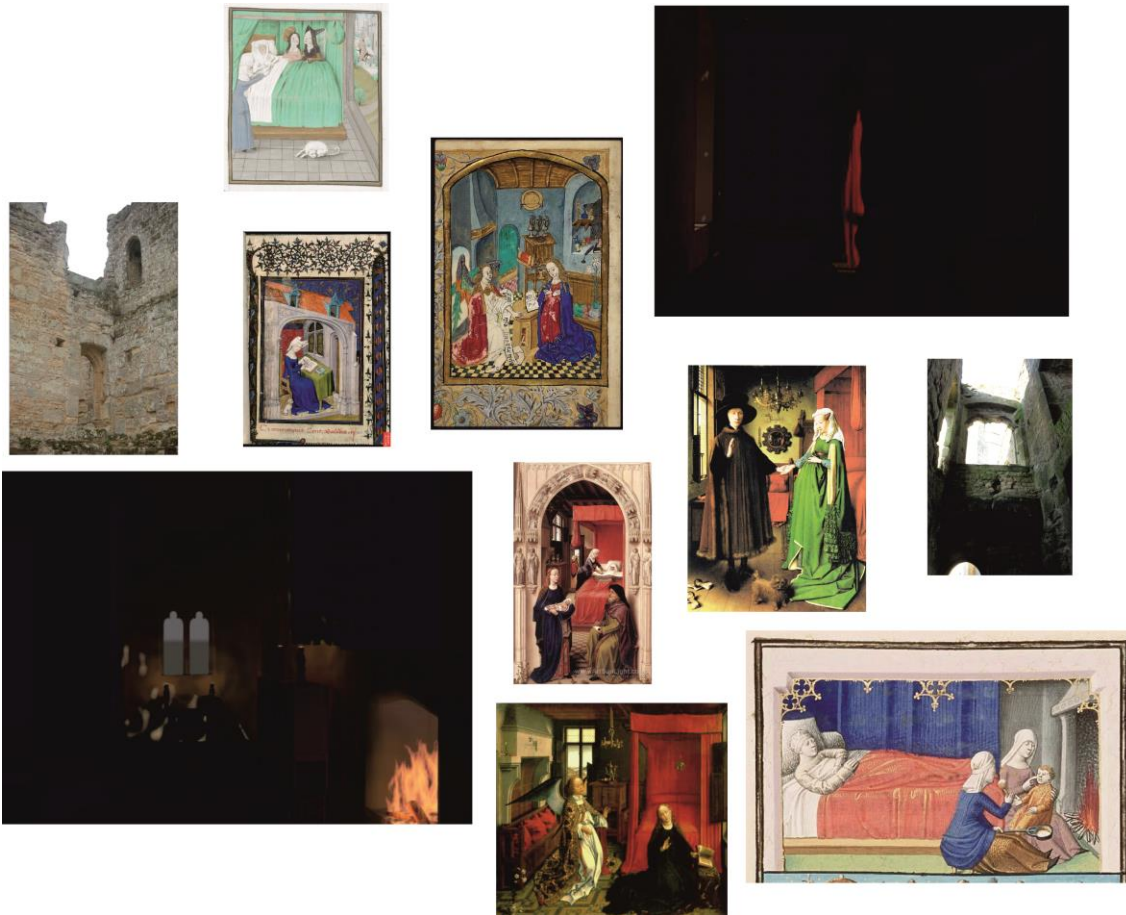
Figure 223: Feminine space mood board (see associated materials for sources of images)

Masculine Space

There has been discussion of the difficulty in tracing women in the medieval period (see (Gilchrist 1999; Ward 1995)). However, it was finding images to represent masculine space that I found more difficult. Although men do feature in a number of images they do not seem to embody spaces but tend to be pictured in the public spaces of the building. Therefore images have been of these areas and objects associated with masculine activity.
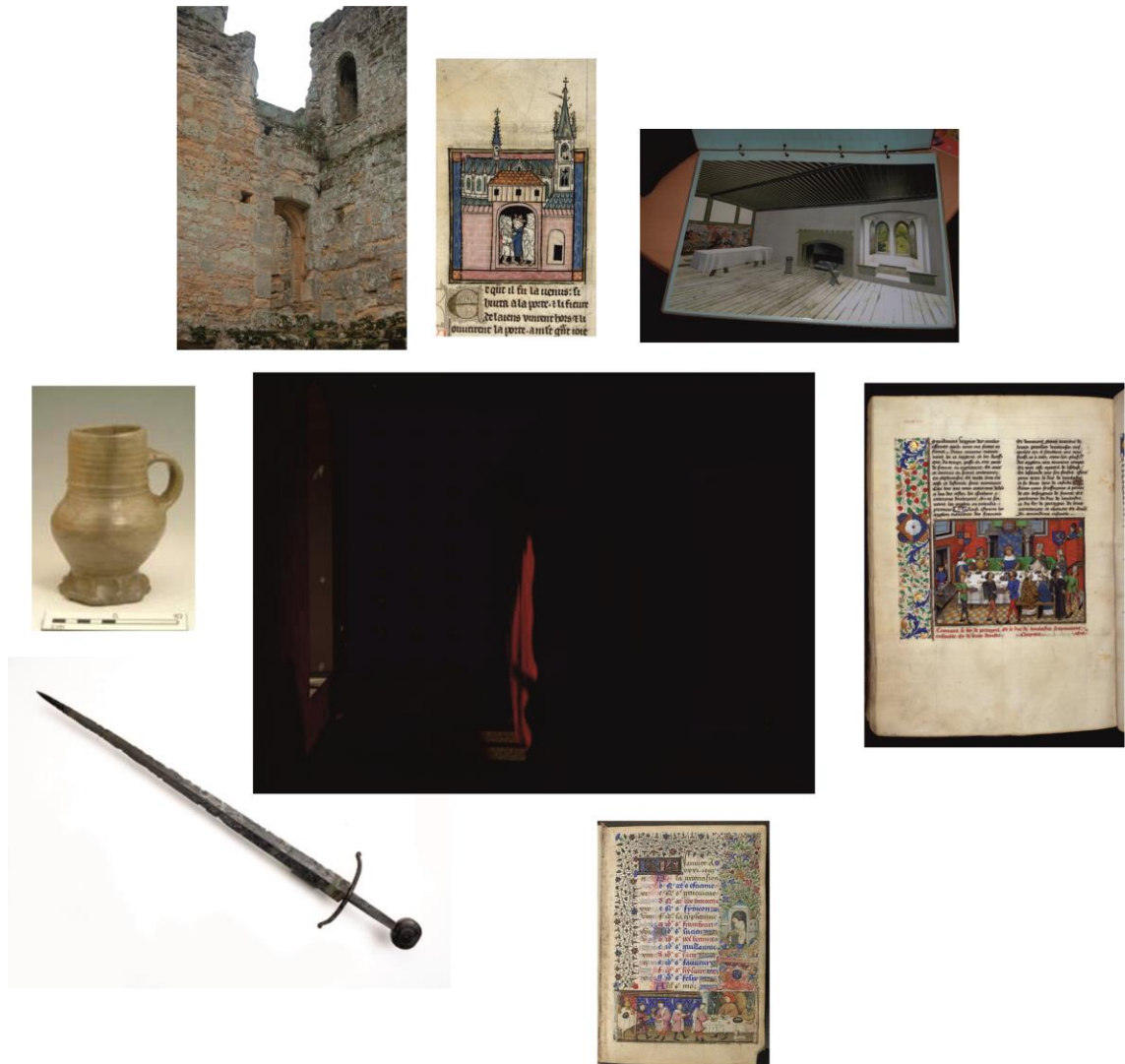
Figure 224: Masculine space mood board (see associated materials for sources of images)

Children/ Birth

I mentioned above when discussing female space that images associated with women tended to focus on children and child birth. This gave me a place to start. I also included a couple of objects associated with children such as a cradle and a toy.

Figure 225: Children and birth mood board (see associated materials for sources of images)

Status

Status is a more difficult concept to visualise. I selected elements which were considered high status in the medieval period in combination with images which shows a marked difference between the status of individuals.
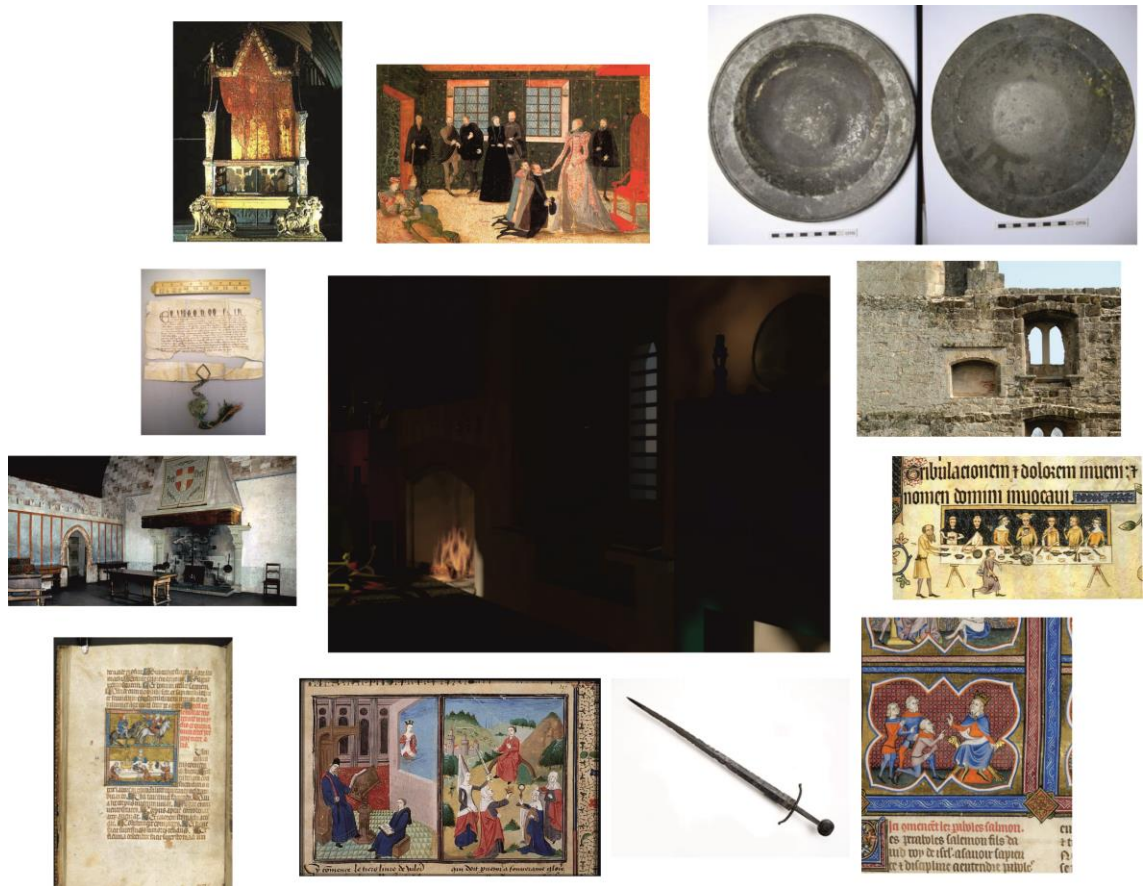
Figure 226: Status mood board (see associated materials for sources of images)

Business

Stock images for business (when they are not of people, mostly men, wearing suits) consist of images in a work environment often communicating with each other or using technology. I chose a similar approach with these images. I selected a series of manuscript images showing business transactions being undertaken with elements of contract making.
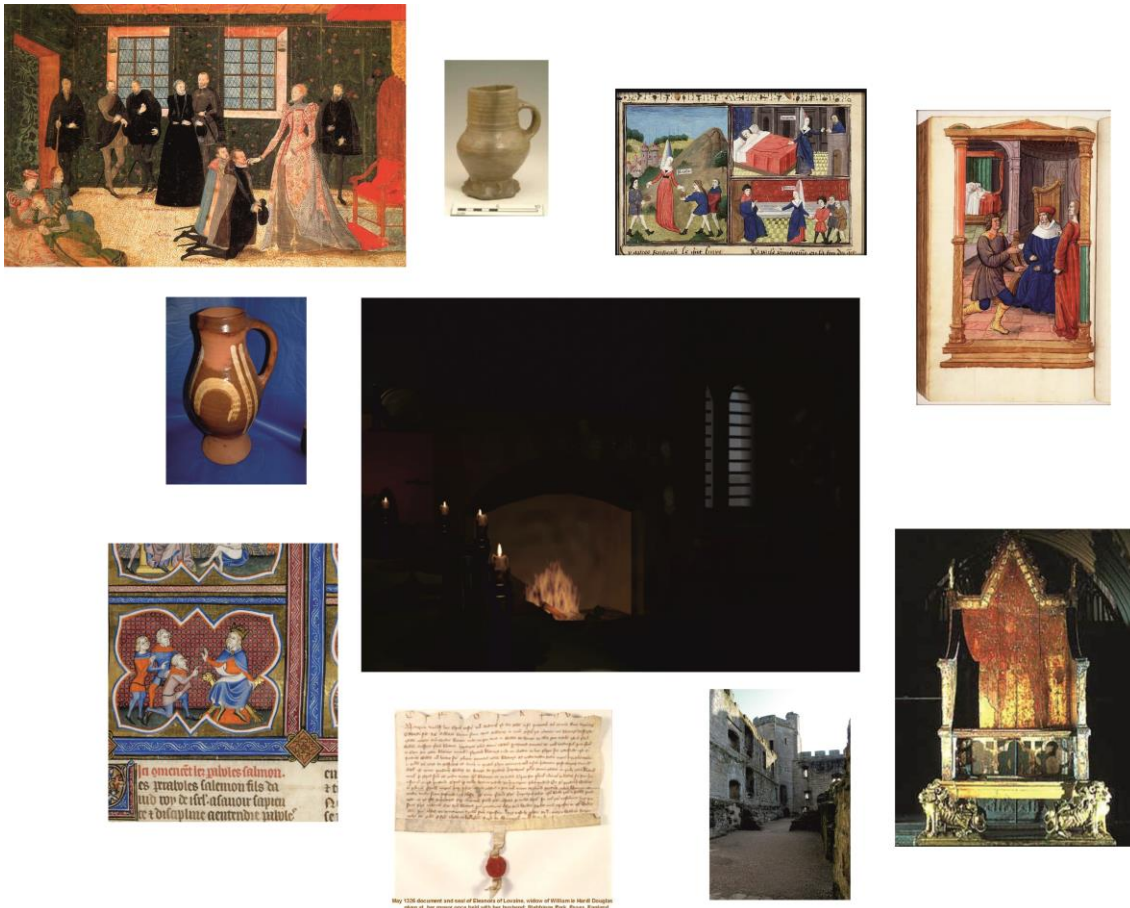
Figure 227: Business mood board (see associated materials for sources of images)

Defence and Security

For images about defence and security I used images which showed defensive elements of building buildings or pieces used for security.
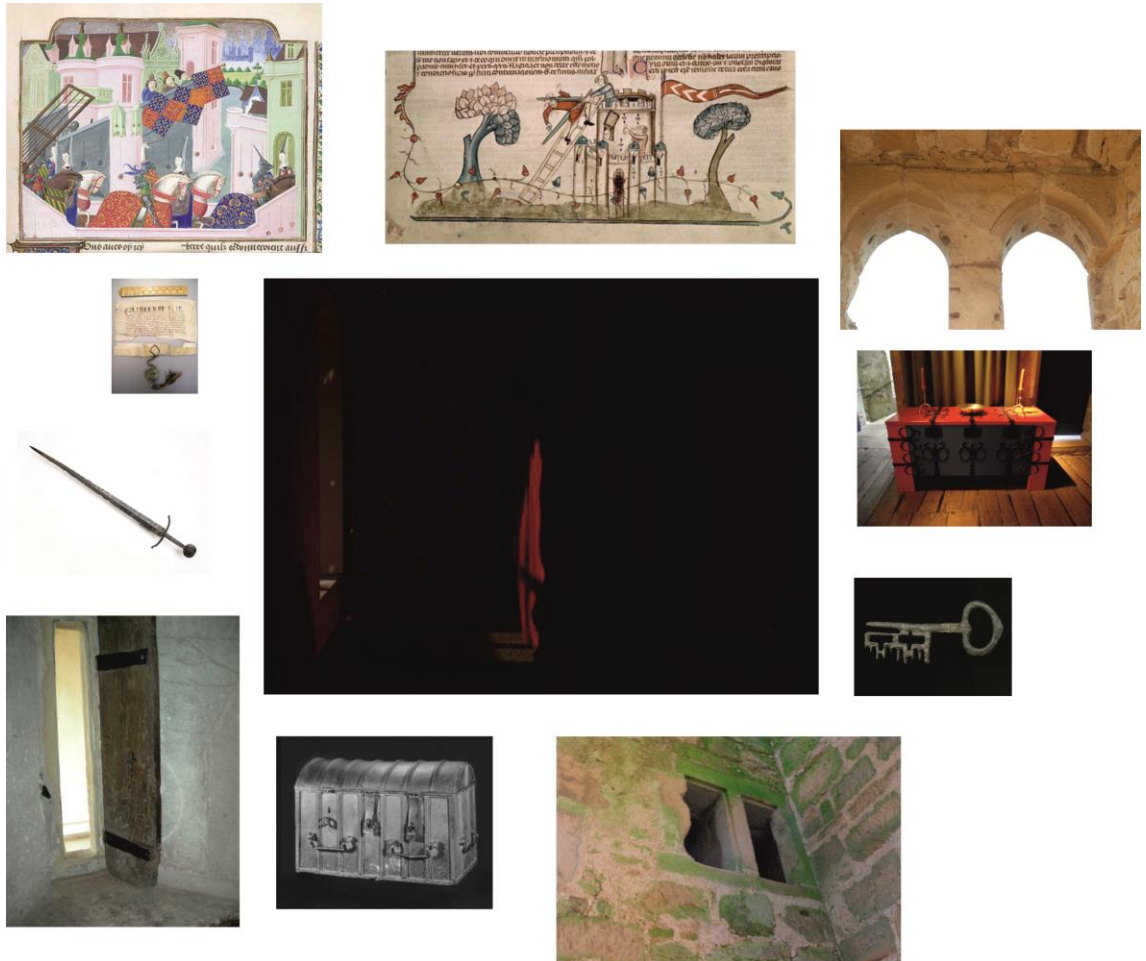
Figure 228: Defence and security mood board (see associated materials for sources of images)

Scent

To elicit a sense of scent using images I used a much more varied range of images than with some of the previous boards. For example I used "smell" tapestry of the Lady and the Unicorn tapestry series. I also used photos of things which would have had a distinctive smell when they were in use.

Figure 229: Scent mood board (see associated materials for sources of images)

Sound

As with the scent mood board I found I had to think around to represent sound. I used some of the concepts suggested by Woolgar (2006) about the senses of the mouth to think about this. I also returned to the idea of soundmakers (which was discussed in section 2.3.1).
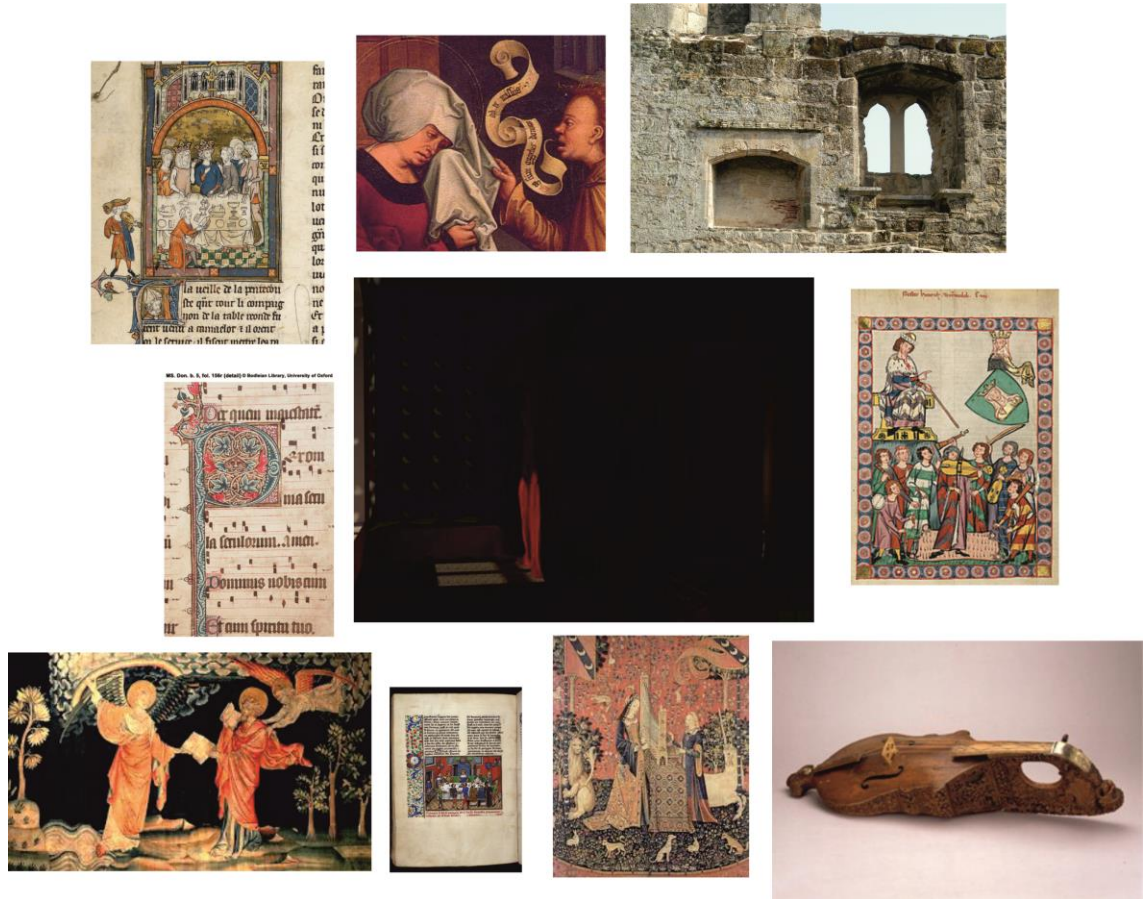
Figure 230: Sound mood board (see associated materials for sources of images)

Touch

The images I used for touch can be divided broadly into two groups: images of physical objects and images showing some element of touch. Images 5 and 7 I thought particularly engaged with the sense of touch and its importance.
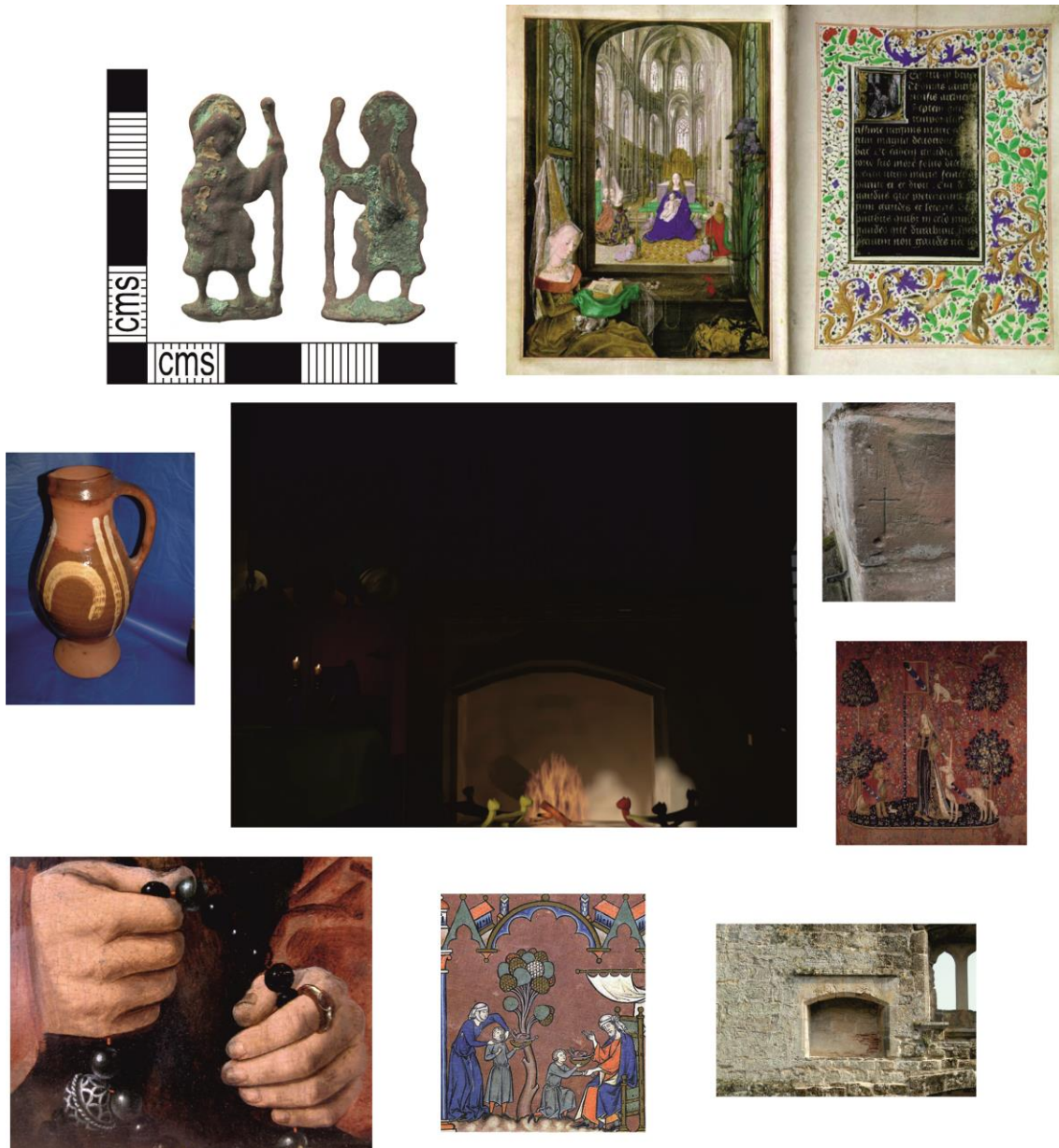
Figure 231: Touch mood board (see associated materials for sources of images)

Family history/ heraldry

Finding images depicting heraldry was straightforward the use of which I discussed above in section 3.1.4.

Figure 232: Heraldry/ Family history mood board (see associated materials for sources of images)

Seasonality

Choosing the images for seasonality I found generally the set worked much better together than individual images. It was much easier to bring images from different times of the year and households moving around.
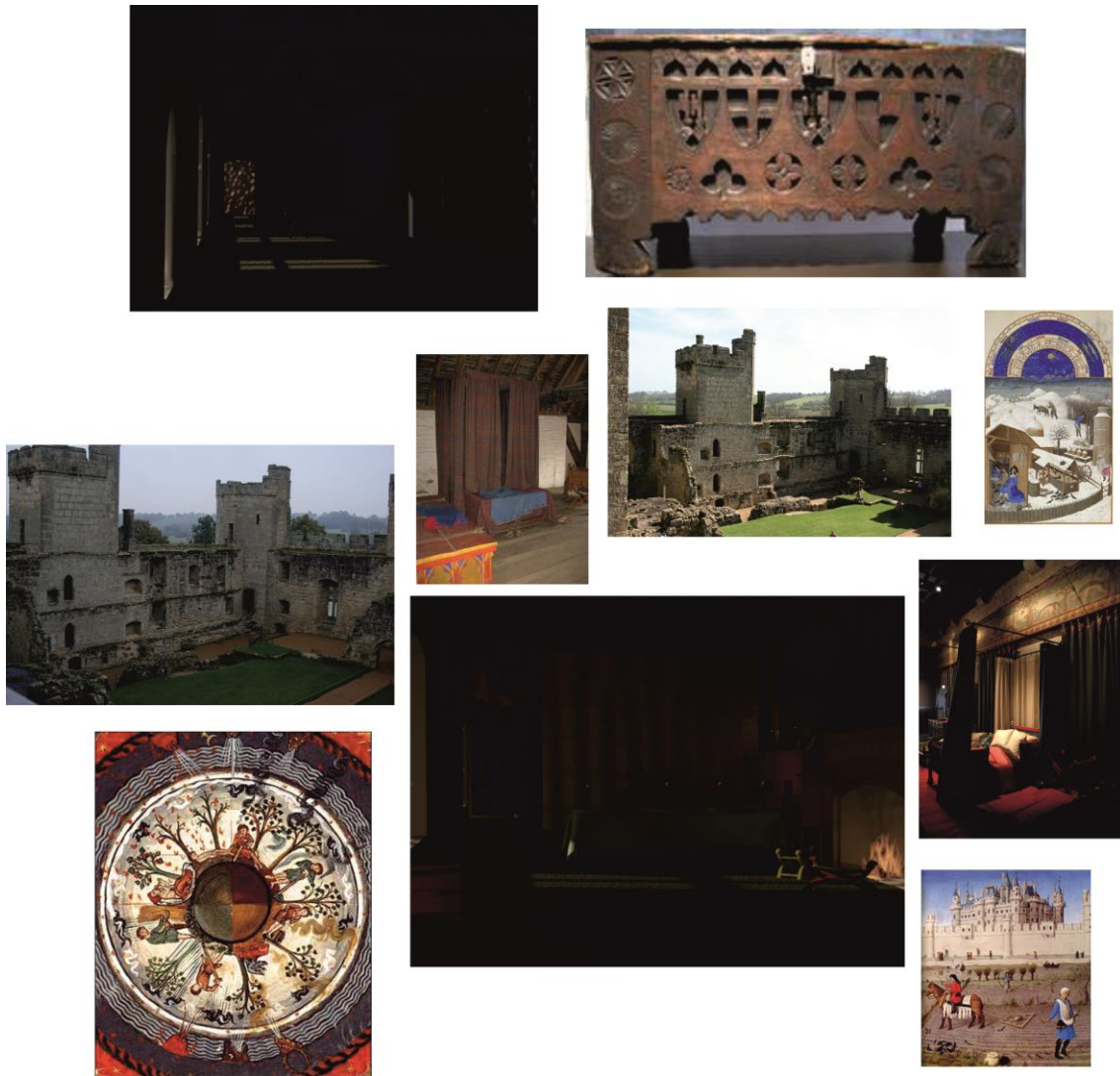
Figure 233: Seasonality mood board (see associated materials for sources of images)

Death

Images about death was particularly challenging. Although there are a number of medieval images about death, they are rarely in a secular setting. I found it difficult to select an appropriate rendered image for this mood board and instead went for a general one. The creation of this mood board highlighted how it is not possible to visualise the entire life course in a particular setting.
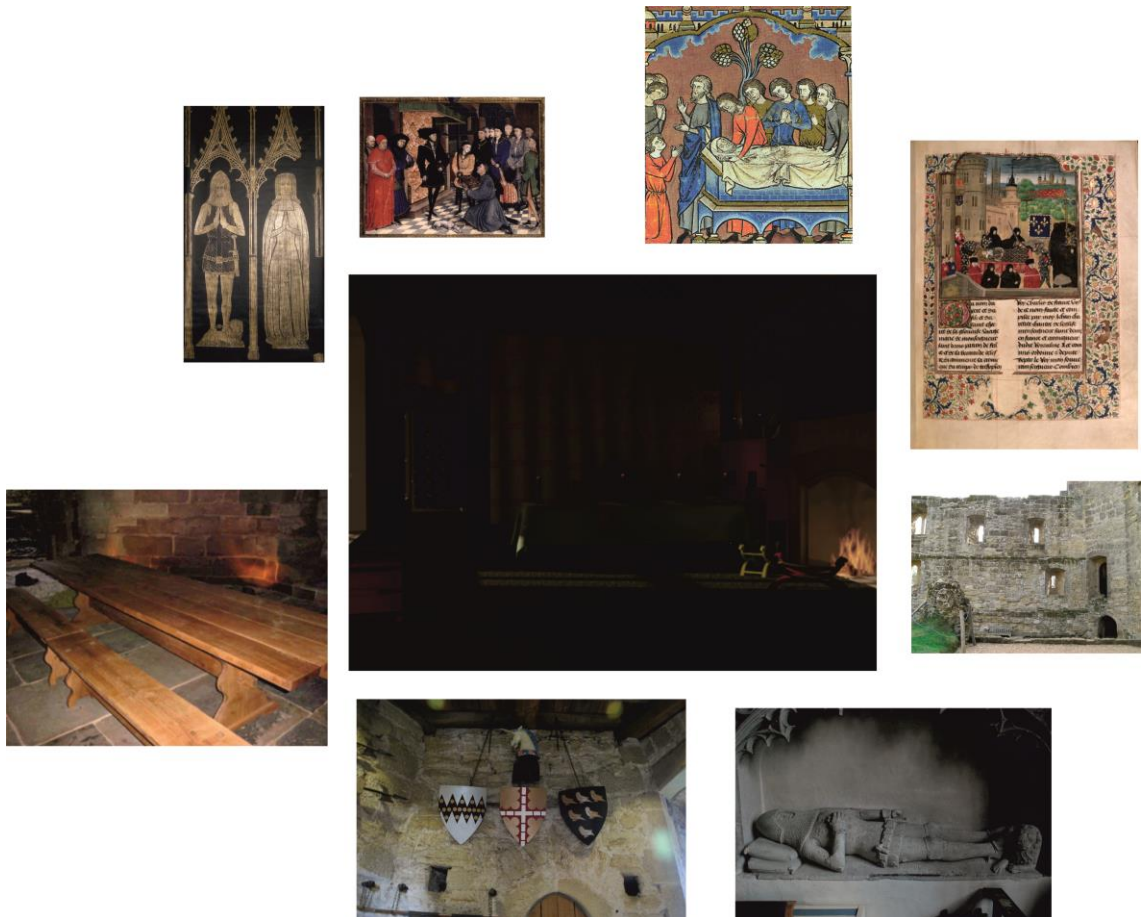
Figure 234: Death mood board (see associated materials for sources of images)

Reverberation

Choosing reverberation for this section was to hopefully draw parallels between this case study and the auralization case study that I will discuss in Chapters 5 and 6. The images were quite similar to those selected for sound. Here I choose more images to do with the sound properties of the room rather than just soundmakers.

Figure 235: Reverberation mood board (see associated materials for sources of images)

Sleeping

There are lots of images to do with sleeping surviving so I combined medieval manuscript images with photographs of reconstructed spaces.

Figure 236: Sleeping mood board (see associated materials for sources of images)

4.4   Analysis

Visualisation has been critiqued in depth (see chapter 2). There have been studies exploring the impact visualisation has had on our understanding of the past (Perry 2009; Moser 2001). People have also explored how the style of image impacts people's trust in an image (Frankland 2012). Others have discussed the need to consider the cinematography or artistic elements. This project is interested in the lived experience of a site and how digital models can help elicit emotional responses. I am also interested in how the interpretation of the site is part of the entire image creation process and therefore how the final image is the result of a process not entirely about presentation of results. My method of assessment needeed to consider this, not what has been included in the image or how physically accurate it is but the human response.

To do this I asked three groups of people to engage with the images used to create the mood boards. The first group were asked to look at the mood boards and select the five images they thought best represented that concept. The second group were given access to all of the images and then asked to select five images to best represent each concept. The final group were asked to select images based on their own choice of concepts.

All of the images were uploaded to flickr and grouped by album. The images for each concept were added to an album and two albums were created of all the images for Groups 2 and 3. Flickr was chosen as a means of disseminating the images, as opposed to printing, as the quality of printed images would be greatly reduced. To undertake the assessment participants were asked to comment or tag the images with their answers.

I then asked each person who undertook the test to discuss the visualisations. They were asked:

- Do you think visualisations help you think about medieval life in Bodiam Castle?
- Do the visualisations work best on their own or as a group?
- Do you think 3d visualisations are affective at capturing the concepts the albums suggest?

I had a total of 19 participants. Unfortunately the test was not as successful as I had hoped. Flickr had issues with multiple people commenting and some users stated that they were concerned that a number of their comments had not appeared. I was also concerned that there was much to take in on some of the tests and some participants struggled to stay focused. Test three shows a marked decreased in the number of tags used on images toward the end of the album. However, this part of the test did make users engage with the images and allow them to assess the use of visualisations in the second part of the survey.

4.5 Results

The digitized results can be seen in Appendix H. The results are complex and can be analysed in a number of way. For the purposes of this thesis I am going to focus on the use of digital renders. I will do this through a two part approach:

- Looking at the images participants selected
- Looking at the answers the participants provided to their consumption of the images.

4.5.1 Part 1

I stated above that I felt elements of the data were unreliable. Therefore how I can use it is limited. The first element I wish to draw out is how the participants interacted with my digital renders in the dataset. Responses from Group 1 appear to be the most reliable as the maximum number of images requested were chosen in the majority of cases (559 of a possible 600: 93%). For each album up to five images could be chosen to represent the concept and there were a total of 6 participants meaning that in each case 30 images were selected. Most of the albums contained one render (the exceptions being Seasonality and Reverberation) and therefore could be selected up to 6 times. A digital image was chosen a total of 37 times out of a possible 132 (28%). Chart 1 shows how many times the digital image was selected for each album.

Chart 1: Number of times each digital render was selected by Group 1
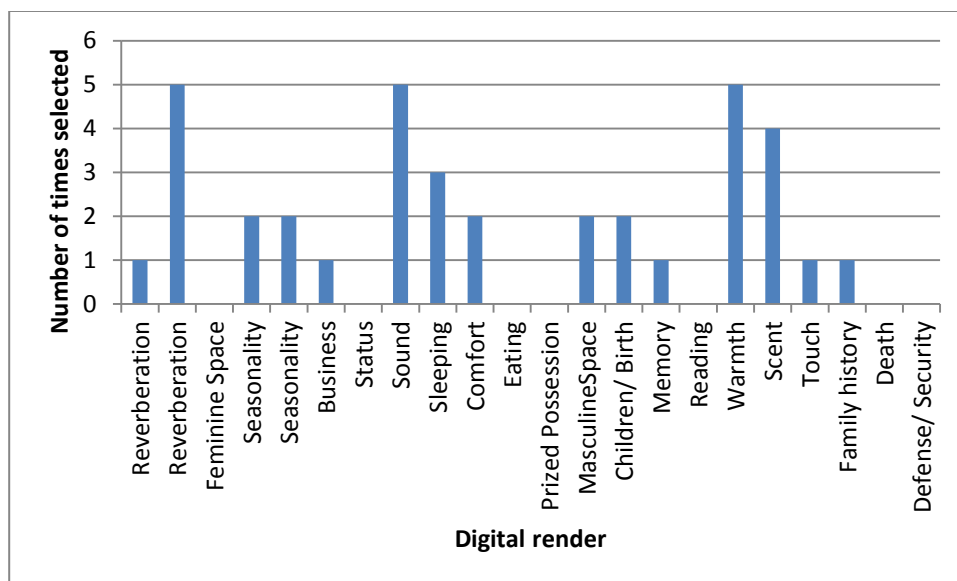
When discussing the creation of the mood boards I highlighted that I had issues selecting renders for some of the subjects. The participants seemed to agree that for some mood boards digital renders did not represent the concepts as well as other images. It is interesting to note that the concepts geared towards sensory engagement (i.e. Reverberation, Sound, Warmth and Scent) a digital render has been selected by most participants.

Engagement and immersion has been explored in game theory. Here (non diegetic) sounds are used to augment the 3d background of a scene and are selected to further immerse the player in the game (Grimshaw & Schott 2008). I argue that when we are viewing the 3D renders a similar effect is created where by our personal lived experiences tell us what we meant to feel. Whereas the other elements require an element of foreknowledge (of the medieval) and therefore the choice of a render is not an easy decision in comparison with more engaging period images. There has also been a number of studies that show visual stimuli can influence our understanding of the auditory environment and vice versa (Hulusic et al. 2012).

Comparing these results to group 2 there is big change (Table 1). Group 2 were provided with all of the images unsorted into albums and then asked to select the five images they thought best represented each concept. There were significantly fewer responses (a total of only 240 of a possible 700: 34%) this may have been the result of the problems I discussed above. However, when

provided with more images the number of digital renders selected was (as a percentage of the total number of images selected) marginally higher.

Table 1: Comparison of the number of images selected by group 1 and 2

	Group1	Group 2
Number of Participants	6	7
Maximum number of images that could be selected	600	700
Number of images selected	559	240
(as a percentage)	(93%)	(34%)
Number of digital renders that could be selected	132	154
Number of digital renders selected	37	22
(as a percentage)	(28%)	(14%)
Percentage of digital renders selected from the total number of images	6%	8%

Digital renders were selected for different concepts in group 2 compared to group 1 (see Chart 2 in comparison to Chart 1). The change in image selection I think has more to do with the lower number of images selected by this group. The number of images the participant had to look through meant that it took longer and the participants lost interest. However, the choice of a digital render to represent "business" is interesting. 6/7 of the participants selected a digital render for this concept and I believe this is based on an inherent prior knowledge of medieval lordship effects this decision.

Chart 2: Number of times each digital render was selected by Group 2

Looking at the results provided by group 3 I can begin to think about the concepts that the images evoked. Figure 237 shows a word cloud of the

concepts that were used to tag individual images (also seen in Chart 3). A number of the concepts selected are very similar therefore I have grouped them together in Table 2. I have also removed any concepts which only feature once to make the data more manageable to observe and this can be seen in Table 2.

Figure 237: A word cloud showing the tags group 3 chose to engage with lived experience at Bodiam Castle

Chart 3: (on following page) Showing all of the concepts selected by participants in group 2 and the number of times those concepts were used

Left chart (axis 0–15):

- Chivalry
- Piety
- Nobility
- Fealty
- Feudal
- Feudalism
- Heraldry
- Heritage
- Hertitage
- Family
- Hierarchical
- Hierarchy
- Status
- Worship
- Cosmology
- Death
- Feasting
- Friendly
- Craftsmanship
- Craftsmanship
- Craft
- Cold
- Echo
- Geometry
- Ceremonial
- Ceremony
- Aristocracy
- War
- Warfare
- Power and war
- Austere
- Austerity
- Majestic
- Clinical
- Clean
- Domestic
- Grey light
- Historic

- Friendly
- Luxury
- Luxurious
- Banquet
- Royal
- Rustic
- Colour
- Colourful
- Status
- Confinement/ Security
- Shelter
- Homely
- Underexposed
- Dawn
- Firelight
- Comfy
- Comfort
- Warm
- Warmth
- Cosy
- Silence
- Dark
- Darkness
- Gloomy

Right chart (axis 0–8):

- airy
- Storytelling
- Commerce
- Privacy
- Spectacle
- Performance
- Tapestries
- Secrecy
- Ornate
- Stone
- Scholastic
- Writing and…
- Manuscript
- Rivalry
- Treason
- Gathering
- Familial
- Hunting
- Community
- Anxiety
- Grand
- Rhythm of life
- Rhytham of life
- Decay
- Decay
- Illness
- Mortality
- Mortatlity
- Wealth
- Image
- Intimidation
- Strength
- Defence
- Defense
- Ruinous
- Wealth and display
- Appreciation of…
- Narrative
- Moment
- Eating
- Smoke
- Smokey
- Scent
- Smells
- Crampedness
- Hard life
- Noise
- Muisc
- God
- Surveillance
- Prayer
- Peasants
- Territory
- Showroom
- Symbolic
- Symbolism of plants
- Seasonality
- Cycle
- Order
- Sleep
- Religion
- Gallentry
- Chilvalry

Table 2: Concepts provided by Group 3 have been combined to groups of similar ideas. These are used in

Banquet	Eating Feasting Gathering
Ceremonial	Ceremony Image
Chivalry	Chilvalry Gallentry
Clean	Clinical
Colour	Colourful Highlights
Comfort	Comfy Cosy Homely Warm Warmth Firelight
Craft	Craftsmanship Craftsmanshi[
Cycle	Rytham of life Rhythm of life Seasonality
Dark	Darkness Gloomy Underexposed
Death	Decay Illness
Defense	Defence
Echo	Music Noise Silence
Familial	Friendly
Feudal	Feudalism

God	Piety Prayer Religion Worship
Heritage	Hertitage Historic Ruinous Showroom
Hierarchical	Hierarchy
Luxurious	Luxury Appreciation of good things Ornate Austere Austerity Wealth Wealth and display Grand Majestic
Manuscript	Scholastic Writing and education Tapestries
Mortality	Mortatility
Narrative	Storytelling Performance
Nobility	Royal Status Aristocracy
Peasants	Fealty Rustic
Scent	Smells
Secrecy	Privacy
Smoke	Smokey

War	Warfare
	Treason
	Power

Chart 4: The concepts that have been used more than once with coding from Table 2

Horizontal bar chart. X-axis: **Number of times each concept was selected** (0 to 35).

Concept	Number of times selected
War	13
Territory	6
Symbolism of plants	6
Symbolic	2
Stone	4
Smoke	5
Sleep	5
Shelter	5
Secrecy	8
Scent	7
Rivalry	2
Peasants	8
Nobility	14
Narrative	4
Mortality	2
Manuscript	10
Luxurious	30
Hierarchical	6
Heritage	11
Hard life	2
Grey light	5
God	29
Geometry	5
Feudal	6
Family	8
Familial	6
Echo	20
Defence	7
Death	15
Dark	17
Cycle	10
Crampedness	4
Craft	5
Confinement/ Security	6
Community	4
Commerce	2
Comfort	24
Colour	7
Cold	6
Clean	2
Chilvalry	11
Ceremonial	2
Banquet	21

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There are a number of concepts which stand out as being selected more frequently than others. I have then extracted the results for purely digital renders (Chart 5) and used the same system of coding used above (Table 2) to produce Chart 6. Two concepts really stand out one linking the renders to darkness and the other to comfort and warmth.

Chart 5: The tags used by group 3 to describe the digital renders
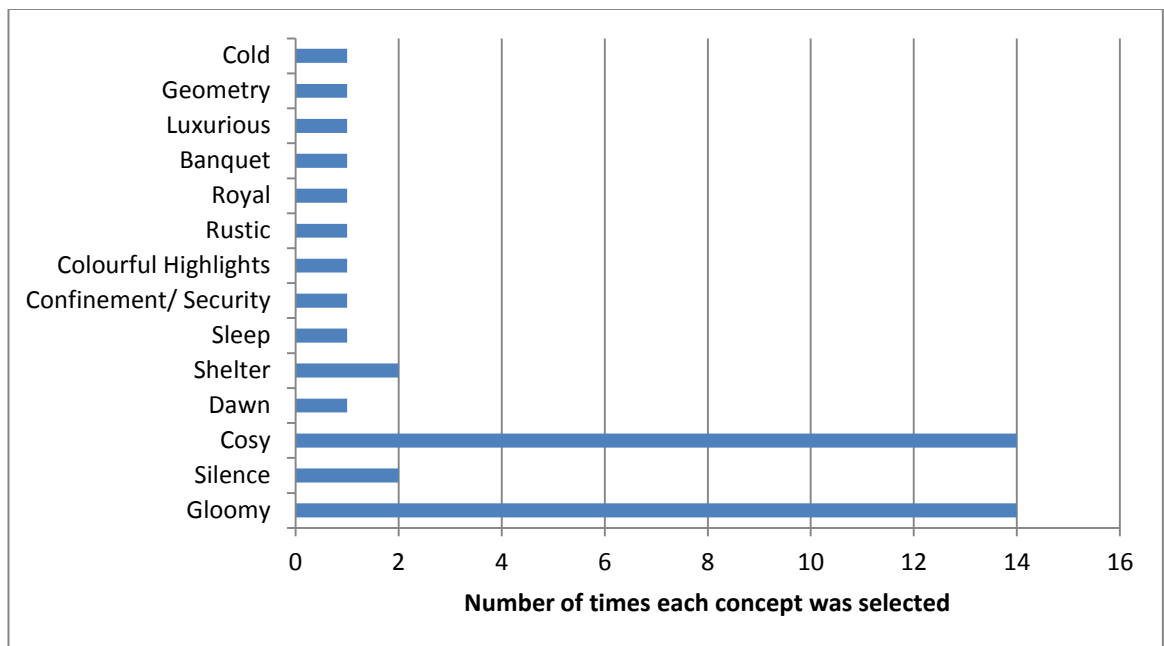
Describing the renders as "gloomy" or "dark" is interesting. As I discussed in 4.2.3.3 I used physically accurate lighting: they are *meant* to appear dark. Our understanding of those spaces through the digital renders is that it is difficult to see: we can understand this from the documentary evidence (section 4.2.2.6: candles). Access and use of candles was highly controlled, because rooms were so dark during the evening and night (and by looking at the lighting assessment in the associated material) during much of the day as well. I will return to the use of this tag in the next section.

The use of the tag "cosy", "comfortable" and "warm" was used for the highly decorated (textile hung) interiors. The render here transforms the understanding of the private apartments from the ruinous photos of Bodiam as it stands today. Comparing this to images that were selected as "cold" provides an interesting comparison, these were either things which are cold to the touch (such as bare stone and tiles) or manuscripts of cold scenes. Images selected for these opposing concepts are very different.

4.5.2   Part 2

Processing the results of the second part of the questionnaire involved handling qualitative data. Qualitative data is complicated by the need to interpret people's responses. Assessment methodologies go into great detail

about how to select groups of people and to phrase questions but advice about dealing with results is more limited (Burnard et al. 2008; Kitzinger 1995; Merriam 2002). Results have to be coded (see Table 3). For example Participant 17 stated "*It helps me situate myself in the space as it would likely have appeared in the past*" which I took as a positive answer to whether visualisations helped the participant think about medieval life in Bodiam Castle.

Table 3: Coded responses for question 1 "Do you think visualisations help you think about medieval life in Bodiam Castle?"

Positive	Negative	Unsure
It can help bring things "to life" and allow us to think about function and activity	I do not think the visualisations helped me to think about Bodiam Castle I believe the other imagery was more effective	I think many of the images equated to clichés about medieval life, and in trying to decide which images to tag, I was almost unconsciously looking for these, as I was looking for the link between a term which I related to as medieval and an image which also appealed to the same set of unconscious assumptions. Maybe a way to circumvent would be to present a single image, and suggest maybe five terms to tag with?
Yes x 6	I prefer drawings from the time	I am not sure. I am always wondering about the written facts not isolated images
Visualisations always help bring the past to life. Contemporary illustrations are		If initially thinking about concepts about medieval life can be difficult and abstract,

particularly engaging, although not always representative of the actual truth (although clothing is always a nice thing to see and understand). Love the reconstructions of the interiors of the castle.	303	only the obvious ones coming to mind, looking at images and engaging with the information they transmit is certainty useful to think about the subject in more detail
Especially to give a view from a different perspective		
It is good to imagine life scenes in context of where they took place and what objects were around		
The connection with the past visualisation produce can be as essential as the real engagement with material culture		
Especially in regard to light and colour		
It helps me situate myself in the space as it would likely have appeared in the past		
They help to understand how spaces were constructed and used and the feel of a room (colour degree of privacy warmth sound and smells)		

elaborations function etc.		

The majority of the results were positive (just under 75%) as can be seen in Chart 7. However, those who answered "no" or were unsure also seem to thinking of visualisation as referring purely to the digital renders as they state they prefer "*Drawings from the time*" (Participant 16) or "*other imagery was more effective*" (Participant 12). Taking this into account only 1 participant (who answered "unsure" (Participant 11) did not think imagery was useful in accessing medieval life.

Chart 7: Results for Table 3 "Do you think visualisations help you think about medieval life in Bodiam Castle?"
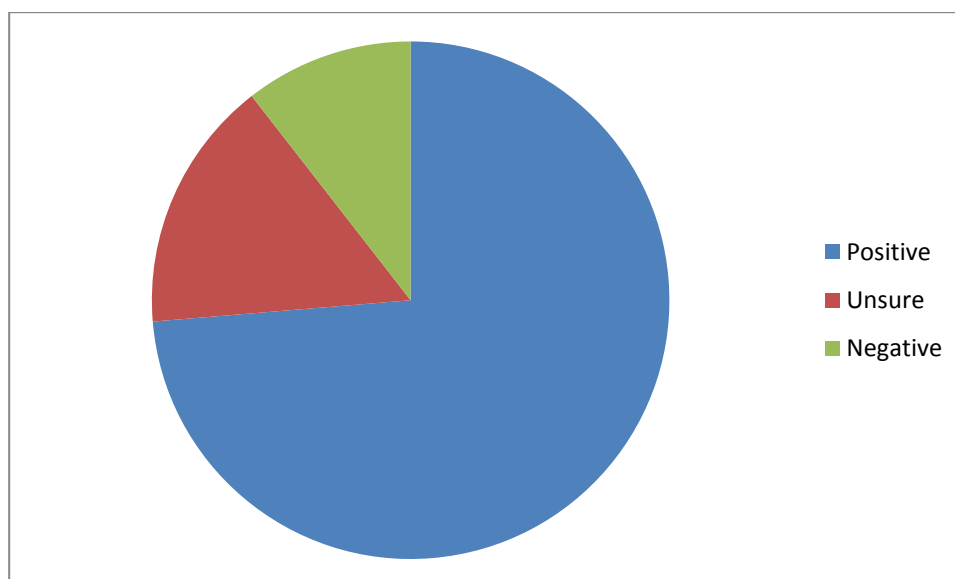
I have established that most of the participants believed the use of visualisations or imagery could be used to explore medieval life at Bodiam Castle. Participants were then asked to think about the second element of this case study: whether the images were best presented as a group or alone. I have again coded the responses (Table 4) and produced a chart of the results (Chart 8).

Table 4: Coded responses for question "Do the visualisations work best on their own or as a group?"

Group	Not sure	On its own

Allows you to get a more rounded idea of different scenarios in medieval life	Perhaps on their own but a verbal suggestion of what to think about sure helps	Might be confusing in a group
A wider scope for understanding	Depend on what it is expected to be represented. They can be used both on their own or as a group	I think there are too many to appreciate as a group
Face element has a different interpretation and for some of them a group would better represents an aspect.	1 X Don't know	Individually, the images make us think deeper about them. When in a group we may tend to use one word to describe it, not feeling the need to scrutinize the visualisations in more detail
Photographs of physical things and a group of renderings work best together		1 X On its own
Especially when representing more abstract concepts like scent and touch		
In context i.e. when (and where possible) connected to their material reality		
one is a good but more are better		
One gets a more holistic sense of space		

To offer a range of perspectives and how spaces may have felt depending on time of day and from the direction/ aspect you are viewing a space. They add a degree of dynamism which is lost when one image is viewed alone (less static).		
3 X group		

Chart 8: Results for Table 4 "Do the visualisations work best on their own or as a group?"
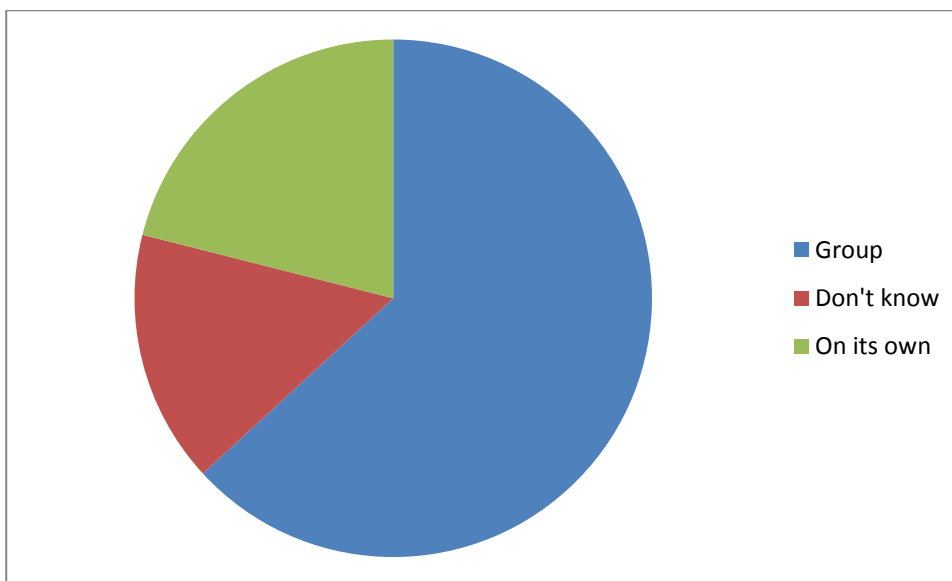
63% of people stated that they believed the images were best presented as part of a group. The negative responses suggested that a lack of verbal or written description made the groupings confusing. A response to the final question from participant 8 "*when representing more abstract things, the other images were definitely helpful in understanding what was being shown*" shows that some participants really felt that presenting digital renders in this way was helpful.

The final question addressed the use of the digital renders and whether users thought they were affective as capturing the concepts. Chart 9 shows the results with 74% stating that they think 3d visualisations are affective at capturing concepts of lived experience. As I mentioned in the results to question 2 a number of the answers suggested that the associated images were very helpful at understanding the digital renders.

Table 5: Coded responses for question "Do you think 3d visualisations are affective at capturing the concepts the albums suggest?"

Yes	Don't know	No
I think so although they are best assisted by the other visualisations for maximum impact. They are effective at helping to place the imagination in a particular scene.	It depends on the level of realism I would say some do and others don't	No, not very effective. Only in one situation did I feel it effectively captured the album's concept.
I think they are more immersive than the 2d image, and hand the view to the viewer more - especially if you have control of what view to take, rather than being guided through a movie. 2d images - as in the album - lets the photographer choose to capture a particular view - and thus they automatically revert to clichés concerning the concepts they are trying to portray. To be honest the images drawn from medieval books i totally failed to even	I think some concepts are more difficult to be represented in images for example I struggled with the representations of the masculine and feminine spaces.	

take in - as i lack the grammar necessary to interpret these.		
Really engaging wonderful stuff	In some aspects but the other images provide more	
When used with different media - ideally can be used to recreate moments in time, life a screenshop. Using other sources (eg text and photos) will better represent a specific element	I think that different types of visualisation fulfil different purposes for instance the sense of warmth darkness austerity are well captured and more evident in 3d images. However, themes relating to hierarchy family harvest etc seem to be well explicit in the 2d images displayed in the album.	
Much harder on multisensorial - good for emotions, smell sound implied		
When they were showing direct representations of objects/ interiors, yes (i.e. for heraldry, possessions). When representing more abstract things, the other images were definitely helpful in understanding what was being shown		
But some of the images are dark and hard to see		

I think they could be, especially when they are creating (re-creating) scenes where this can't be done (at castle due to lack of objects/ space etc) or scene (far away visual access for learning on computer). I didn't find many of the 3D visualisations on here as useful as I could have because I couldn't really tell what was going on because they are dark/ hard to see	309	
3d visualisations are an essential way of bringing reality and interpretation together		
the albums suggest areas that cannot be visualisation: music education birth death etc. Neutral processes e.g. emotions		
It brings them alive and are thought provoking. They are effective at allowing you to consider how people actively used these spaces in a medieval context not just what they looked like.		

Yes X 3		

Chart 9: Results for Table 5
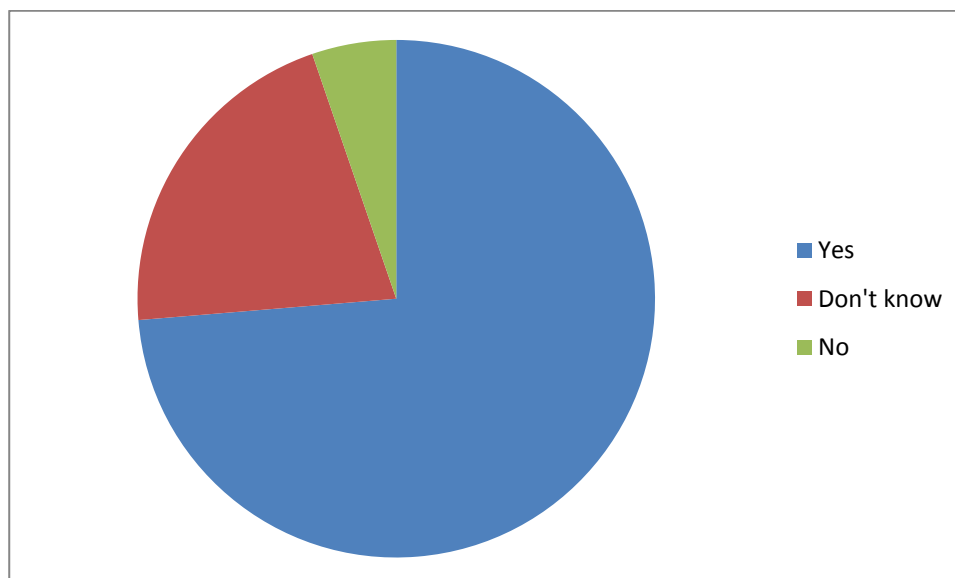
4.6   Conclusions

The visualisation case study set out to produce a digital model of the private apartments of Bodiam Castle. Then present these images alongside a number of images from supporting media to a group of participants to see if they feel that the images can be used to aid understanding of lived experience at Bodiam Castle.

Lived experience is complex, as I discuss in my glossary, it brings together so many elements of personal understanding of a space it is difficult to assess whether I have been successful at engaging with that. As a research methodology I felt the creation of the digital model allowed me to bring together a whole range of different resources and material evidence for the use of that space at Bodiam Castle in the first instance. Through this I understand how the space could have been used during the medieval period and question the excepted understanding of its experience. I also brought together a whole range of different pieces of evidence for the furnishings of late medieval domestic spaces of the gentry. Mood boards then provided an effective means of conveying that research to participants.

The results provided by the participants suggested that the digital model was effective at communicating elements to do with the lived experience of Bodiam Castle. They also highlighted that the use of a mood board (presenting the digital renders as part of a group of image) was effective and added a level of authenticity to the images.

If there had not been a time restriction to the completion of the project it would have been interesting to undertake the same assessment of the mood boards but with a series of experts being brought in. The answers to part 2 of the questionnaire highlighted that some participants did not feel they had the expert knowledge of the medieval period to correctly assess the imagery. I also felt that it would be interesting to see how a group of visualisation specialists responded to the mood boards. The use of the words "dark" and "underexposed" highlighted to me that many of the participants are not used to looking at rendered images and therefore look at them in a different way.

However, the group of participants were a useful sample for assessing the success at providing information to a non-expert audience. Therefore the results show that the mood boards would be an effective mode of communication for the Trust to use for their interpretation at Bodiam Castle.

The visualisation project was successful, but I want to consider lived experience beyond the visual engagement with medieval sites and want to explore the multisensory. The next two chapters will look at Ightham Mote and Auralization as a method of exploring the lived experience of a space. This will look at how sound is another way of thinking about the use of space instead of visualisation.

Chapter 5:   Ightham

Chapter 5 and Chapter 6 discuss the second digital project focussing on acoustics. A lived experience approach moves beyond just the visual experience towards a multisensory understanding of a site. Technology was developing towards fully immersive digital "CAVEs" (Cave Automatic Virtual Environment) which allow multisensory engagements with the past and other experiences (Forte & Pietroni 2009). Their popularity has faded in the last 5 years; instead use of head mounted displays are becoming the focus of multisensory engagement (see the Oculus VR (OculusVR 2014) and Sony's Project Morpheus (Stuart 2014)). The use of highly developed technological methods is still the predominant method of engaging with experience beyond the visual. This project instead uses software and techniques developed within architectural acoustics with the intention of modelling and auralizing medieval space. These can then be assessed through subjective and quantitative methods to discuss the spaces reverberation and intelligibility.

The reader will notice that this chapter is much shorter than the corresponding one for Bodiam (Chapter 3). Unlike Bodiam, Ightham has not been at the centre of a heated debate, nor is it considered one of the most iconic builds of its time, so significantly less discussion over its use has occurred. I begin by introducing the site with a discussion of its location, the history of the building and its owners and work that has been undertaken there to date. Then in the second section I introduce the acoustics project.

5.1   Introduction to site

Ightham Mote today is a National Trust property with medieval origins which has been much developed over the later centuries (See Figure 238). The building is a mismatch of different styles resulting from building works over the centuries. Both internally and externally the building appears to have been designed to fit in its rectangular moat. Although there has been relatively little written work undertaken on the property it was the subject of a major conservation project to preserve the building between 1989 and 2006. As a

result of these works the building was entirely taken apart and put back together allowing a complete understanding of its construction and the different elements of the building. The work undertaken is the subject of a Time Team Special (TimeTeam 2004).
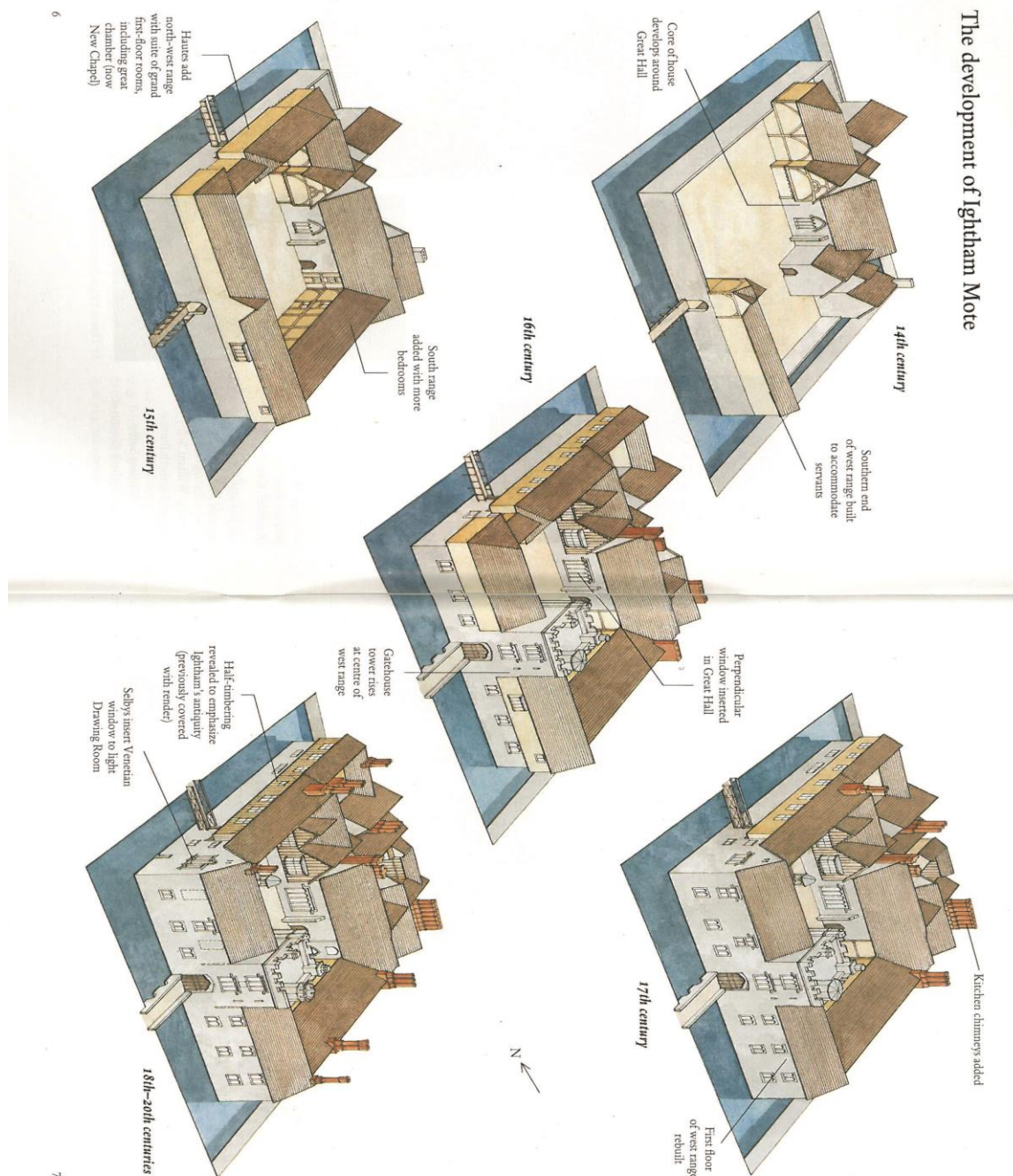

Figure 238: Guidebooks illustration on the development of Ightham Mote from the early 14th century to the present day (Garnett 2005: 6-7)

Ightham Mote (Figure 2: page 5) can be compared with Bodiam Castle during the late 14th century. Although they are not contemporary (Ightham dates from the beginning of the 14th century and Bodiam the end) their owners moved in the same local circles and the buildings conform to the same layout. Like Bodiam, on the inside it is a medium sized manor house with the standard layout of services, great hall, solar and chapel (Figure 239). During this period the owners were MPs for Kent or Sussex respectively, having moved to estates obtained through their marriage; Bodiam being built on land inherited by Elizabeth Wardieu and Ightham Mote being brought to the marriage by the first owner's wife. They both turned to politics following military careers which established them with a network of friends and influence (Minihan 2012). However, both chose to represent themselves very differently, as will be seen in the following sections. Ightham is a much more discreet building. It is located in a remote area, difficult to find and only prominent in the direct landscape surrounding the building. Unlike Bodiam, a new build, Ightham was developed from an earlier building.
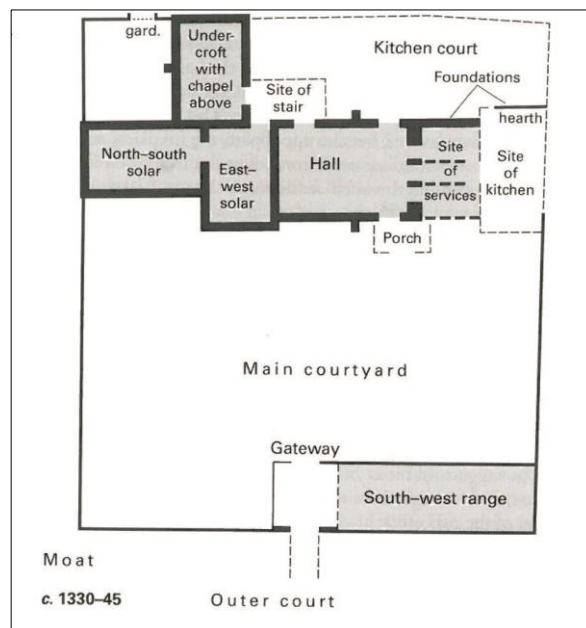
Figure 239: Floor plan of Ightham Mote in the early 14th century. Most importantly it displays the standard medieval house plan that can be seen across the range of buildings (Emery 2006: 359).

The following sections will locate Ightham Mote then discuss the development of the building and the history of its owners.

5.1.1 Location

Ightham Mote is located to the east of Sevenoaks in Kent, just outside of the village of Ivy Hatch (See Map 3). The estate is placed on a steep slope within part of the Weald. This area is part of a tertiary and cretaceous age sequence of rocks (sands, clays and limestone's) that is known locally as the "Weald Dome". Erosion has resulted in the removal of the higher areas of this formation exposing the oldest sandstone which is surrounded by younger patches of chalk. The garden, water features and building are found in a valley on the edge of the older patches of sandstone known as Dinas Dene with the Mote Stream running through it. The stream feeds the series of water features, which are also complimented by natural springs. These water features consist of a series of ponds and pools (Figure 240 and Figure 241) (as at Bodiam) which lead into the moat and then down to form a mill pond (Figure 242). The shape of these pools, ponds and the relationship of the house with the manor has changed since the 14th century. The presence of this water source is the primary reason the manor house has been located here, as the first building on the site was a mill (Ford et al. 2009) for the evidence of the siting of the mill see Appendix I.

Figure 240: Ponds and streams at Ightham Mote leading down the valley into the moat. These have been remodelled in later years as the garden was landscaped. Photo taken from the north looking south down the gardens to the building.

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Map 3: Ightham Mote location. Ightham Mote is found on the outskirts of the village of Ivy Hatch (Edina 2014)

Figure 241: Ponds at Ightham Mote flowing into the moat. Photo taken from the north-west towards the building.

Figure 242: Mill pond at Ightham Mote. Photo taken from the south of the building.

The valley and estate today are thickly wooded enclosing the site and obscuring the view of the building from most directions. Locating the building in such a unobtrusive place has led to one of the building's legends dictating that Ightham Mote survived a looting from Cromwell's soldiers as they got lost in the countryside and instead raided another house of lower standing (Garnett 2005). Even today the approach is difficult with the National Trust property having to close in winter due to the roads becoming blocked or too dangerous.

5.1.2   History of the building

The name stems from Ightham, a village two miles to the north, which derives from a Jutish warrior from the 5th century, and Mote which has been interpreted in a variety of ways to mean moat, moot or mot (Garnett 2005). Its history is much confused by the building of Ightham Court in the village of Ightham itself. The similarity of the modern name of both of these buildings has made tracing the original owner of the building hard. Suggestions that Isolde d'Inge was the properties first owner have become prominent as she appears to own much property in the area including Ightham Court (Minihan 2012). However, this does not necessarily appear to be the case. The first definite appearance of the building in archival sources is in the will of Sir Thomas Cawne (or Couen) in 1370 as "La Mote". Figure 243 shows his effigy at the church of St Peter in Ightham the next village (Emery 2006b: 358).

The earliest dendrochronology dates the building as 1325; these suggest that a two storied structure stood in the south-west corner of the site. The oldest areas of the building which can still be seen are the Great Hall, the solars, the old chapel and a kitchen (which has since been altered) which date from 1330-42 (Figure 244 shows this area of the building from the exterior) (Garnett 2005). This forms the original building; however, the archival evidence suggests that it is built on the site of a mill: it is possible that timbers were reused in the creation of the building (Emery 2006b: 358).

Figure 243: Effigy of Sir Thomas Couen at the Church of St Peter's, Ightham. The effigy is found next to the alter: opposite the other memorials to later owners of Ightham Mote (seen in Figure 249 and Figure 250).

Figure 244: Ightham Mote in Kent, taken from the east showing a small area of the medieval building, and the later expansion of the building. The new chapel can be seen to the right of the image.

Building works continued over the following centuries, ranges being added in the 15th century to create the sealed courtyard house that we see today. In the last quarter of the 15th century a series of cottages (Figure 245) were built to the west which created an outer courtyard for stabling, which was then transformed into staff quarters. Much of this area was later destroyed and only some of the buildings can still be seen. A gatehouse was added in the 16th century transforming the entrance to the 1321 building (Figure 246), the ranges were extended and a number of decorative features added such as the perpendicular window in the great hall (Figure 247) and the internal timbering of the solars and surrounding ranges. The 17th century saw kitchen chimneys added and further rebuilding in the west range to create a symmetrical front (Garnett 2005).

Figure 245: Cottages to the west of the main building, they were originally constructed to form an outer courtyard for stabling. Much of this area was destroyed by fire and these are the replacement buildings.

Figure 246: The Gatehouse at Ightham Mote. Photo taken from the south-west.

Figure 247: Insertion of the perpendicular window in to the Great Hall. We can also see the lack of porch. The change in roof line shows the removal of the services as does a straight joint in the masonry directly below.

Finally in the 18th-20th centuries a Venetian window was added to the drawing room and the half-timbering was uncovered to emphasise the antiquity of the building according to Victorian fashions. The outer court of stables and cottages were rebuilt to widen the use of the estate (Figure 248).

Figure 248: Victorian stables and coach house now used as the Trust shop to the east of the main building.

5.1.3   The builder and later owners

Ightham, unlike Bodiam, is not a new building. The first confirmed owner is Sir Thomas Couen who bequeathed the Mote to his son Robert Couen. Unlike Dallingridge, Sir Thomas had moved into the area from Staffordshire. He was one of many northern soldiers who created estates for themselves in Kent following their military careers (Minihan 2012). Dallingridge's family were based in Sussex, politically and geographically close to Bodiam on the Sussex border (Goodall 2011: 314).

There is no record of Sir Thomas being in Kent before 1363: which is a much later date than the earliest construction date for Ightham, as has been discussed. There have been suggestions that prior to this the building was owned by one Isolde Inge who held the estate within the village of Ightham as

a widow in 1340. However, whether "La Mote" (Ightham Mote) was part of this estate is uncertain as it is not discussed directly. Sir Thomas Couen definitely maintained links between Ightham Mote and the village when he moved to Ightham Mote as he was buried and his effigy installed at the church there Figure 243: page 320. This relationship continues in later years with the Selby's also choosing to be buried there (See Figure 249 and Figure 250).

Recent research suggests that the building or site of the building was originally a mill (see Appendix I). It passed through a series of transactions between 1324-6 which state that "*a moiety of a watermill*" "*by the way the Hegteham*" (Hegteham is an early form of Ivy Hatch) was part of an estate at "Eytham" or "Eghteham" and Shipbourne (for locations of Ightham, Ivy Hatch and Shipbourne see Map 4)(Minihan 2014). Emery (2006:36) suggests it could have "*evolved from a mill and embanked mill pond which was modified to become the constantly spring-fed moat*" linking the mill site to the property as it stands today. However, this still does not link Thomas Couen to the previous owner of the site or the first builder.

Thomas Couen died in 1374 and Ightham Mote was inherited by his eldest son Robert. When Robert died in 1399 he bequeathed it to his widow Margery. Robert's sister, Alice, came into possession of the property at some point and it is through her second marriage that it passed into the ownership of the Hautes in the same year.

The Hautes held the estate for all of the 15th century and the early 16th century. Although the early owners did not seem to favour the property (there seems little development until the 1470s) the family undertook much construction during this time to enclose the courtyard. The family also had royal connections, which during the Wars of the Roses proved dangerous resulting in the estate being confiscated by Richard III in 1483, not to be returned until 1485.

Either the extensive building or trouble with the crown meant that in the early 16th century the Haute family ran into financial troubles. In 1518 the house had to be mortgaged and then sold. Ightham Mote was briefly owned by a Thomas Wellys before being bought by Sir Richard Clement.

Figure 249: Sir William Selby and Sir William Selby's tombs at Ightham Church. Both Sir William's were owners of Ightham Mote in the 16th and 17th century.

Figure 250: Dame Dorothy Selby at Ightham Church; she brought the manor as dowry in her marriage in the 16th century.
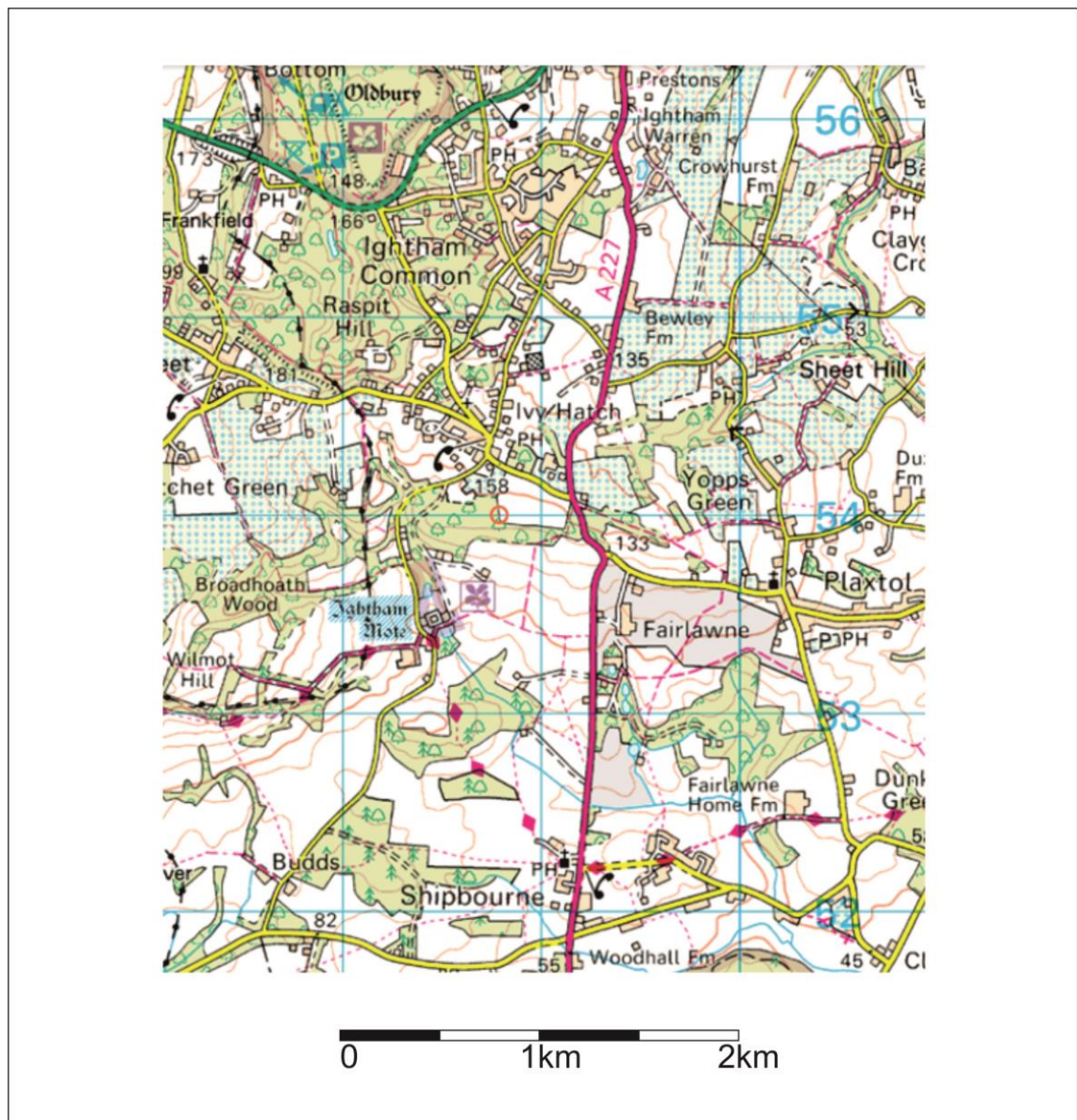
Map 4: Locations of Ivy Hatch, Shipbourne and Ightham (Edina 2014)

Sir Richard Clement worked his way upwards by taking service in Henry VIII's court. As a younger son he had no estate and bought Ightham Mote with his wife's money from a previous marriage. He is responsible for the presence of emblems of Catherine of Aragon (Figure 251) and Henry VIII. These became uncommon in England after the royal divorce and in fact would have presented a danger to the owners in the later years of Henry's reign. On Clement's death Ightham Mote passed through a series of owners who did not make an impact on the building until it was sold to Sir William Selby. The Selby's maintained the house for nearly 300 years again making few alterations to the building. There is no documentation for this period: no letters, documents or memorials other than in the parish church survive. It was not until 1880 on the death of

the last Selby descendent that the building began to fall into disuse. It was let between 1887-90 and was finally sold in 1889 (Starkey 1982).

Figure 251: The pomegranate of Catherine of Aragon on the perpendicular window of the Great Hall at Ightham Mote (Fuery 2012)

The house was bought by Thomas Colyer-Fergusson. He undertook a series of repairs and restoration which prevented the building from falling too far into disrepair after years of neglect. Ightham went through a series of owners at this point, none of whom had the financial security to save the building. It was not until 1985 on the death of Henry Robinson, the final owner, that it was bequeathed to the National Trust who undertook surveys and repairs to the building for over ten years restoring the building to how it stands today (Garnett 2005).

5.1.4   The setting

Today Ightham is tucked away in woodland giving the impression of being a "*hidden place*" (Garnett 2005). As at Bodiam and Scotney the building has been located at the bottom of a slope that obscures the building until the final

approach. There is some debate as to whether this has always been the case. Although guidebooks and (as discussed above) later rumours suggest that it was always concealed by woodland this may not be strictly true. Estate maps from 1692 suggested that the area directly surrounding the house was mostly open fields with only an orchard shielding the approach (see Figure 252) in which case the interpretation of the estate as being a concealed place is a myth.
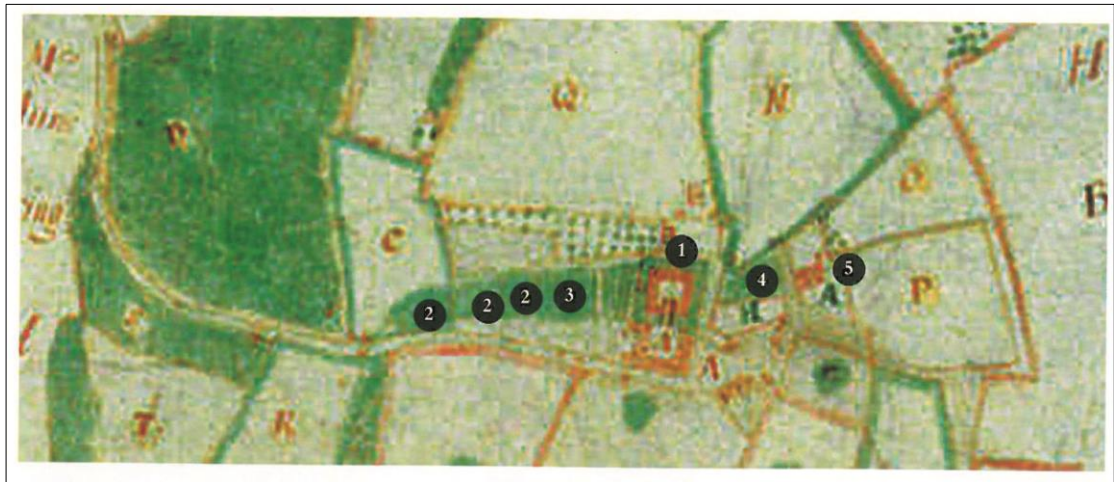
Figure 252: Ightham Estate Map, produced in 1692 by Abraham Walter (Ford et al. 2009). It shows the building is not surrounded by woodland as it is today, but instead appears to be surrounded by farmland.

However, whether it was concealed by woodland or not, the building itself is still *"hidden"*. Unlike Bodiam it is not located near any principal roads or waterways, rather the property could be described as in the middle of nowhere. The family appears to have close connections with the local church at Ightham; this is not the same as the close relationship the Dallingridge's appear to have with Robertsbridge Abbey, however.

The designed landscape as we see it today is a later addition, undertaken in the mid-19th century and in place by 1867 (see Figure 253) (Ford et al. 2009: 14). As at Bodiam, Ightham is also surrounded by cascading pools of water. These pools are not to related to the creation of a designed landscape as has been theorised at Bodiam, but instead they have been constructed for use as fish ponds or for a mill. As Taylor states *"there is no evidence of [a medieval] designed landscape at Ightham"* (Ford et al. 2009: 120). However, the new approach to Bodiam suggests the landscape as less "designed" and more

economic (see Chapter 3) which fits in with the suggestion of the same at Ightham. Another element to consider is whether pools can be multipurpose, as with medieval interior spaces. The pools or water could work as both aesthetic elements and working fish ponds.
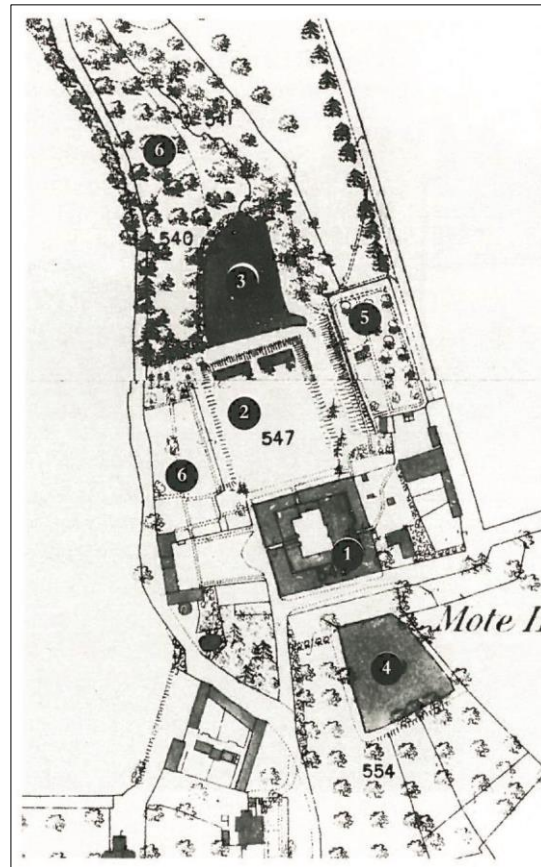
Figure 253: Ightham Mote in 1867 Ordnance Survey map (Ford et al. 2009), suggests that the land surrounding the buildings are mostly made up of orchards and that a formal planning of the gardens has taken place

Of the landscape surrounding the building there is no evidence of a medieval deer park or of medieval gardens (though evidence for these were probably removed through later development). The setting instead is mediated by a natural medieval landscape with two approaches being dictated by the topography and human interaction only impacting on a practical level. This means the introduction of the ponds and the construction of orchards and kitchen gardens. This being said we do not know how the ponds would have affected the approach with the need, at the very least, to cross the moat if not be guided through the range of ponds and the edge of the valley (Ford et al. 2009).

5.1.5   Use of space

The internal layout of Ightham in the medieval period has not been greatly affected by the later development of the building. The block of the Great Hall, Undercroft, Solars and Chapel remain broadly in their original state. The services have gone and the entrance to the hall has lost its porch (see Figure 247) while the solars have been developed for use as bedchambers and receiving rooms. The original entranceway has also been adapted with the development of the gateway and the western ranges (Leach n.d.; Leach & Rumley n.d.).

The house has always been a combination of timber and stone; but much of what is visible now was uncovered during the restoration period in the 1800s to give an illusion of age (Leach n.d.; Leach & Rumley n.d.; Leach n.d.). Although Ightham now appears as a courtyard house the medieval building only encompasses one or two ranges. The rest of the building was built up over the centuries to create the enclosed courtyard seen today (see Figure 238). Ightham Mote is laid out according to the "spatial grammar" of 14th to 16th century buildings (Johnson 2010: 65-86). This layout can be seen by comparing the plan of Bodiam (Figure 50: page 126) with the plan of Ightham (Figure 239: page 315). The two halls are flanked at one end by services and at the other lead into solar chambers. Although not in the same position each of the buildings also have chapels accessed through the solar chambers. They also feature a small chamber with a vaulted roof (see Figure 254 at Bodiam and Figure 255 at Ightham) this feature I have discussed as being a strong room in section 1.1.

This crude illustration shows how the sites although a different shape broadly have the same key elements that feature in late medieval buildings in the same layout for procession through a building. This image is not to scale as there is not a scale drawing of the floor plan of Ightham Mote, so the Bodiam plan has been scaled to the same size to demonstrate the pattern of rooms of kitchen, services, hall and solars.

Figure 254: Vaulted chamber at the bottom of the south-east tower. This is found at the high end of the hall on the ground floor, a feature that can also be found at Ightham Mote (Figure 255), Penshurst, and Great Chalfield.

Figure 255: Vaulted chamber at Ightham Mote

To continue the comparison with Bodiam, although of a similar layout they are presented in different ways. Bodiam gives the impression of martial strength and external power (Figure 37: page 108). Ightham however, is not a crenelated building nor is the moat a symbol of defence, but more a deterrent to thieves.

Internally they are also different; Bodiam is all straight edges and chamfers typical of the Perpendicular style as discussed in section 1.1.2 (see glossary and Figure 256), with few decorative motifs found over the building. Ightham has a different stylistic display of power. The building is ornamented within the entranceways and in the great hall with faces and people carved into the bases of archways, (see Figure 93: page 179 and Figure 94: page 180).

Figure 256: Window at Bodiam Castle, note the chamfered edges of the window. These are where a right angled corner has been cut off to create a smooth edge.

The first two faces are encountered at the entrance to the hall. However, with the removal of the porch it is hard to say whether these have been added at a later date.

The ones on the interior are the most interesting in terms of conveying a message. Due to the low numbers of literate people in the Middle Ages symbology was employed to impart messages or instructions. Johnson (2002) discusses in *Behind the Castle Gate* how buildings provide a spatial grammar of expectation. This means that images in public spaces can be read to inform individuals of appropriate behaviour (Johnson 2010: 15-6). This is taken a step

further in the hall. The first engraved beams on entering show a man, toiling under a great weight, appearing to hold up the hall (Figure 257). I suggest this links to the idea of lordship in feudal society. On the entrance to the hall everything becomes part of a narrative: the lord gives his judgements at the head of the hall, while the toiling servant looks on from the "low" end of the hall. The next faces seen in the middle of the hall are the most clear. Again they appear to be holding the ceiling up (Figure 258 and Figure 259), they stare intently "up" the room towards the high table. As at ecclesiastical sites where the building gives social clues this could be giving instructions through the architecture to those entering (Woolgar, 2006: 179-180), showing how one should behave towards their lord. The final two faces at the top of the hall are the hardest to read (Figure 260 and Figure 261). Again they give the impression of holding up the room but they look like they are wearing masks. Also, in the centre of the beams at either end of the hall there appears to be a green man carved into the wood (Figure 262). It is hard to see as the lighting is so dark, which would mean that it was even harder to view in the medieval period.

Figure 257: Figure carved into the beam at Ightham at the "low" end of the hall by the services.

Figure 258: Figure from the centre of the hall at Ightham, these figures are much clearer and stare intently "up" the hall towards the seat of the lord

Figure 259: Figure from the centre of the hall at Ightham, these figures are much clearer and stare intently "up" the hall towards the seat of the lord

Figure 260: Figure from the "high" end of the hall, it appears to be wearing a mask as it looks down the hall towards the entrance

Figure 261: Figure carved into the "high" end of the hall at Ightham. He appears to be wearing a mask and carrying a shield, perhaps taking part in an entertainment?

Figure 262: The green man at Ightham. It is carved into the principal beams at their height making them extremely hard to see without strong lighting.

At the end of the hall one can progress into the undercroft (see Figure 255: page 333) which as at Bodiam is a small room with a vaulted ceiling (see Figure 254: page 332). These rooms have yet to be defined as a "feature" of buildings of this age but they are present at many builds of this period and later. Rooms like this are found not just at Ightham and Bodiam, but also at Penshurst and Great Chalfield. They characteristically sit just off the high end of the great hall and are on a level slightly below the floor level. They are vaulted or have a stone ceiling, suggesting that there was some need for security. I believe they were used as a strong room not just for coin or valuables but for documents, hence the particular protection again fire. This is a further part of the performance of the medieval life of the gentry classes where appearance and ritual is central to everyday life. A lord can create privacy and undertake private or public transactions easily away from the hall by moving to this space.

The next space adjacent to the entranceway to the vault is upstairs to the private apartments. Again they are positioned more deeply in the building as can be seen in the access diagram (Figure 15: page 30). These are more modest than at Bodiam and consist of two rooms or solars with no original

garderobe remaining. However, they have the more traditional layout of being able to progress from one directly into the next. Both of them have access to the old chapel. Many writings (Emery 2006b; Newman 1969; Grenville 1997; Wood 1965) about Ightham make comment about the orientation of these apartments. One runs north south, and the other east west. This arrangement appears to be a rare feature; although it may just be a concession to the placing of the chapel above the vaulted room alongside the solars.

As at Bodiam the Chapel is accessed from the private apartments. It is a small room which is joined to the first solar (east west facing) via a squint. The room itself has been remodelled a number of times since its original construction. A floor and fireplace has been inserted into the room and then removed again (Leach n.d.).

5.2   The Acoustics Project

As stated, visualisation is a methodology which has frequently been applied to archaeological contexts. The technique can be applied to a range of research questions and, as I have demonstrated through the case study at Bodiam (discussed in chapter 3 and 4) it can be used as a research methodology and a method of interpretation. There has been much discussion concerning the uncertainty of created images and how their creators deal with subjectivity in their results detailed in Chapter 2. This being said the arguments concerning these issues are growing stale, we cannot create a perfect model of the past. Acknowledging these issues is important but I suggest that concentrating on dealing with these issues is no longer taking the discipline forward. Instead I propose we move past the understanding of a space through its visual experience and consider the other senses. I have discussed above how experience is multisensory and how until recently an ocularcentric approach has been assumed in the study of the past, greatly limiting our understanding of the lived experience.

The acoustics project began as I wished to step away from the visual approaches. However, this project needed to provide a way of approaching sound in the past beyond highlighting its potential. We have discussed above how one of the major flaws in digital visualisation has been to bring in computing specialists rather than having an archaeologist undertake the work

themselves. I suggest the same issue has arisen in archaeoacoustics. Projects tend to be driven either technologically by acousticians, theoretically by archaeologists or when in combination bring in one of each to take on each role. However, even in the cases when both acousticians and archaeologists are consulted communication between the two seems flawed. This limits what results can actually tell us and how it can inform our understanding of the past.

To try and avoid this outcome I contacted the Institute of Sound and Vibration Research at Southampton, who were very keen to form a collaboration. Through this collaboration I was able to attend a Master's module on *Architectural and Buildings Acoustics*. This introduced me to the principles of studying acoustics as well as giving me an introduction to the software available. It also allowed me to discuss the options of using these techniques with experts who could advise me on what it is possible to achieve with the software to date and what is not. Through this I understand auralization and acoustical modelling in a way that is unfamiliar to most archaeologists and gives me the insight I need to successfully apply this technology. This really highlighted to me how, unlike in visualisation, modelling spaces acoustically is much more complicated. The technology is not as developed; the software is not as accurate as visualisation and therefore has to be calibrated with recordings.

Archaeologists are not the only ones to struggle with this. Acousticians continue to apply their techniques to heritage spaces to explore the experience of sound in the past. However, as Murphy states, "*the context is critical! Acousticians are not archaeologists and they need to help interpret our results.*" (Murphy 2014). Dealing with uncertainty has been a particular issue based on these relationships. When I first suggested this project I encountered a number of communication issues as to whether auralization could be appropriately applied towards my research aims because the spaces I wanted to work with have been modified over time and the experience has changed. The nature of uncertainty in archaeology and how we approach this (discussed in chapter 2) is something acousticians do not study and it is only with discussion focussing on this we have been able to move forward with the approach.

Despite discussing how a mixed archaeologist/ acoustician team can create problems, one student from ISVR (Diego Murillo Gomez) was interested in working on heritage spaces which are interesting or complicated. His interests lay in real time rendering techniques for auralization and heritage spaces provide relevant case studies where this work is appropriate. This has resulted in us working closely together to gather and process data and inform each other's understanding about the space we are working in based on his greater experience in working with acoustical software and mine of archaeological training in the study of buildings.

Ightham Mote was selected as the case study for work on acoustics as it is not a ruined building and therefore has complete and sealed spaces (the software I worked with could only process data collected in sealed space). Although the spaces have been greatly adapted internally, the structure of the spaces is relatively unchanged. Simulation of the acoustical properties of a space is not as accurate as visualisation and therefore has to be calibrated with recordings. This has meant that Ightham is the only property available to me for which this technique is appropriate.

The following chapter (6) will discuss the results of this assessment.

Chapter 6:   The Acoustics Project

Chapter 2 has discussed the study of sound in past environments and the theoretical implications of the discourse. I highlighted how, although projects exist, many of them divide between humanistic and technologically driven aims or team members (as demonstrated in Figure 33: page 75) rather than working in true collaboration. This project intends to bring together these divergent intentions with an approach which uses technology to further explore the human experience of living in medieval buildings.

Through the course on Architectural and Building Acoustics I gained an understanding of the discipline and the methodology to be used. As part of the course students are expected to undertake an acoustical survey of a space (a different space each year; in the two years I attended these were lecture halls) and then model the space in CATT-Acoustic (Acoustical modelling software) to determine the modelling technique. I took part in all available practical classes enabling me to use the equipment and undertake tutorials in the software. By doing this I was introduced to the limitations of the technique and other students' research interests which focus solely on these problems. In undertaking this case study in this way I feel I am bridging the gap between archaeologists and acousticians realising the potential of acoustical studies. Similar to visualisation, archaeologists are now adept at building computing modelling projects and understanding the potential and the limitations of the approach. I also understand what is possible through the use of acoustical methodologies and can apply them correctly, creating a project which applies the technology while being grounded in archaeological theory. In a similar vein Damien Murphy at York, while based in acoustics, has developed a methodology with archaeologists to undertake interdisciplinary projects exploring acoustics of heritage sites (Murphy 2006). As this is an emerging field his work is not yet widely published.

This chapter begins by introducing the aims of the project. It then discusses the methodology consisting of data collection and modelling, in which the glossary section on building acoustics will be helpful. I then explain my two methods of analysis: subjective and numerical, before discussing the results and conclusions.

6.1   Aims of the Acoustic project

The aims of this section of the thesis could be approached in a number of ways. Undertaking this as part of an interdisciplinary project means that it has multiple aims and the methodology has to ensure all of these are encapsulated. Here I discuss my aims in contrast my colleague Murillo Gomez is using the data for a different purpose. His work focusses on the ability to use simulations to create auralizations of spaces with complex geometry and how they can be rendered in real time. He is creating a series of models and developing a technique for rendering them which combines elements of Geometrical modelling with Wave-based methods. The roof of the Great Hall at Ightham Mote is considered highly complex and therefore appropriate to his work. My thesis is showing how digital media can be used to explore lived experience; I want to demonstrate the ability to use acoustic techniques to move beyond visual approaches. Therefore the key aims of this case study are to:

- show what we can learn from measuring the acoustical properties of a space;
- explore whether we can model spaces to obtain the same results;
- show how this can then be applied to archaeological sites.

I have focussed on these aims because although archaeology has collaborated on acoustical work before (Murphy & Brereton 2009; Till et al. 2013; Devereux & Jahn 1996) projects tend to be driven either by a heavily technological approach or a highly theorised approach with only one element taking the focus. Projects also tend to focus on monumental architecture (Watson 2006; Murphy 2006; Reznikoff 2006) and rarely explore every day spaces (see Figure 33: page 75). They also rarely consider the changing space over time. In Chapter 2 I highlighted that auralization and acoustical technologies are not as advanced as those of visualisation. Therefore my project has to reflect this. I need to assess the ability to accurately model spaces and, before exploring how modelling can be used, to discuss the experience of sound in the past.

I wish to engage with the acoustical study in the same way I have for visualisation, using the process of creation as a method of interpretation. I

discuss not only the results of the data but also how this can be interpreted to inform what we know about the experience of living in the middle ages.

Ightham Mote is the case study for this work. The Great Hall, the Oriel chamber (east-west solar) and the Old Chapel date from the 14th and are therefore my focus. In the first instance I want to explore the acoustical characteristics of the hall as it stands today (i.e. is the decay of sound more suited to public speaking, music or private conversation). I also want to see if we can begin to explore the directionality of sound i.e. are their differences in the acoustical properties of the hall according to different source and receiver positions. This work is based on a survey of the spaces in Ightham Mote as it stands today. To be able to apply this technique to exploring "medieval Ightham Mote" we need to be able to model the space in the Great Hall as it was laid out in the 14th century. Therefore we need to explore how accurate modelling of the space is before we consider what the modelled space of 14th century Ightham Mote could have sounded like. I discuss the accuracy of the modelling below when discussing the methodology.

My research questions aim to explore not only the direct experience of sound through intelligibility, quality of sound and auralization but also to discuss the impact of the effects of sound in the medieval environment and what it means in terms of how public and private is perceived in a medieval building through our understanding of the medieval lived experience.

Further, the acousticians were able to test a series of different recording techniques on acoustically interesting spaces and provide Murillo Gomez with a case study of a geometrically complex space.

To explore these questions we have undertaken the following activities:

- record the acoustics of the space;
- model the space as it stands today and in the 14th century;
- use the recordings to fine-tune the model;
- create a series of auralizations;
- assess the auralizations according to numerical methods (clarity, intelligibility) and subjective assessment (listening tests).

6.2   Methodology

The origins of building acoustics were discussed in section 2.3.3). The discipline studies the ability to predict acoustical properties of rooms or spaces in order to design an optimal environment for the use of the space. However, predictions in sound quality are not always accurate; a famous example of this was the construction of the Royal Festival Hall in London South Bank Centre. Here the building was designed to create an optimum performance space for music. On completion audiences deemed it "dry" and performers found it hard to perform in the space due to a short reverberation time. An intervention on the part of performers led to a reconfiguration of the space for better quality (Kirkegaard 2007). Problems with predicting the aural environment such as this example have resulted in a move to explore sound through virtual environments. This is a development from purely studying the mechanics of sound to engaging more with the environment the sound is propagated within. This allows the discipline to move away from looking at the problem in a linear fashion and instead exploring the range of responses a space will provide and how to address those issues in different ways (Barron 2009: xiv).

The focus of acoustical studies has been to try and understand the sound quality of different spaces (with a particular focus on auditoriums). Sabine's work (discussed in section 2.3.3) led to the understanding that reverberation time (the definition is given in the glossary) is in direct relation to the volume of the room and the amount of absorption of the surfaces in the room (Barron 2009: 6). Reverberation time (T60) was the first of a series of values which allowed the quality of sound to be assessed (Barron 2009).

Trying to understand the sound quality in any given space has developed into the exploration of complete spaces. The recording of reverberation time provided a numerical value that could be worked with to understand that space. This value is very useful when determining the reverberation of a space in response to standing noise volume (Vigran 2008: 106). It has also been used as a measure to suggest whether a space is suitable for different types of music (Barron 2009: 30). Music written to be played by an organ for example sounds best with a long reverberation time as the polyphonic nature of the instrument allows notes to overlap and for pieces written for it to embrace this feature e.g. Bach's Toccata and Fugue in D minor (MovieMongerHZ 2010). In

contrast Early Classical music tends to be homophonic with compositions being lighter and clearer without overlapping a shorter reverberation time is required for this to be clear, but not so short as to sound dry such as the iconic Eine kleine Nachtmusik (Mozart 2011).

Buildings in which the spaces are designed for a specific purpose such as musical performance require the assessment of more properties (see Table 6 for a description of each measurement and its advantages and disadvantages) (Vigran 2008: 106). Particularly useful in this sense are values such as Early Decay Time (EDT) which is used to explore how sound decays when the sound continues to play (whereas reverberation time only works with the sound decay after it has been turned off) (Barron 2009: 46). Objective Clarity is a measurement that explores the difference between early and late arriving sound which creates an index related to the clearness of the sound and the feeling of reverberation (Vigran 2008: 108). Ecophon Group (2014) provide a good demonstration on their website.

Table 6: Objective Measures of Room Acoustics

Reverberation Time (t)	The duration required for the space-averaged sound energy density in an enclosure to decrease by 60dB after the source emission has stopped. This can be obtained by recording the impulse response of a room and integrating this result. It can also be obtained by recording the sound pressure after exciting a room with a noise. It is often not possible to generate the level of noise needed to record t (often referred to as t60) instead a smaller decay is recorded and the sound then extrapolated, these are usually done in levels of 20dB or 30dB and are referred to as T20 and T30 respectively. See Chart 10: page 367 for a graphical representation (the decay curve). This value is used to characterise a rooms acoustics allowing it to be compared to other spaces. Shorter reverberation times are spaces with high levels of absorption whereas more reverberant spaces have longer reverberation times.
Impulse Response	A method of obtaining decay curves to calculate

(RIR)	reverberation time. The reverberation time is discussed below and can be measured in a set space. However, it can be calculated more accurately by measuring the Impulse Response. Impulse Response is required for the creation of auralizations, the RIR can be recorded in a space and then used to assess the success of the modelling software, when the recorded RIR is the same as the modelled RIR one can believe it has been successful.
Clarity (c)	Can be measured from impulse response using a phase analysis. It is the balance between early and late arriving energy and can be measured as either c50 or c80
Early Decay Time (EDT)	The reverberation time, measured over the first 10 dB of the decay. This gives a more subjective evaluation of the reverberation time. The user can also change the decay interval of this parameter. As RT parameters, the EDT is computed for every octave band. It is expressed in ms.

These measures are based on calculations of the Impulse Response of the space. Impulse Response is discussed in the glossary but in essence it is the sound pressure recorded at a point in a room following the excitation of the room by a source (Standards 2008). This can be used as a method for obtaining the decay curves (results of the Impulse Response) needed to calculate reverberation time.

These objective measures provide a good place to start discussing the soundfield of a room. However, when listening to sounds it is often hard to discern the subtle differences picked up by measurements. Vigran describes sound as being intangible as it is hard to engage, record and reproduce the exact conditions under which it was originally experienced. Therefore it is important to consider the subjective response to any given auralization (Vigran

2008: 103). This can also be the reason why these measures are so important: they provide an index to compare subjective impressions to.

Although reverberation time can usually be calculated based on architectural drawings these other measurements cannot. One approach which has been used is to use scale models of the space; another is to introduce computer modelling to predict the acoustical properties of a room. It is also possible to go to a standing space and measure the impulse response or reverberation time of a space. Scale models and computer modelling do not have perfect results when using prediction methods (as discussed above in reference to Southbank centre) and in fact can be entirely misleading when applied by those who have not worked with them before (Barron 2009: 7); which is why the aims of our project are to assess their success.

Computer modelling, or prediction software as it can be referred to, not only provides a means to generate these numerical values but can also be used to give visual descriptions of these results; finally and most importantly for this project they can present results by auralization (Vigran 2008: 144). Visual methods cannot always be relied upon as they show even tiny differences in the soundfield which would not be picked up by our ears (Barron 2009: 19). I would argue that only exploring responses visually leads to a highly ocularcentric approach as discussed in Chapter 2.

Auralization is the technique of creating audible the acoustical parameters of a specific environment (Kleiner et al. 1993). Vigran (2008) describes it more succinctly as suggesting the technique *"…implies that one may listen to music or speech "played" in a room at the design stage."* (Vigran 2008: 144) when discussing the technique in reference to room design. That is, just as architects can model buildings before their construction, acousticians can model the acoustical properties of a space allowing people to listen to their soundfield. Like visualisation this is based on numerical data collected via survey of the specific environment, either acoustically or visually (which will lead to a prediction of the responses). When applied to archaeological environments this gives us the opportunity to interpret soundfields of past environments. We know we cannot record the response of a space as it stood in the past so therefore we are already having to consider how we predict (accurately) the environment we will be working with.

In acoustical studies auralization has more than one definition. I am choosing to define it as the process of producing audio from numerical data. In acoustical studies it can refer to only the final step of making numerical data audible (Kleiner et al. 1993) (and not just the sound propagation and survey leading up to this point). This is taken from work by Vorländer (2007) whose description is the most up to date and therefore considers in more depth the use of computing methods. I have taken this definition as when discussing the visualisation process I work from the first visits to site right through to the actual creation of the image and consider all aspects to be involved in the process. The principal issue with modelling sound is the same as modelling visuals: replicating not only the first incident wave or beam but also the reflections of light or sound makes it incredibly hard to model. There are two methods for approaching room acoustics as discussed above, wave-based methods and geometrical methods. Although physically correct wave-based methods, are not helpful when it comes to prediction or modelling due to the need to calculate the "normal" or reflections for each frequency (Kuttruff 2009: 101). Instead we model sound as a ray instead of a wave in the same way as we do visualisation by using ray tracing techniques to reduce the computational workload.

Broadly the methodology for creating auralizations involves estimating the RIR, making the convolution with anechoic audio material and reproducing the result through a sound reproduction system. This means using a piece of software to model the space (shape, surface properties, position of source and receiver), this can be used to calculate the specified measurements. Creating the auralization you need a sound file of an anechoic recording (something recorded in a room which does not reverberate) which you will convolute (where the sound signal is adapted to sound like the room that has been modelled) to represent the designated sound and speaker combination. This is then played through a designated sound system. A sound system has to be selected in advance as the signal has to be adjusted to account for the colouration produced by the frequency response of the headphones. This is done automatically in CATT, they should also be binaural (if interested in localisation) and open (Vigran 2008: 144; Kuttruff 2009: 101).

The main criticism of most auralization methods is that they do not calculate the RIR from measuring the space, but instead estimate it based on a building

survey (modelling or simulating the properties); and this is why designing acoustics for buildings is so challenging. However, the methodology can be expanded to allow the RIR to be recorded in a known space instead of estimated based on the physical qualities of the room. In this instance the estimated RIR can be calibrated using the known RIR in the software until it produces the correct result.

There are also two principal issues with generating sound. Primarily the issue is with the sound source. To create an audibly compelling auralization the sound source must conform to the same sound outputs in terms of level and directionality as the original (Wang & Vigeant 2008). The second is that there is a lack of sound material that can be used. This is the lack of sounds recorded under anechoic conditions so they can be processed to undertake the characteristics of the space being modelled. There have been a few projects focussing on recording sound such as Murphy (2006) and the Archimedes Project (Hansen & Munch 1991). However, directionality nearly always limits the recording. Usually only one microphone is used to record and this means that the recording is limited in the direction the recording occurs and will not create a sound field. This could be dealt with by recording the sound using a microphone array, generating a range of different directions. This would however require huge numbers of calculations (Otondo & Holger-Rindel 2005). Instead it is suggested that if the RIR is recorded using a directive source of similar values to that being used later in the auralization (directional for a directional source) then the same considerations will occur under auralization (Murillo Gomez 2013).

Sound propagation can also be limiting; if the room response is measured the properties of the source and room are included in this measurement. If one knows the nature of the source being used when the RIR has been recorded, it is possible to calculate the nature of the absorption and reflection of the room. However, when using numerical methods to calculate the RIR this has to be estimated. As we will discuss later this is one of the key issues with the creation of auralizations for non-standing remains in archaeology.

While visualisation through augmented reality and real time gaming applications has provided the ability to move around spaces, the ability to adjust a sound field in the same way is not as simple. Although there are GPS

based devices which allow sound to be triggered by GPS location (such as noTours (Tomas 2014)) the same is not possible within a building. It is also not possible to render sound in real time due to the high level of processing required to calculate the room impulse response based on location and source position before then adding binaural information and anechoic recording. This is the area of study for my ISVR partner Diego Murillo Gomez (Murillo Gomez 2013).

The methodology we used will be discussed below in two sections, firstly data collection, followed by the modelling and processing.

6.2.1   Data Collection

Planning for the survey began in May 2012 when access permissions were sought for Ightham Mote, accommodation was arranged and a time was coordinated for the ISVR team and I to undertake the work. This proved more challenging than expected, it was not until April 2013 that we gained access to the space and accommodation through the partnership with the Trust.

The data collection consisted of two elements, one for measuring and one for modelling the space. The impulse response for each of the rooms had to be recorded. Once the room impulse has been calculated it can be used to explore the Clarity, The Early Decay Time (EDT) and the reverberation time. Secondly a basic building survey had to be undertaken to allow us to model each space for creating the auralization.

We undertook this survey according to the standards laid out in ISO 3382-2 (Standards 2008). This dictates that the spaces being surveyed must be sealed during the measurement and background noise should be at as close to a constant as possible. We had intended undertaking the survey during the National Trust winter closing. This was not possible due to a series of delays by the National Trust booking us accommodation. Instead we arranged to work after the property had closed and into the night. This prevented staff and visitors moving between the spaces and also ensured that background noise was generally at a constant level and also at a minimum. The standards suggest that the space needs to be empty during measurement, so we had to ensure we could work in adjacent spaces. If we had not been able to work at this time of day the number of people in the spaces could have significantly

affected the results. Humidity and temperature can also affect the air absorption which in turn affects the impulse response. As Ightham Mote is a listed building these factors are continuously monitored and we were given access to this data.

The basic set up for recording the acoustics of a space can be seen in Figure 263. The laptop sends out a signal noise (we used a sine sweep which can be heard via the associated materials) which is passed through an amplifier to the source which excites the room, the receiver records the response to the source at that point which is sent back through an amplifier to the laptop. The source should be as omnidirectional as possible, and so we used an omnidirectional loudspeaker (Figure 264) in the chapel and Oriel room. Instead of an omnidirectional source we used a loudspeaker in the Great Hall. This is because it produces a flatter frequency response when using the transducers we had available (Murillo Gomez, P.Comm). The receiver should also be as omnidirectional as possible and taken straight to the amplifier and a laptop running Adobe Audition (Software that allows you to edit soundfiles) to display the decay curve. Adobe Audition can also be used to ensure that the apparatus is not overloading (where a speaker cannot handle the loudness of the sound being sent out), meaning that the impulse sound can be assessed to ensure it creates a clear response.
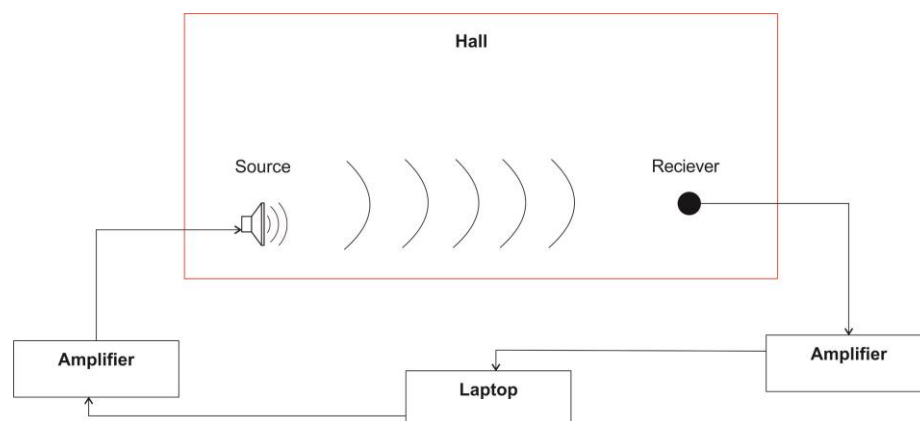
Figure 263: Diagram showing the setup of the equipment used for measuring the Impulse response of a room.

Figure 264: Omnidirectional loudspeaker used in acoustical survey. Each of the black circles is a directional speaker allowing sound to be emitted in "all" directions.

The equipment used is not specific to acoustical work, and new pieces are constantly being designed and tested to explore different ways of recording sound. The basic needs of undertaking a survey of this type include:

- a microphone;
- a loud speaker;
- amplifiers;
- a laptop.

We also took an omnidirectional loudspeaker, Kemar (Binural microphone Figure 265), and an omnidirectional microphone (Figure 266). The kemar and omnidirectional microphone allow us to recreate 3D audio.

Figure 265: Kemer microphone, is a binaural microphone which is designed to record the sound as if a human was listening to it, therefore there are two microphones to left and right of the head.

Figure 266: Omnidirectional microphone, this consists of microphones pointing in "all" directions allowing sound to be recorded as it is received from different directions

The Oriel and Chapel were measured with the omnidirectional loudspeaker and a normal microphone. These are much smaller spaces than the Great Hall and we decided not to continue the auralization of these spaces as we did not have time to complete them within the course of either of our theses. In the chapel, source and receiver positions were selected which related to whether the service was being performed or listened to. The positions in the Oriel room were more difficult to select. I was very interested in trying to explore the relationship of sound being transmitted through the squint; however, the software requires the positions to be at least a meter away from any boundaries of the model. Therefore positions closer and further away from the squint were selected instead.

In the Great Hall we used a directional loud speaker and all three microphones. The standards require at least two source positions and at least four receiver positions. We used twelve receiver positions, taking four measurements for each position (Figure 267). The standards are a set of guidelines that ensure the level of accuracy recordings are taken to, if they are shared by different researchers. They also ensure that the measurements taken will give accurate results not skewed by equipment or working protocol. Positions were selected

as a means to explore the changing sound quality across the hall. In Chapter 1 I discussed how the experience of the hall was highly ritualised and organised according to social standing; the positions across the hall will allow us to compare the experience of sound at the "high" and "low" end.
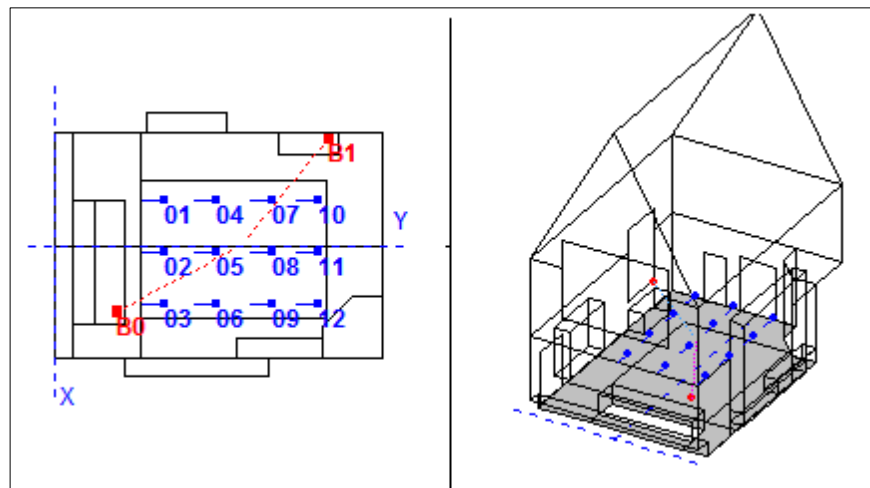
Figure 267: Position of source (red) and receivers (blue) in the great hall we used positions 1, 6, and 11 in our calculations

A sine sweep signal was used to record the impulse response instead of a chirp or other method (discussed above). The sine sweep excites the room with a soundwave that moves from a low (below audible) frequency to a high (higher than audible) frequency during the measurement period. This will help us to calibrate the model during auralization as we will be able to compare the room's response at a range of frequencies. By recording the range of frequencies we can look at how noises of different pitch are affected by the space. Frequency is proportional to wavelength which has a significant affect in small spaces.

After taking all the measurements of the acoustical response of the rooms, we also needed to undertake a basic building survey to allow us to model the space. The first building survey we undertook was very basic. Modelling in CATT acoustic is done via code and requires every surface to be produced as a separate plane. In the same way that visualisations have to be rendered to accurately produce lighting conditions, the same is true of acoustics to determine late reflections in sound waves, the more complex the geometry the longer the rendering time. Therefore models are generally kept very simple as what is gained in the production of an accurate model is not deemed

worthwhile for the increase in modelling and processing time. The accuracy was significantly reduced from that used in Chapter 4: for example, the ceiling was modelled as straight lines, not including the detail of the beams. However, it was decided to create a second model to test these assumptions. As I will discuss below, we wanted to see how correctly assessing the roof would affect the results. To do this we returned to Ightham Mote and used a Total Station connected to a laptop running TheoLT (the same technique used to undertake the survey work at Bodiam, see 4.2.1) to undertake a simple survey of the building, recording a single truss that could be copied along the hall.

6.2.2   Modelling

Modelling the building required a few tasks to be undertaken before we began the actual modelling of the space. Firstly we needed to record the directionality of the source. As discussed above the standards suggest using a source which is "as omnidirectional as possible". As an omnidirectional source can overload the microphone, we used a directional loud speaker and measured its directionality in the anechoic chamber (dead room Figure 268). This ensures that the response being recorded is not affected by the reverberation of the space. This can then be used within the simulation.

The second task was to record a sound to play during the auralization. To help establish the nature of the models that were being compared we recorded myself reading a sentence about Ightham "*This is the great hall at Ightham Mote near Sevenoaks in Kent. It is one of the oldest areas of the building dating from the 14th century.*" This was undertaken in the anechoic chamber in ISVR at the University of Southampton (Figure 269) and allowed us to not only use it during modelling but also for auralizing the recorded characteristics from the survey. It was decided at a later point we would also want to compare a male and female voice to see if the change in pitch affected the results. We did not have time to return to the anechoic chamber to record another sample and instead had to use a previously recorded sample.

Figure 268: The Anachoic Chamber at University of Southampton. This room does not reverberate; it is a "dead" space. This allows us to record sounds to be used in Auralization or test the quality of instruments to be used in acoustical testing.
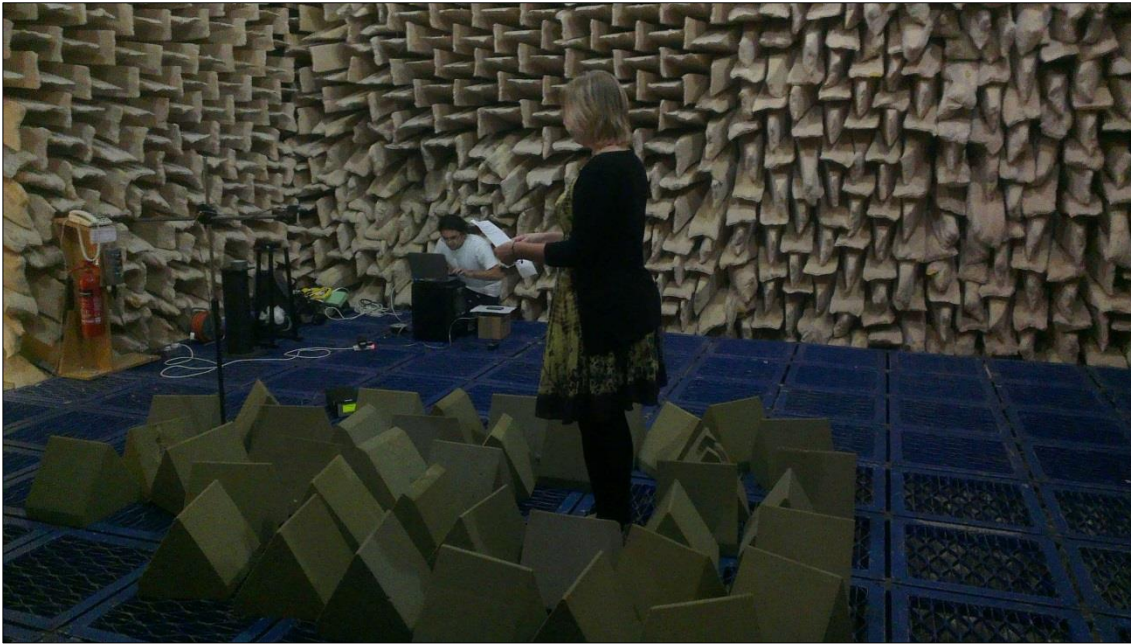
Figure 269: Recording the script for the Auralization.

There are a number of modelling packages available for working with acoustics (Odeon and CATT are two of the most popular). My colleague and I have been trained to use CATT, which is a software package based on the geometrical acoustics approach discussed above. It can be used for both prediction and auralization, and was therefore deemed appropriate for this project (Dalenbäck 2011).

CATT works by creating a graphical description of a room using a structured hierarchic text format. Geometry can also be imported from AutoCAD and Google Sketchup. The program itself does not have a graphical interface. The graphical description is defined according to dimensions for corners and planes using its own coordinate system. Planes cannot overlap and the model must be sealed. Surface properties of each plane must also be defined according to their material. This contains information about the scattering and absorption properties of the fabric. The materials I used and their properties can be found in Table 7 (Absorption) and Table 8 (Scattering). This information about the physical properties of the materials has been taken from a number of references which are detailed in the table which are found in the CATT acoustic library. In essence we selected surface properties based on those we recorded during the buildings survey. For example we used WOOD FURN for wooden furnishings such as the table and chests. However, they also need to

be selected based on the possible sound transmission to other rooms and therefore we chose a different value for the wooden panelling of Hollow Wooden Podium (Dalenbäck 2011; Vorländer 2007). The reason for this change is discussed in more detail below. It is based on a visual inspection of the measured properties of the space such as reverberation time according to frequency then observing the same of each of the material properties that have a big influence on the surface (large planes) and matching them together.

Table 7: Absorption coefficients from Catt-Acoustic library data

Material	125	250	500	1000	2000	4000	Ref
Brick	0.08	0.08	0.14	0.18	0.2	0.35	Petersen
Glass	0.35	0.25	0.18	0.12	0.07	0.04	Karlen
Wood	0.4	0.3	0.2	0.17	0.15	0.1	Karlen
Wood furniture	0.14	0.1	0.06	0.08	0.1	0.1	Petersen
Tapestry	0.17	0.4	0.7	0.86	0.84	0.82	Cremer
Tile floor	0.02	0.02	0.02	0.02	0.03	0.03	Karlen
Carpet	0.09	0.08	0.21	0.26	0.27	0.37	Karlen

Table 8: Scattering coefficients from Catt-Acoustic library data

Material	125	250	500	1000	2000	4000	Ref
Brick	0.13	0.56	0.95	0.95	0.95	0.95	Vorlander
Glass	0.2	0.2	0.2	0.2	0.2	0.2	Catt
Wood	0.13	0.56	0.95	0.95	0.95	0.95	Vorlander
Wood furniture	0.13	0.56	0.95	0.95	0.95	0.95	Vorlander

Tapestry	0.1	0.1	0.1	0.1	0.1	0.1	Catt
Tile floor	0.2	0.2	0.2		0.3	0.4	Catt
Carpet	0.1	0.1	0.1	0.1	0.1	0.1	Catt

(Vorländer 2007b)(Dalenbäck 2011)

All three spaces were modelled and can be seen in Figure 270 (Old chapel) Figure 271 (Oriel) and Figure 272 (Great Hall). However, the time constraints meant we did not continue with the Old Chapel and Oriel Chamber.
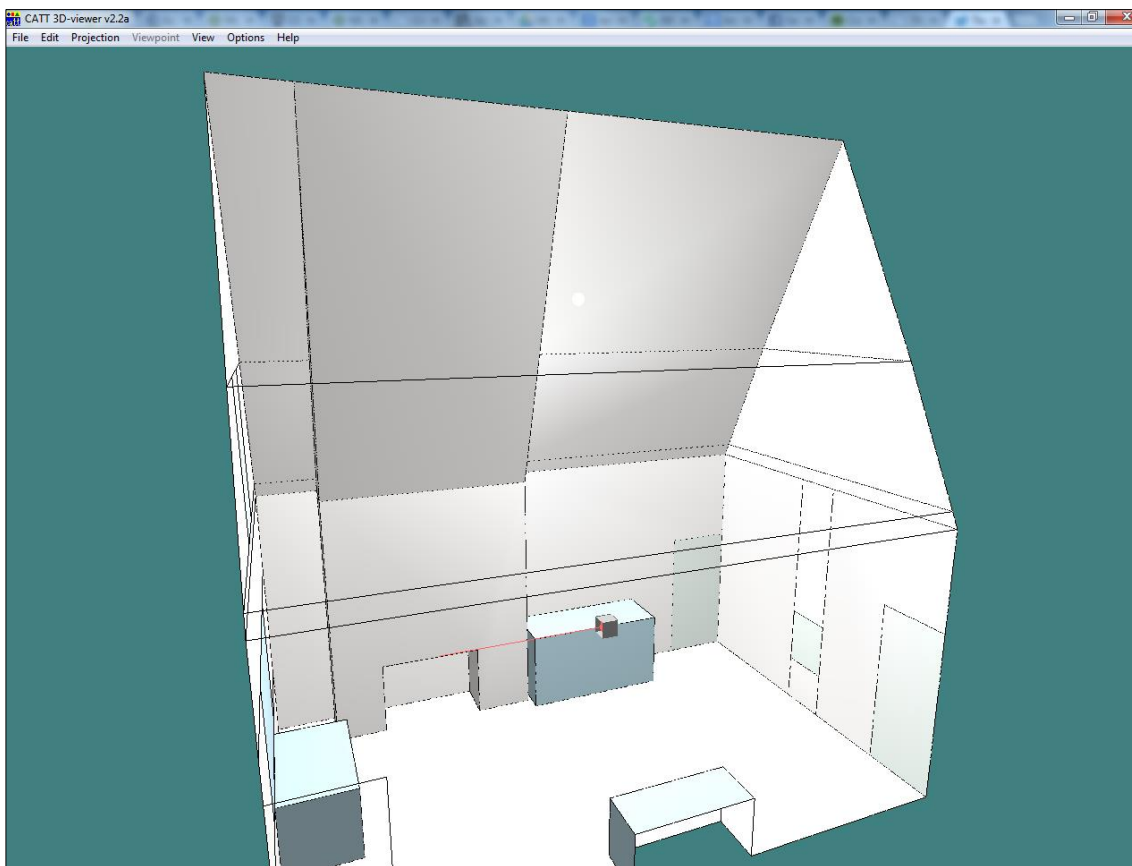
Figure 270: CATT-acoustic model of the Old Chapel at Ightham Mote
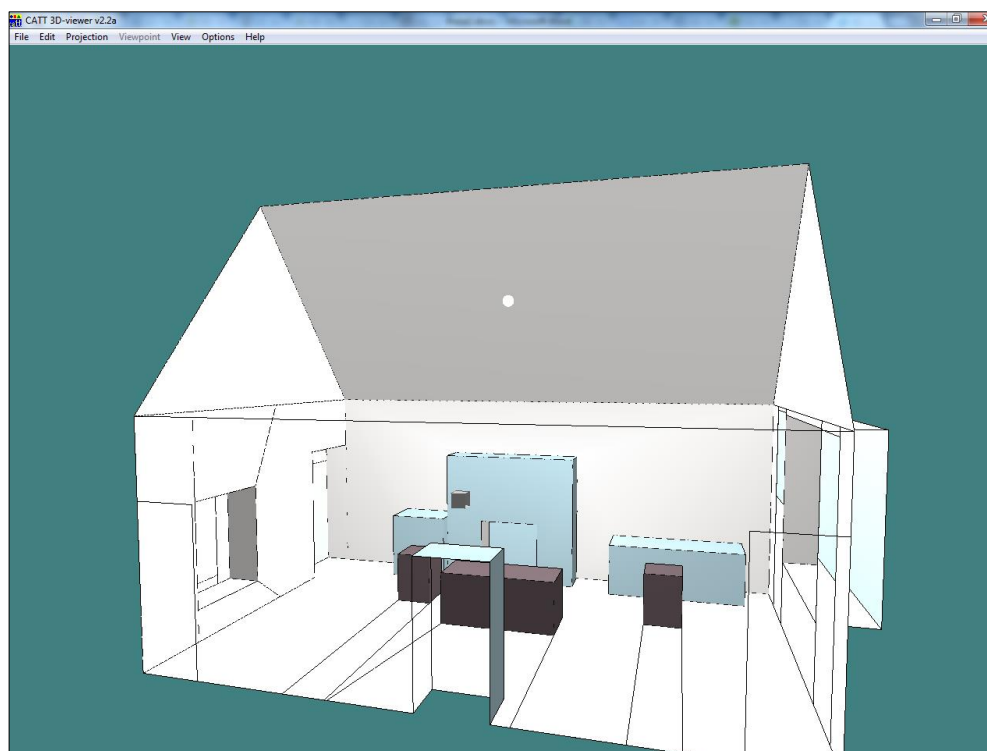
Figure 271: CATT-Acoustic model of the Oriel Chamber at Ightham Mote
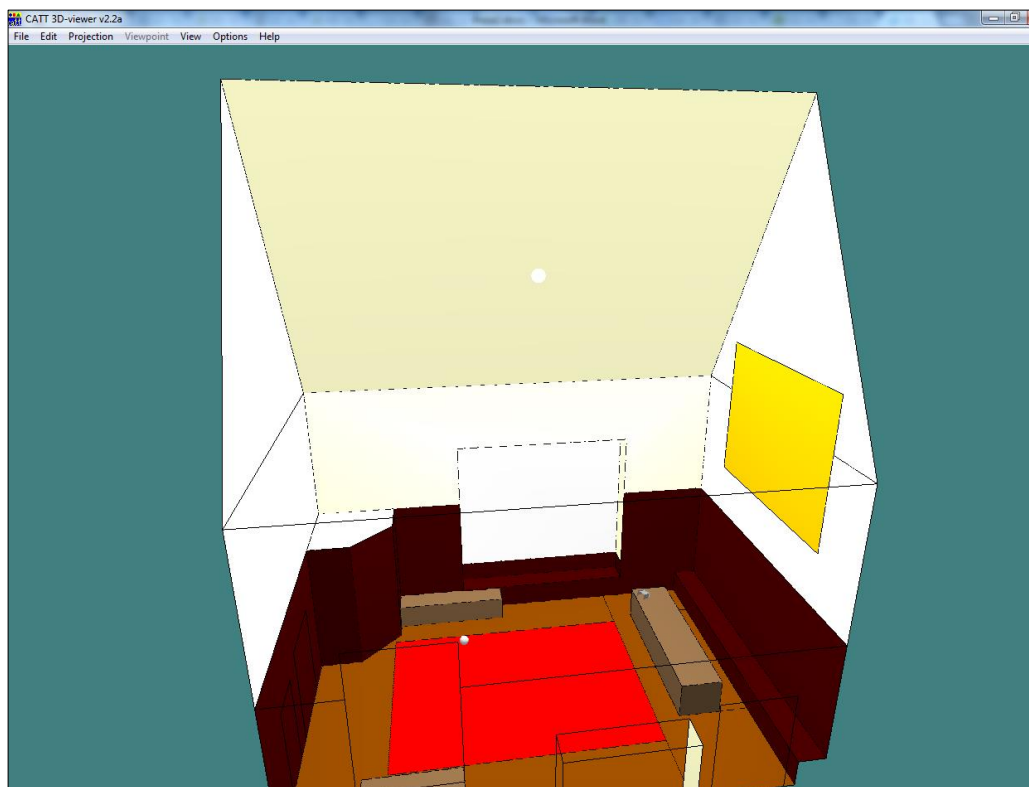
Figure 272: CATT-Acoustic model of the Great Hall at Ightham Mote

The results of the auralization of the measured responses can be heard as Track5.wav. Our first approach at the modelling produced the results in Track4.wav. As you can hear, they do not sound the same and as you will see in section 6.3.2 the measured parameters are not the same (Chart 10 and

Chart 11).

Chart 10: Comparison between measured and simulated responses according to Early Decay Time
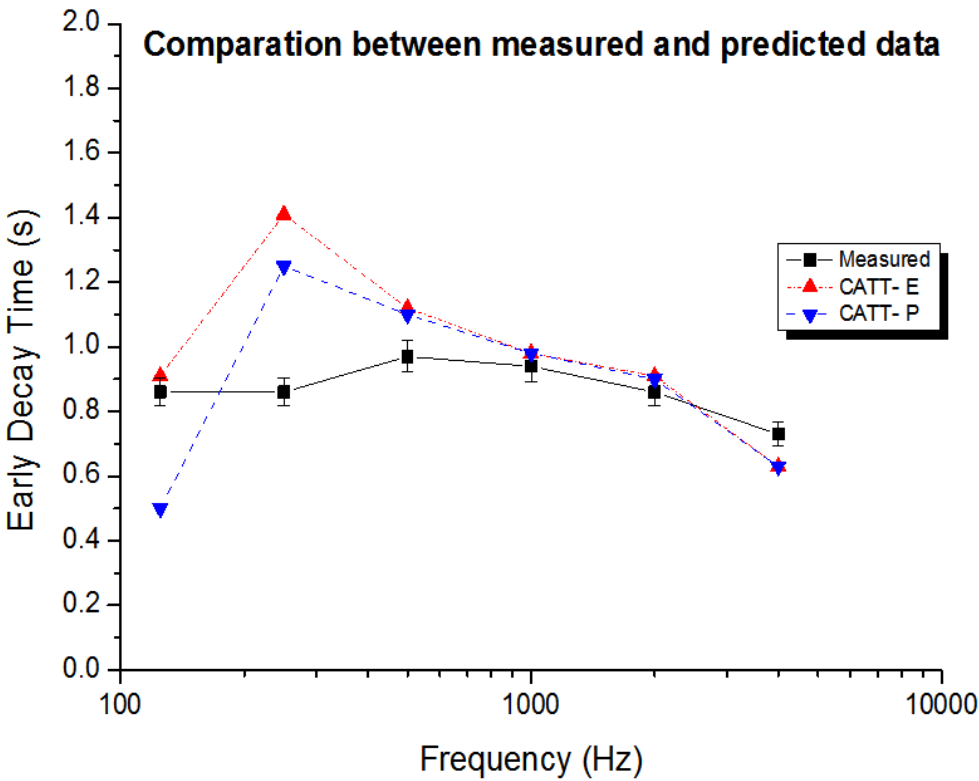
Chart 11: Comparison between measured and simulated responses according to Reverberation time. There are two simulated responses based on how the estimation is made, using energy addition (red) or pressure addition.

Comparation between measured and predicted data
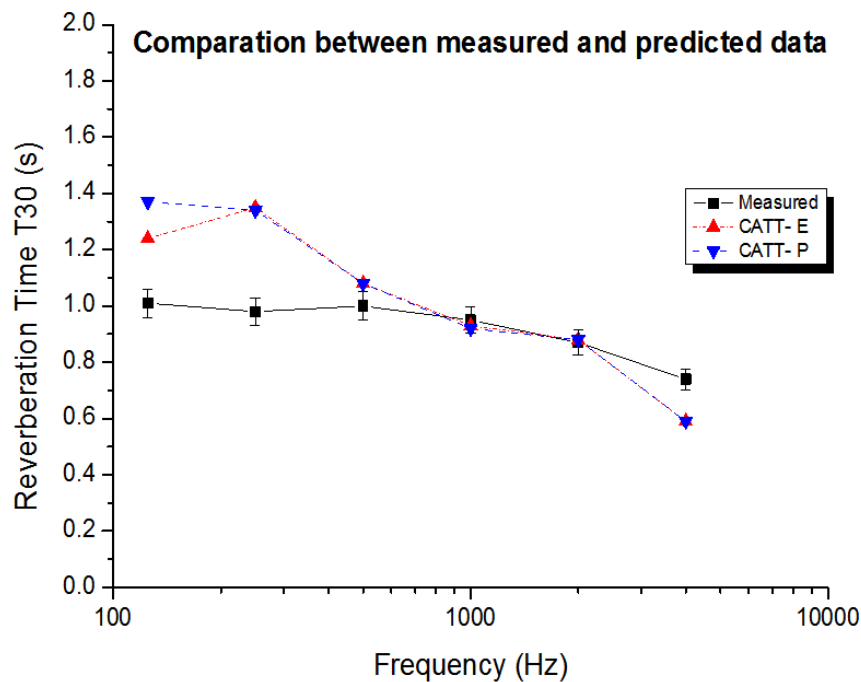
One of the reasons for this is because the simulation struggles with low frequencies. This is due to the reflection of sound waves at low frequencies the phase relations can become out of sync causing a drop or rise in amplitude of the wave. Amplitude is related to the energy of the wave which is why the results here are affected as the simulation compares to mechanisms for calculating the parameters: Energy Addition or Pressure Addition. Low frequency soundwaves have a long wavelength: changes in phase and energy with a small number of waves will have a greater effect on the energy than with a large number of waves (Wolfe 2014) which is particularly problematic.

Chart 10 (page 367) and

Chart 11 (page 368) show the difference between the two methods of calculating reverberation time and EDT. The difference between the two results demonstrates that the results below 500Hz are deemed unreliable as the two methods do not give similar results. To improve the quality of the simulation we firstly attempted to enable diffraction in CATT which calculates the diffraction of sound in more detail. The results can be seen in Chart 12 and Chart 13. There is very little difference between the simulated results with and without the diffraction turned on. This is because the diffraction is based on hard surfaces and the wooden panelling is therefore not considered. This has a particular impact in these receiver positions.

Chart 12: EDT with diffraction enabled in comparison to the results of the simulation without diffraction
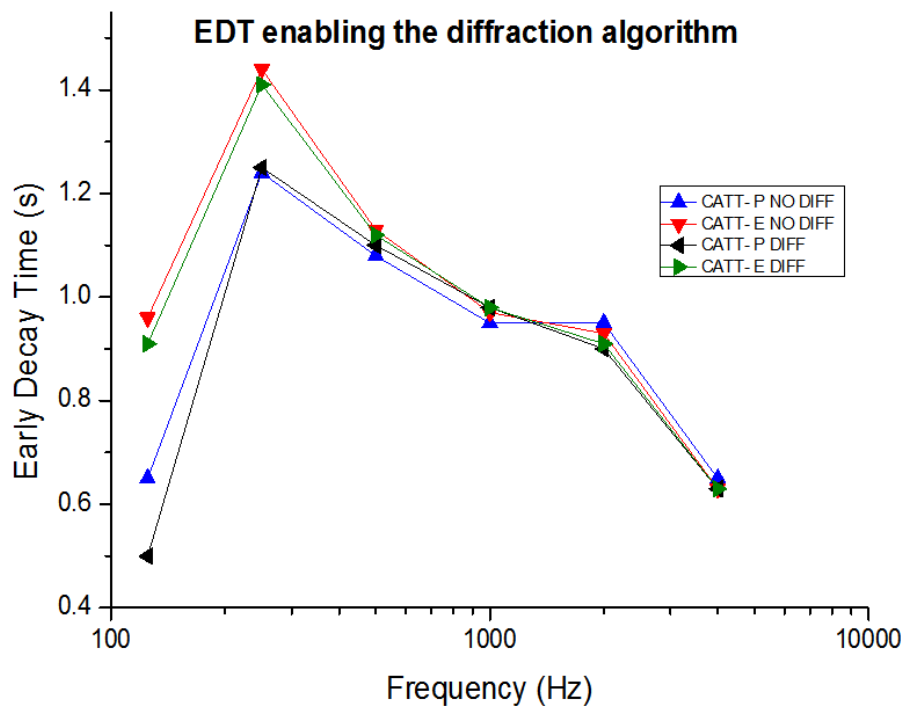
Chart 13: Reverberation time with diffraction enabled in comparison to the results of the simulation without diffraction

T30 enabling the diffraction algorithm
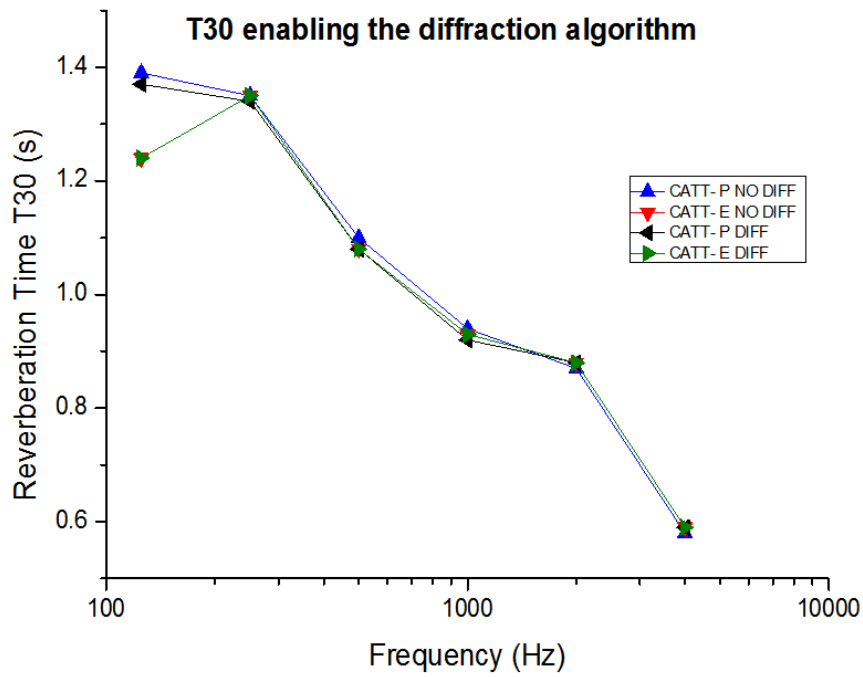
Our next attempt to calibrate the model used a methodology suggested by Aretz (2012) which determines the absorption coefficients from the results of the reverberation time according to the measured results. It uses an equation to determine the overall level of absorption that would satisfy the reverberation time. Then some of the values are adjusted to allow us to bring the results to equal a product of the overall absorption coefficient. These can be seen in Chart 14 and

Chart 15.

Chart 14: Comparison of the measured and simulated EDT after calibration of the absorption coefficient
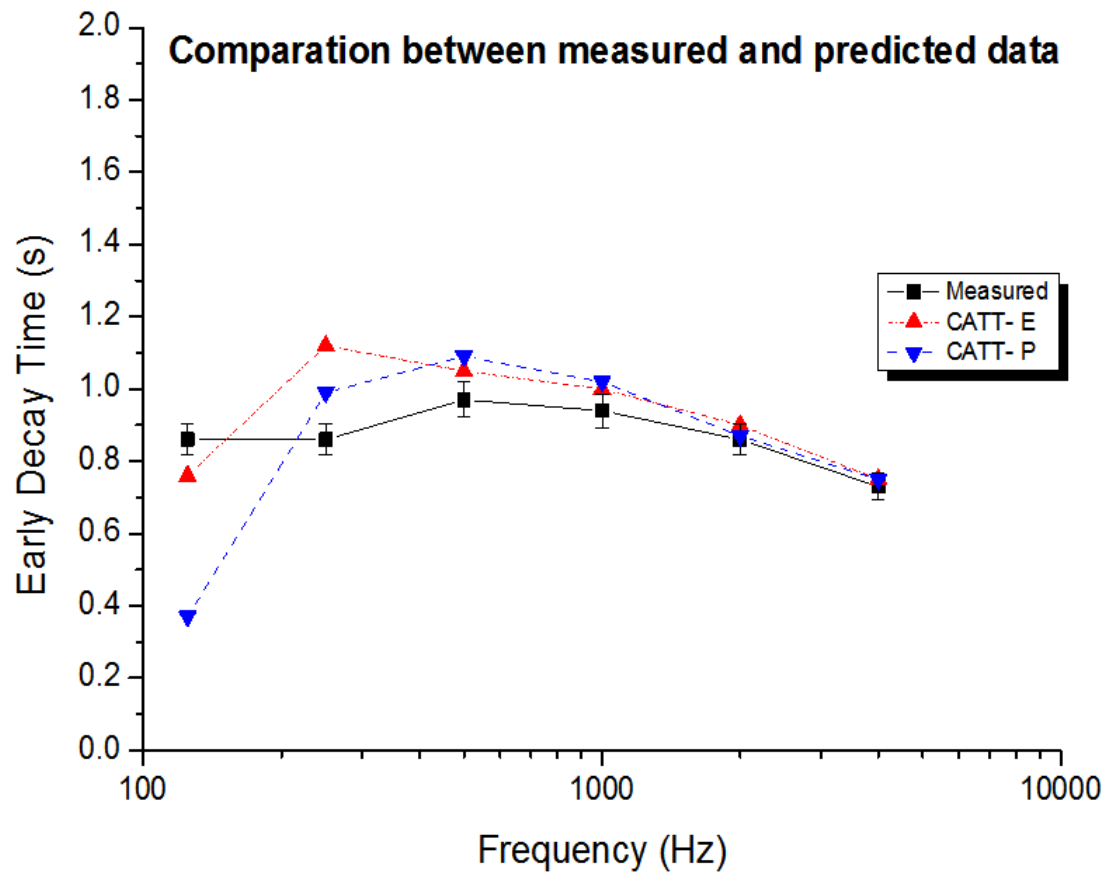
Chart 15: Comparison of the measured and simulated Reverberation Time after calibration of the absorption coefficient
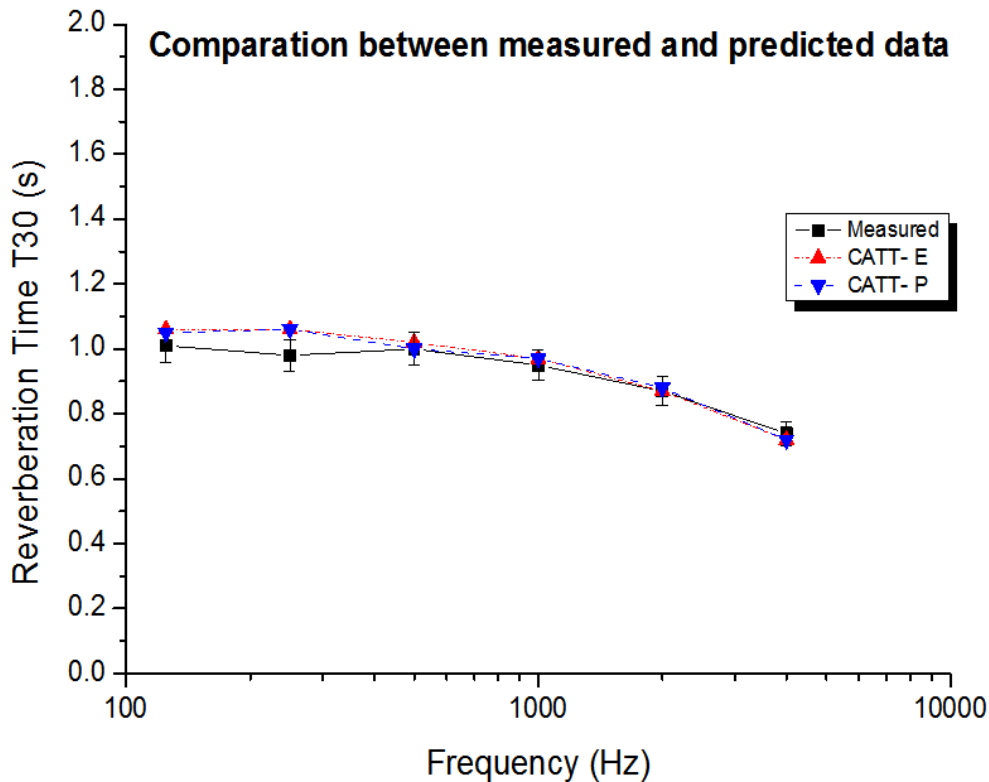
At this point I moved on to creating the auralizations. To reproduce the sound in order to allow someone to listen to the auralization I took the recording of my voice and convolved it according to the measured results or the simulation to produce a sound file. This generates .wav files some of which we have already discussed. We produced a series of auralizations with both male and female voices from the simulation and the measured responses. The numerical results highlighted to us that the simulation and measured auralizations were still not the same. To address this I applied a filter in Adobe Audition which removed the low frequency sounds (the problematic sounds as discussed above) from the auralizations.

The results of the modelling process are discussed in the next section titled "analysis".

I also produced a basic model of Ightham Mote as it could have stood in the 14th century. The intention for the creation of this model was to explore the option of using CATT Acoustic to model past spaces rather than historic spaces as they stand today. When I started this project using the software in

this way was considered not possible by Murillo Gomez. As I have learnt more about the modelling process I understand that this is to do with the lack of reliability in the results as has been discussed earlier. I have created this model to highlight the ability to begin to think about applying the technique in this manner, using the modelling of the current space to inform us on scattering and absorbing materials as well as shape of space in the same way as I would in producing a visualisation. Combining this with what I have learnt about medieval spaces discussed in chapter 1 and chapter 4 I aim to demonstrate we can begin to think about modelling the acoustics of space in the past even if the results are not yet as reliable as we would hope. In essence the issues I am encountering are the same issues found with visualisations but here they are easier to comment on.

6.3   Analysis

To test the success of the modelling of the space I undertook two levels of analysis. Primarily the results of the acoustical survey can be compared according to the numerical values discussed in 6.2, EDT and Reverberation time. These values can tell us about the experience of sound in the room. I highlighted earlier how these values are used to discuss the properties of spaces, we can use them to characterise the experience of sound in the hall. They can also tell us about how affective the modelling has been as they allow us to compare the measured responses to the simulated responses.

However, "*our ears are not as sensitive to distance as the impulse response plots would suggest*" (Barron 2009: 19). A critique of visualisations is that they are rarely assessed following their completion, not allowing further engagement with the images or an assessment of the success of the final result (Gillings 2005; Tost 2007). The fact that listeners do not always detect differences that computers can, has led me to also undertake a subjective analysis of the human response to the models. I assess how effective the auralization technique has been, whether the acoustical properties of Ightham Mote can be recreated through modelling, and how people perceived the results according to the numerical qualities of clarity and the feeling of a sense of place through a listening test. The listening test also allow us to look at the results of the old hall in comparison to the new hall to see if the acoustical properties appear to have changed.

By taking a dual approach I can consider the effectiveness of the model not just in a mathematical sense but also in a human sense. Unlike visualisation, auralization is not as reliable and is thus harder for us to assess as our sense of hearing is not as keen in this aspect as vision. Therefore the nature of a compelling model needs to be further explored and the results compared.

6.3.1   Subjective analysis

In October 2013 we gathered a group of 26 archaeologists (visualisation specialists and medievalists) and engineers (predominantly acousticians) to assess subjectively the series of models we produced. They were placed in a sound proof room and provided with a questionnaire, laptop and a set of Sennheiser HD600 headphones. They then worked their way through a questionnaire which required listening to a series of tracks consisting of the Auralization of the recorded measurements for Ightham Mote and the model.

The questionnaire was designed to explore the success of modelling the building, comparing the results of the measured environment to that of the modelled environment. It has also been designed to compare results to those numerical properties which I will discuss next.

The questionnaire can be seen in Appendix J, the track numbers have been kept consistent and these are provided on the attached disk. (Questions 14-29 refer to work undertaken by Murillo Gomez on another project. He felt that it would be easier to undertake both analyses together while a group of people were assembled.) The raw data of responses can be seen in Appendix K. Questions 1-12 explore the success of the acoustical modelling and 13 shows how we could use Auralization to explore the experience of Ightham Mote. I have chosen to not look at Questions 3 and 8 in great detail. These questions compare how listeners experienced reverberation and intelligibility in each of the auralizations (simulate, measured, simulated filtered and measured filtered) for male and female voice. This question was not constructed well, there is some doubt as to which track one should compare the responses against Chart 17,

Chart 18 and Chart 19 show the responses to question 3 where the auralizations are produced with a female voice. Each chart should be compared

with Chart 16 which is the auralization produced by the measured impulse response before being filtered.

Chart 16: Measured results of Ightham Mote, exploring reverberation with a female voice
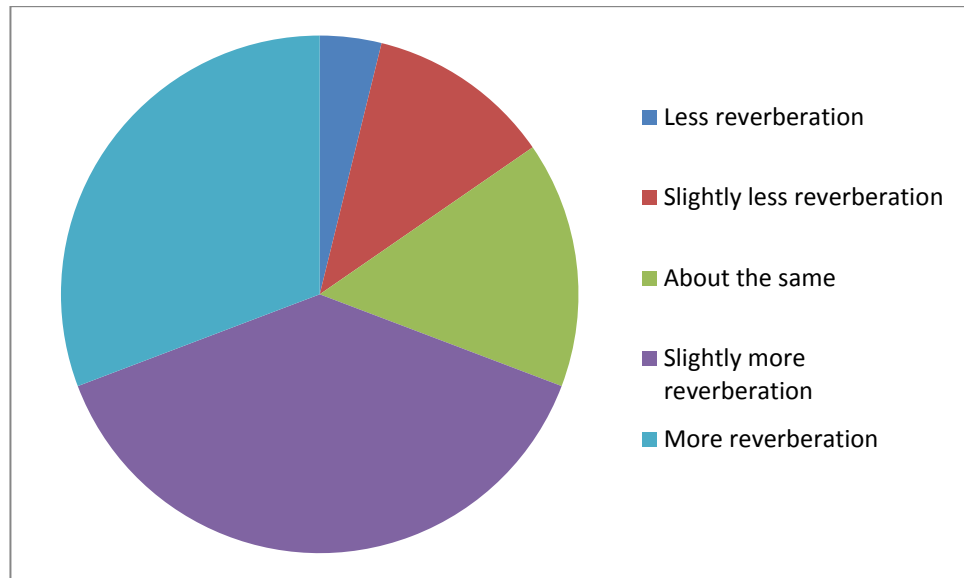
Chart 17: Simulation of Ightham Mote, exploring reverberation with a female voice
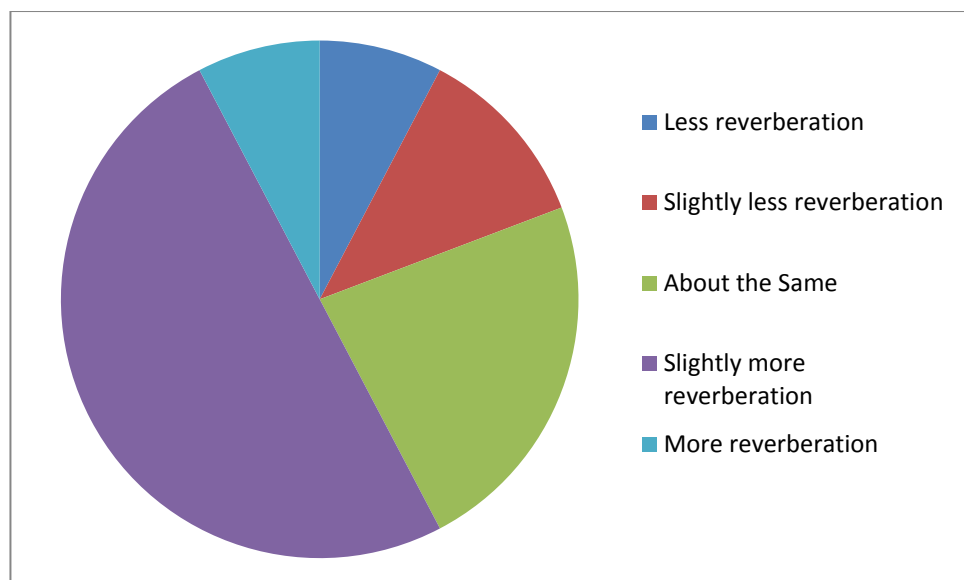
Chart 18: Measured results of Ightham Mote with a filter, exploring reverberation with a female voice
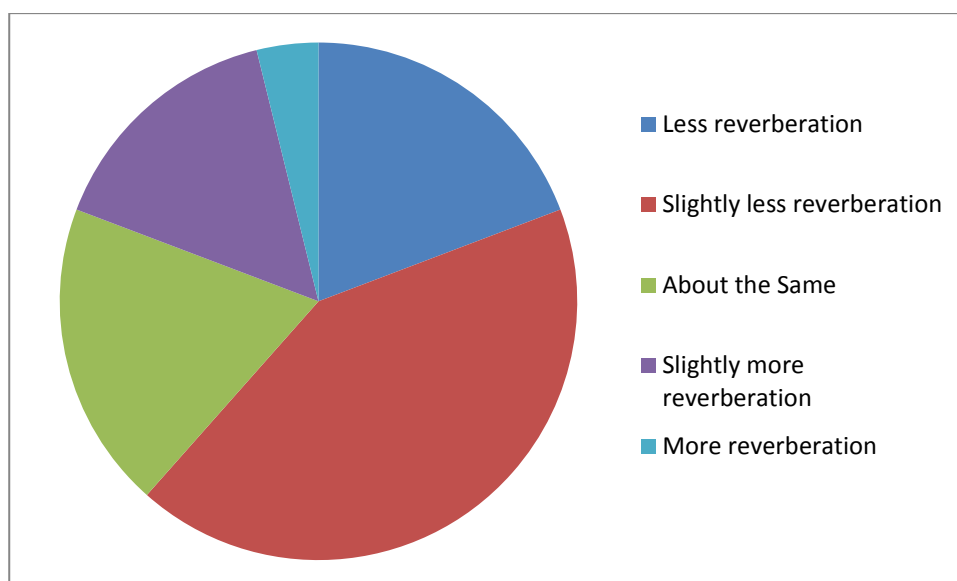
Chart 19: Simulation of Ightham Mote with filter, exploring reverberation with a female voice.
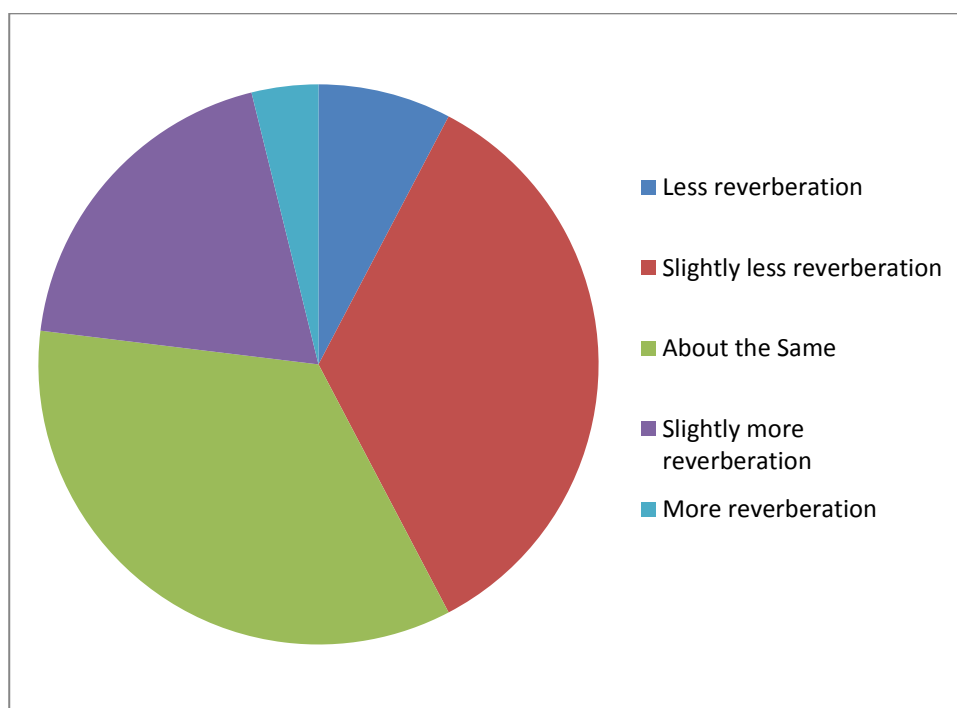
Chart 21, Chart 22 and Chart 23 where the auralizations have been produced with a male voice. Each chart should be compared with Chart 20 which is the auralization produced by the measured impulse response before being filtered. There was no consensus that any of the results were the same and there seems to be a considerable range as to whether they were significantly different or only a little different. Fortunately other questions also explored these concepts and I can use these answers to analyse the success of these factors instead.

Chart 20: Measured results of Ightham Mote, exploring reverberation with a male voice
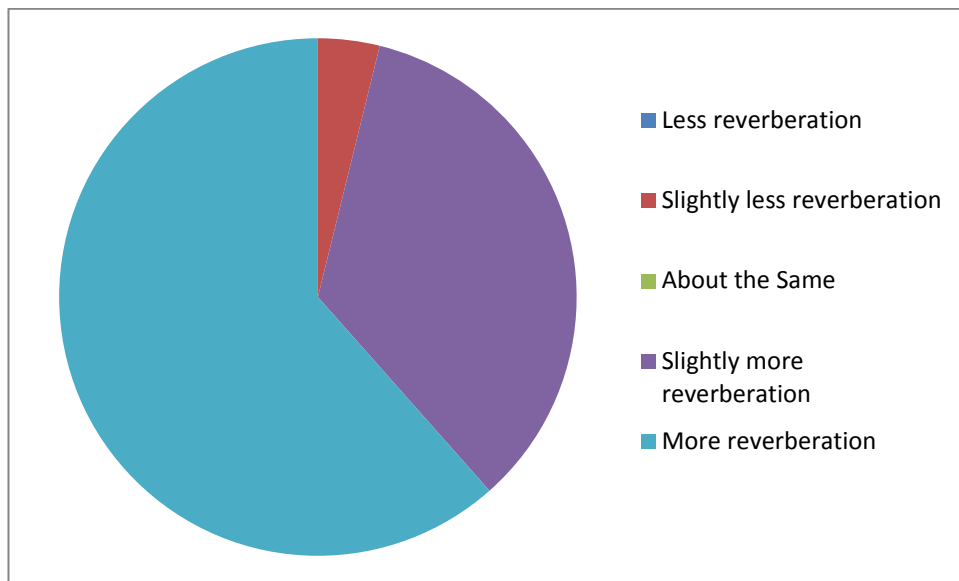
Chart 21: Simulated results of Ightham Mote, exploring reverberation with a male voice
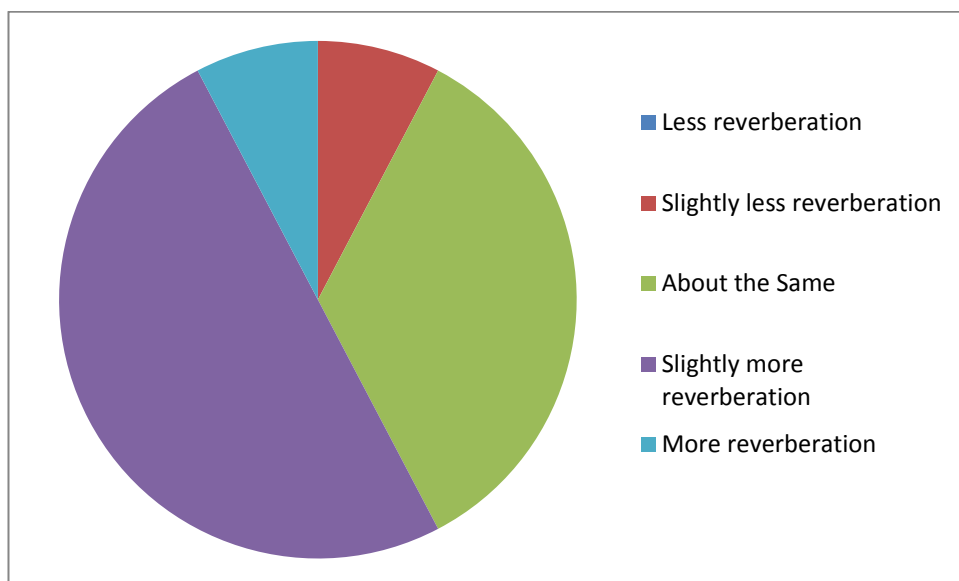
Chart 22: Measured results of Ightham Mote with a filter, exploring reverberation with a male voice

- Less reverberation
- Slightly less reverberation
- About the Same
- Slightly more reverberation
- More reverberation
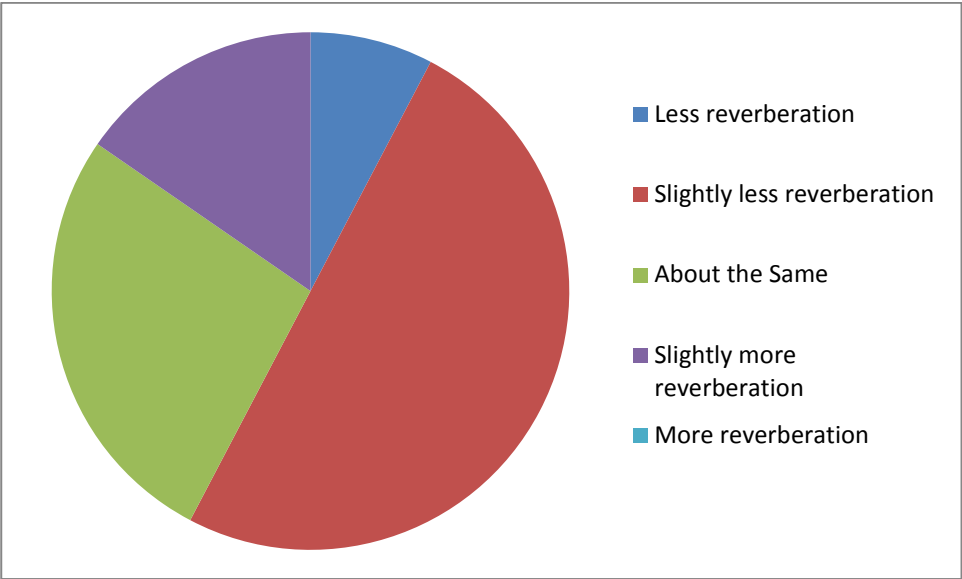
Chart 23: Simulation of Ightham Mote with a filter, exploring reverberation with a male voice

- Less reverberation
- Slightly less reverberation
- About the Same
- Slightly more reverberation
- More reverberation
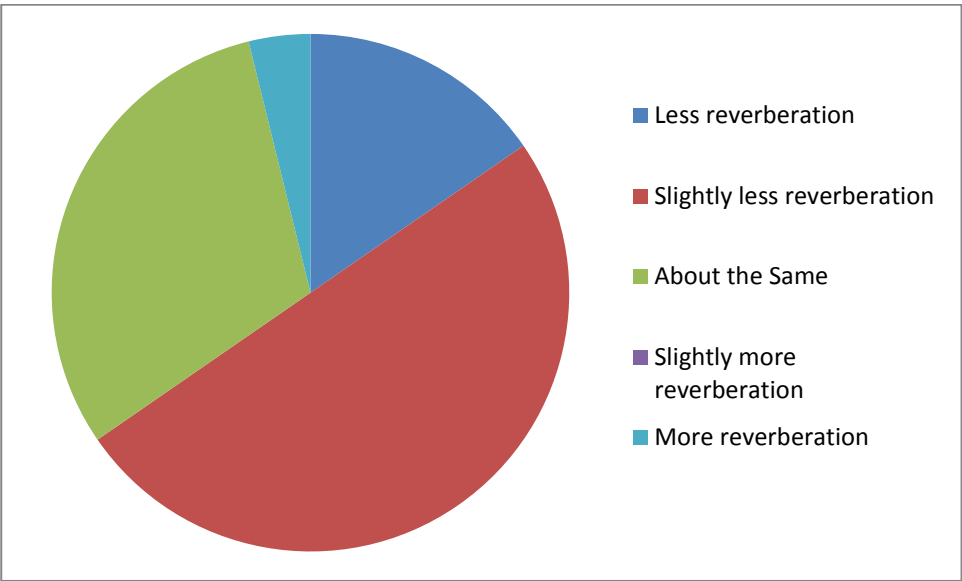
Table 9: Results of the questionnaire, the statistical test used to analyse it and the chart the data can be seen in

Question number	Statistical test	Chart	Track number	Voice	H_o	H_1	Significance level	Calculation tables	X^2_{calc}	x^2_a	
1	x^2	Chart 24	1	Female	The distribution of responses for each of the source positions is not different.	the distribution of responses for each of the source positions is different.	0.05	Table 14	X^2_{calc} = 10.5384 6	x^2_a = 9.4 87 73	H_1
2	x^2	Chart 24	2	Male	the distribution of responses for each of the source positions is not different.	the distribution of responses for each of the source positions is different.	0.05	Table 15	X^2_{calc} = 25.5384 6	x^2_a = 9.4 87 73	H_1
1 & 2	x^2	Chart 24	1 & 2	Comparison between female and male	the distribution of responses to the male and female Auralization voice for each of the source positions is not different.	the distribution of responses to the male and female Auralization voice for each of the source positions is different.	0.05	Table 16 Table 17	X^2_{calc} = 33.0 666 7	x^2_a = 9.4 87 73	H_1
3		Chart 16, Chart 17,	3-10								

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		Chart 18, Chart 19									
8		Chart 20, Chart 21, Chart 22 & Chart 23									
4 & 6	KS	Chart 25	4 & 5 7 & 9	Female	there is no difference between the auralization of the Great Hall according to reverberation when a filter is applied	there is a difference between the auralization of the Great Hall according to reverberation when a filter is applied	0.05	Table 18	D_{maxobs} = 0.44461 5	$D_{max0.05}$ = 0.3 80 94 9	H_1
9 & 11	KS	Chart 26	12 & 13 16 & 18	Male	there is no difference between the auralization of the Great Hall according to reverberation when a filter is applied	there is a difference between the auralization of the Great Hall according to reverberation when a filter is applied	0.05	Table 19	D_{maxobs} = 0.24	$D_{max0.05}$ = 0.3 84 66 6	H_0
5 & 7	KS	Chart 27	4 & 5 7 & 9	Female	there is no difference between the auralization of the Great Hall according to timbre when a filter is	there is a difference between the auralization of the Great Hall according to timbre when a filter is	0.05	Table 20	D_{maxobs} = 0.28 307 7	$D_{max0.05}$ = 0.3 80 94 9	H_0

					applied	applied					
10 & 12	KS	Chart 28	12 & 13 16 & 18	Male	there is no difference between the auralization of the Great Hall according to timbre when a filter is applied	there is a difference between the auralization of the Great Hall according to timbre when a filter is applied	0.05	Table 21	D_{maxobs} = 0.44	$D_{max0.05}$ = 0.384666	H_1
13	ks	Chart 30	19 & 20	Female	there is no difference between the responses about the level of reverberation of the auralization between the model of the old hall and the new hall	there is a difference between the responses about the level of reverberation of the auralization between the model of the old hall and the new hall	0.05	Table 22	D_{maxobs} = 0.84	$D_{max0.05}$ = 0.384666	H_1
13	x^2	Chart 30	19 & 20	Female	the responses about the level of reverberation of the Auralization is not different for the model of the old and new hall	the responses about the level of reverberation of the Auralization is different for the model of the old and new hall	0.05	Table 23 & Table 24	X^2_{calc} = 36.15238	x^2_a = 9.48773	H_1
13	KS	Chart 31	21 & 22	Female	there is no difference between the responses about the level of clarity of the auralization	there is a difference between the responses about the level of clarity of the auralization	0.05	Table 25	D_{maxobs} = - 0.44	$D_{max0.05}$ = 0.384666	H_1

					between the model of the old hall and the new hall	between the model of the old hall and the new hall					
13	x^2	Chart 31	21 & 22	Female	the responses about the level of clarity of the Auralization is not different for the model of the old and new hall	the responses about the level of clarity of the Auralization is different for the model of the old and new hall	0.05	Table 26 & Table 27	X^2_{calc} = 14.08119	x^2_a = 9.48773	H_1

In the majority of these cases we can reject the null hypothesis. I will go through each question stating what the results mean to the success of the project.

Question 1 and 2 were designed to explore how successfully the model of the room can be used to render directionality. The answers to this question can tell us about how we can model the experience of sound. Chart 24 shows the responses and also allows us to compare the difference between auralizing a male voice and a female voice which will be relevant to the second part of this test.

The first question we need to ask of this data is whether the auralization was successful at modelling direction. If the auralization was unsuccessful at modelling direction we would see a fairly even spread of responses. To test whether they are evenly spread or not I have used a chi-squared test which compares observed proportions of responses against calculated proportions (for workings see Table 14 (female voice)

Table 15 (male voice). The chi-square test showed that we could reject the null hypothesis and that the distribution of responses are not equally spread as we

would expect if the modelling of directionality was not possible. The correct answer was B, which was the modal value.

The results were not unanimous and they were not consistent between male and female voice: Chart 24 shows the two distributions. A chi-squared test was used to compare the distributions (for workings see

Table 16 and Table 17). The results of the chi-square test showed that that the distributions were not the same. This means that the frequency of the voices has had an effect. As discussed above (Section 6.2.2) there was difficulty modelling the low frequency of the room and we therefore applied a filter to see how participants would respond to the frequencies of the auralization that the numerical analysis deemed as being the same. This seems to have improved the ability of our respondents at placing the speaker as the modal value is more defined when exploring the male voice (as can be seen in Chart 24). The male voice is at a lower frequency and the filter would have removed some of the differences in the sound.

Chart 24: Comparison of respondents answers to question 1 and 2 asking which speaker the sound was coming from.
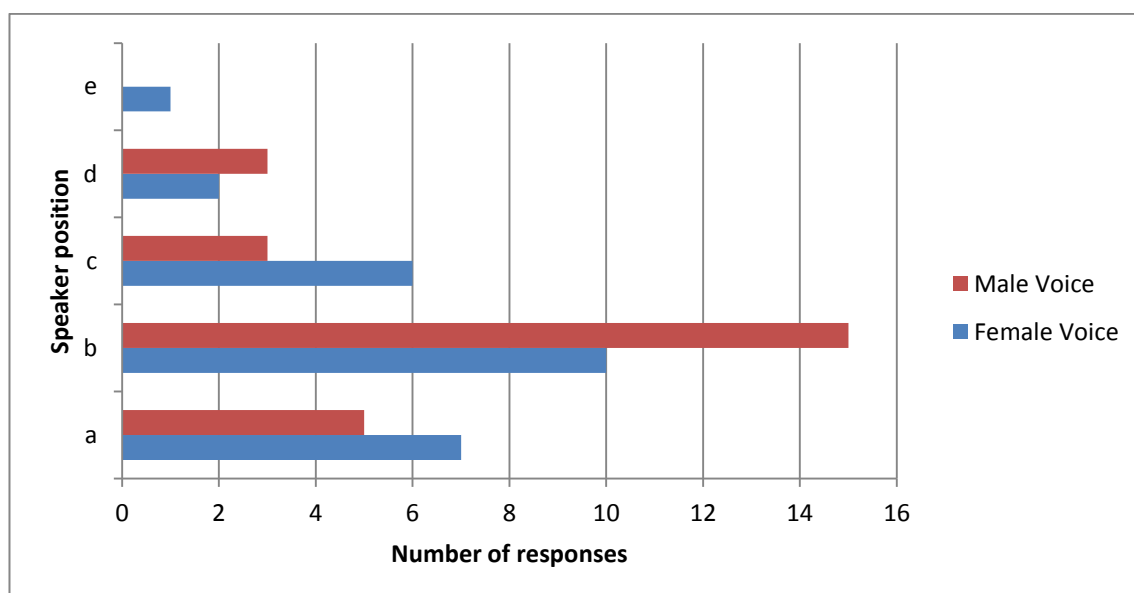
Questions 4-7 and 9-12 are to assess the success of modelling the space acoustically. As discussed above we applied a filter to the measured and simulated models to remove the inconsistency at low frequencies. To see how this has affected the results we asked a series of questions comparing the two models. I used a Kolmogorov–Smirnov (KS) test to see how respondents

considered the experience of sound with the inclusion of the filter according the sense of reverberation and timbre with both a male and female auralization the results can be seen in Chart 25, Chart 26, Chart 27 and Chart 28.

Chart 25: Female Voice comparing simulated and measured responses to sense of space or reverberation when a filter is applied
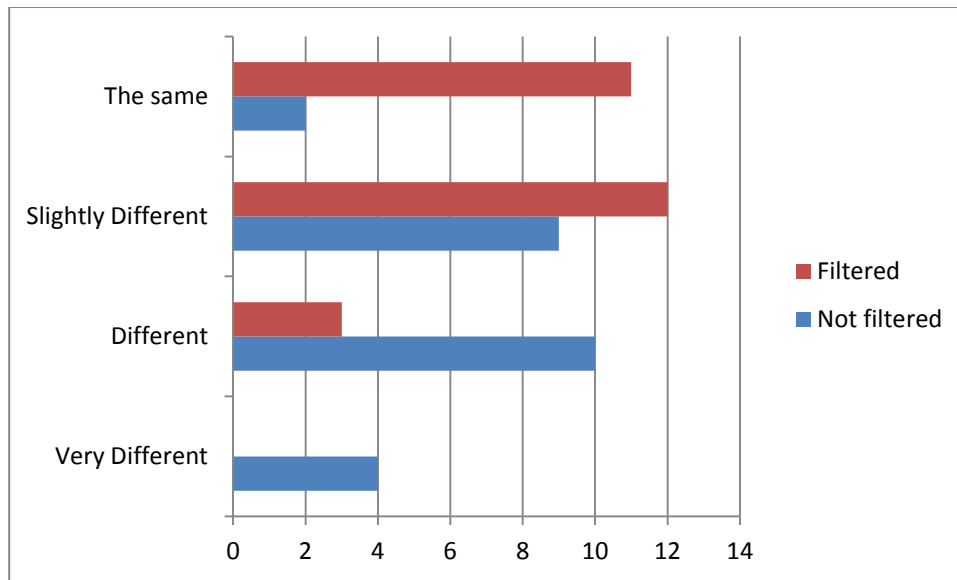
Chart 26: Male Voice comparing simulated and measured responses to sense of space or reverberation when a filter is applied
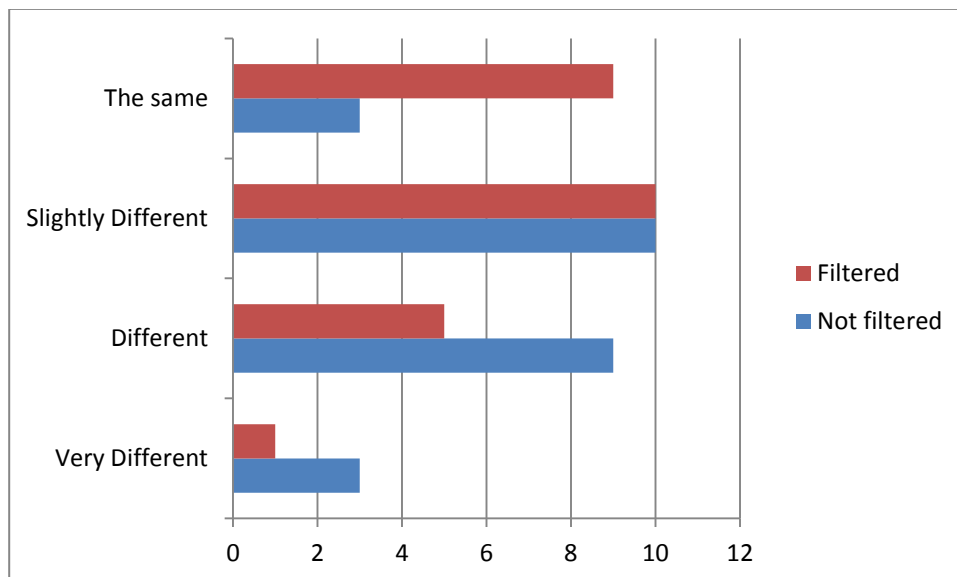
Chart 27: Female Voice comparing simulated and measured responses to timbre/ tone when a filter is applied
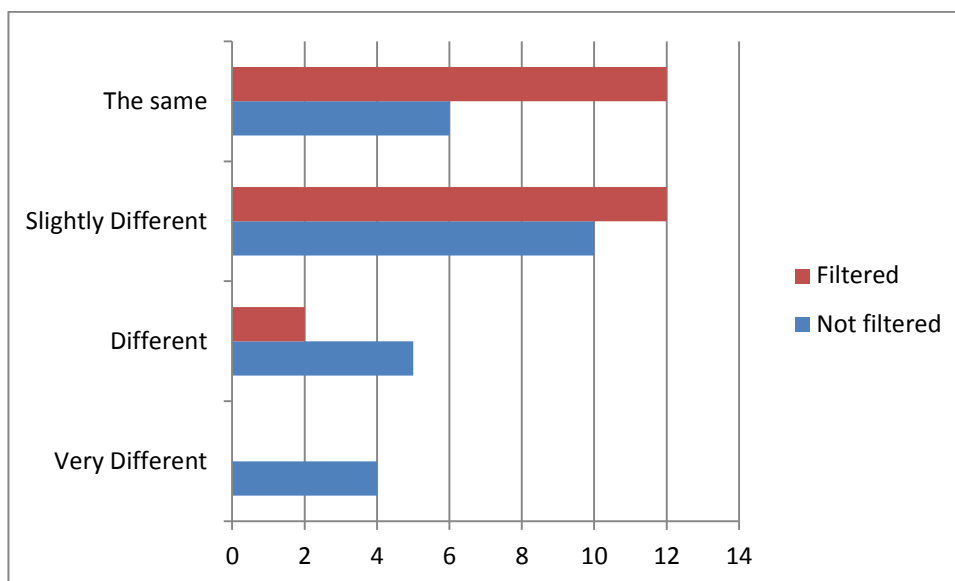
Chart 28: Male Voice comparing simulated and measured responses to timbre/ tone when a filter is applied
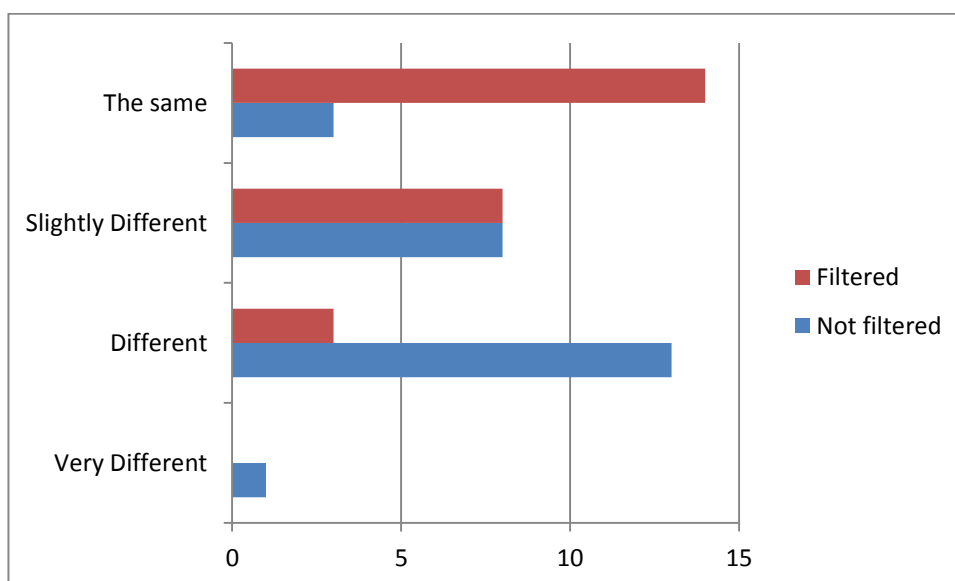
Out of these four tests we can only reject the null hypothesis on two occasions and can say that there is a difference between the auralization of the Great Hall with a male voice when a filter is applied to the timbre and with a filter on the reverberation on a female voice. On this level we cannot state that the modelling of the sound was improved by introducing the filter as we cannot even suggest that the results are different in all instances. However, one observation of the data in Chart 29 showing the response to the female

auralization with respect to reverberation we can see how the modal value of responses moved from different to slightly different with 88% of responses being either slightly different or the same instead of 46%. While the male response to the modal value moved from different (52%) to the same (56%). I think this shift is quite significant. It is a marked improvement on the results without a filter.

Chart 29: Showing how peoples responded when comparing sense of space or reverberation of tracks which have been simulated and measured with and without a filter. When the Auralization was produced with a female voice.
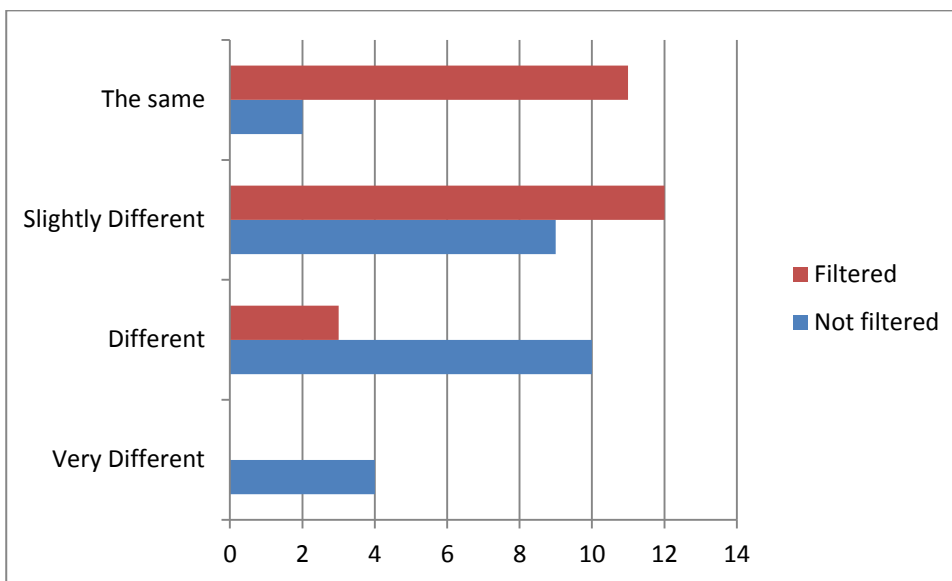
Finally question 13 asked about the comparison sound in the measured response of the great hall with a basic model of the great hall with medieval furnishings and fittings. My intention here is to demonstrate that the soundfield in the Great Hall is different in the present than it would have been in the past and we can use the two assessment techniques to further explore this if we assume that the modelled spaces is effective. I have used both the KS test and chi-square test to assess for a difference between the responses to both sets of data. Firstly for reverberation and secondly for clarity the results can be seen in Chart 30 and Chart 31.

Chart 30: Comparing sense of reverberation between the model of the old hall and the model of the new hall on a scale of 1 -5 with one representing less reverberation and 5 more.
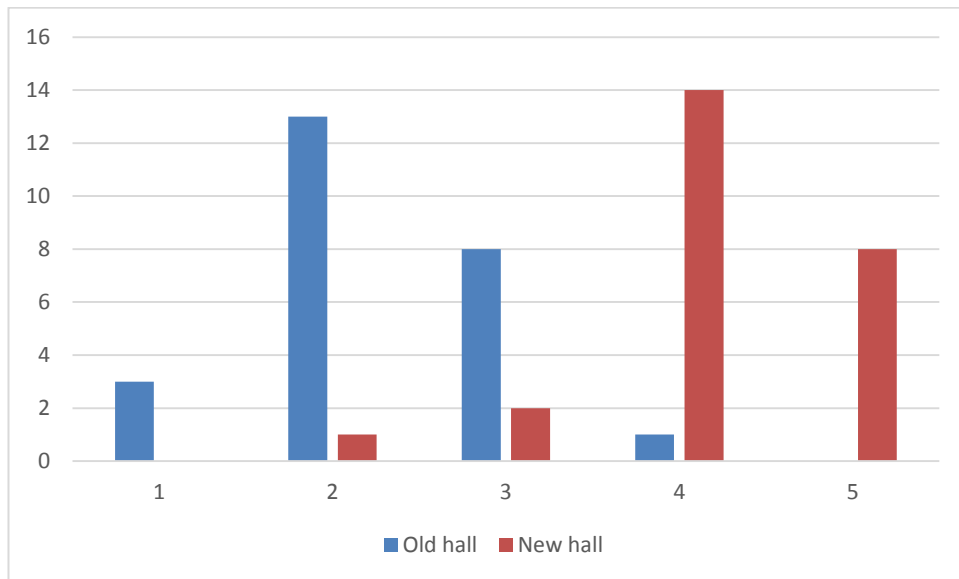
Chart 31: Comparing sense of clarity between the model of the old hall and the model of the new hall on a scale of 1 -5 with one representing hard to understand and 5 easier to understand.
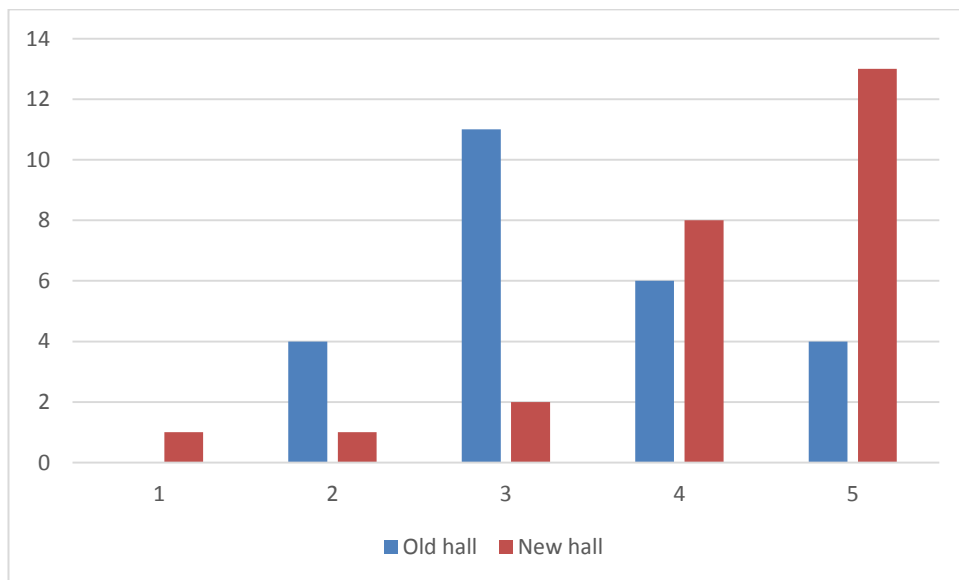
In both of these tests, for both parameters we can reject the null hypothesis. This will be further discussed in the results section.

6.3.2   Numerical Analysis

The numerical analysis consists of comparing a series of parameters about the acoustics of the room. These are explained in Table 6. In this section I will compare the results of the simulation with the measured responses to see how successful the modelling was from an "objective" perspective. These measures will then be used to determine the nature of the soundfield in the room and what the space is most suited to (music, public speaking, private conversation) which I will detail and will be used to discuss the experience of the space.

Table 10: Reverberation Time (T_{30}) in octave bands (63 Hz – 4000 Hz) (low Hz is lower frequency and therefore lower pitch). The measured responses are the results which we acquired while recording at Ightham Mote and the simulated responses are based on the mode

T_{30}/ Hz	63	125	250	500	1000	2000	4000
Measured AVG (sec)	0.98	1.01	0.98	1.00	0.95	0.87	0.74
Simulated (sec)		1.03	1.02	1.02	0.95	0.87	0.77

Table 11: Early Decay Time (EDT)

EDT/ Hz		125	250	500	1000	2000	4000
Measured AVG (sec)		0.86	0.86	0.97	0.94	0.86	0.73
Simulated (sec)	Pressure	0.50	1.25	1.10	0.98	0.90	0.63
	Energy	0.91	1.41	1.12	0.98	0.91	0.63

6.4   Results

In conclusion we can firmly state that at this time it is not possible to accurately model the acoustical properties of a space without a significant level of calibration, in this case based on the recording of the space as it stands today instead of modelling a space from scratch. The results of the reverberation time and early decay time show an inconsistency between the model and simulation particularly at low frequencies. This inconsistency is also seen in the results of the listening test. However, the listening test did highlight how applying a filter to remove the low frequency responses produced a better correlation between measured and simulated results. I feel there is scope of undertaking an analysis such as this particularly in spaces which are still standing.

However, in undertaking the acoustical analysis we learned a number of things about the properties of the Great Hall at Ightham Mote. The reverberation time was short for such a large space (around 1 second) suggested that it is a perfect space for drama and the spoken word (Barron, 2009: 452) but not really for music (Barron 2009: 30). This is on the proviso that the measurements were recorded when space was empty when full we can take away 0.2sec which would make it even less suitable for music (INfo 1995). In section 1.1 where I discuss the Great Hall I bring up Woolgar's interpretation of experience of sound. The results of this case study to some extent agree with Woolgar's discussion on halls as quiet places (Woolgar 2006) allowing the acoustical properties to encourage a ritualised decorum not polluted by excess sound.

It was particularly interesting that the reverberation time was constant across the board. This means that the experience of sound was the same for those seated at the lowest and highest ends of the hall. Because of this we can assume that the lord did not have any better experience of any performances and therefore there was no class restriction of the experience of being in the hall. I highlighted in Chapter 1 how I would not be comparing ecclesiastical sites to secular. Some forms of church architecture limit sound from reaching the ends of the church building meaning that the experience of the service was different across the classes. These results may have been affected by the size

and regularity of the space. It would be interesting to undertake the same analysis on a much larger hall like that at Penshurst.

Modelling the old hall and comparing the subjective experience to the new hall suggests that the experience of reverberation was less in the new hall. It was also slightly easier to understand speech in the new hall. This highlighted that in this case it was still not a space in which to listen to music at least according to my suggestion for the furnishings within the space. However, these are only preliminary investigations.

6.5   Conclusions

This chapter has discussed Ightham Mote and how it has been used as a case study to explore the use of acoustical survey as a method for exploring the lived experience of late medieval buildings. I have discussed how the decision to work on acoustics instead of visualisation came about and why it is important to move away from the ocularcentric approach that archaeology has focussed on. Using the literature review above, I have highlighted the issues associated with working in this area of archaeology, both theoretical and practical.

The results of this case study highlight the problems suggested by Barron (2009: 7) (discussed in section 6.2) are still inherent with the modelling of sound. In this example it has not been possible to completely reconcile the numerical parameters (section 6.3.2) and the results of the listening test (section 6.3.1) between the simulated model and the measured example. However, if it is possible to measure the properties of a room this can be used as a method of calibration for modelling the space. These measurements also provide us with a method for exploring the sound properties of the building as it stands today to allow us to begin to assess the experience of sound in that space. What is inherently lacking in a number of other approaches to archaeoacoustics is the absence of basic understanding of the technique and what the results then show or lack (Till et al. 2013; Till 2011; Scarre & Lawson 2006).

Most importantly we can use this technique in the same way as we would in visualisation. There is no reason not to critically assess and research our

models in the same way that we would undertake a visualisation project i.e. as a method for informing our understanding of the lived experience of the space. The results must be used with an understanding of how they were created and the undermining issues with the creation of an auralization.

These models allow us to consider the aural experience of Ightham Mote as a space where speeches can be given easily but music would fall short. The research therefore highlights Ightham Mote Great Hall as an intimate and calm space. However, to take this research forwards I would want to further explore the furnishings and fittings that would be modelled. To test this discussion about public speaking I would suggest recording anaechoically a period-specific musician to test the subjective experience of music in the space. I would also explore the transmission of sound beyond the bounds of the hall. The hall itself forms part of a set of rooms and as such it would be interesting to see how private, or not, the conversation would be. Finally I suggest, following the theoretical background detailed in Chapter 2, that we cannot look purely to the experience of sound to understand the space. Acoustic and visual stimuli need to be explored in combination with the aim of creating a multisensory experience of the site.

In essence I feel there is significantly more that can be done with this technique beyond my thesis. However, this thesis will look at how we can bring together the work undertaken in both case studies to try and piece together both a visual and aural experience of Ightham Mote. This forms the final case study in Chapter 7.

Chapter 7:   Towards a lived experience

In section 2.4 I discussed the importance of a multisensory understanding of experience. At that point I was discussing the ocularcentric approach which archaeology has taken to the past. My first case study at Bodiam created a series of visualisations to explore how these can access elements of a lived experience. At the end of that chapter I highlighted how, despite the success of the case study at addressing issues of uncertainty and transparency in the creation of digital visualisation, it was still an ocularcentric approach. To address this issue, my second case study highlighted the aim of creating accurate auralizations. These can by no means be considered ocualarcentric, indeed they are aural centric. By looking at one sense individually we are prioritising our understanding of how that contributes to our life experience. In reality as the phenomenological way of thinking (as discussed in section 1.2.3.5) has suggested, we understand the world as a result of our entire multisensory bodily experience.

Therefore in this final chapter I bring together what I have learned from the acoustics and visualisation projects. The two projects have highlighted how we can use digital technologies to explore different elements of lived experience in isolation. Experience of place is an understanding based on all the senses working together combined with memory and past experience. Many of these elements I cannot access in this study, but I can explore how the responses to auralization are affected by adding visual stimuli.

This case study combines the auralization of the Great Hall at Ightham Mote with the mixed media approach taken in the visualisation project. In combining the two I am able to explore how a multisensory approach can affect our understanding of the space. This questions whether the experience of sound changes but also how the emotional responses discussed in the Bodiam case study are affected by the combination of both visual and aural stimulus.

7.1 Aims

The aim of this project is to explore how consuming both visual and aural media in combination compares with consuming them individually. In essence, does adding vision to the auralization improve understanding and does adding audio change the emotional response to the visual.

The case study is simple. I will bring together the auralizations created as part of the Ightham case study with a series of photographs of the Great Hall. I use a similar questionnaire to the one used in chapter 6 to explore how responses are affected when the images and auralizations are consumed simultaneously.

7.2 Methodology

The methodology is simple. A series of participants with a background in archaeology will undertake a listening test to identify how their experience of the auralizations discussed in chapter 6 are affected with addition of a visual element.

Due to limitations of time I elected not to produce detailed 3D models of the space, but instead use photos of the hall in accompaniment with sound. Unlike the previous case studies there is not a numerical analysis to the assessment as we already have the numerical responses to the auralization. Instead I am focussing on the human responses. The questionnaire has been written with this in mind. Questions are repeated with and without photographs; and finally the listener is asked to comment on their personal experience of the test.

7.2.1 Auralization

The work on the auralization of the Great Hall has been completed for the acoustics project (Chapter 6). The second listening test will be undertaken comparing the auralizations convolved from the measured impulse response and the impulse response gained from modelling the Great Hall.

7.2.2 Visualisation

The visuals were kept very simple. Images were selected to give an impression of the space in the hall and therefore did not include any close ups. The

intention was that these would give a feel for the space and a level of expectation about the experience of sound in the room. I also felt that these would be easier to consume in the context of the questionnaire and help someone listening to the auralizations.

7.3   Analysis

The aim of the test was to establish whether the addition of a visual element affected the results. Fifteen people undertook the listening test, all with a background in archaeology. The experiments took place in an isolated room in the archaeology building with a questionnaire, laptop and a set of Sennheiser HD 600 headphones (opened binaural headphones). Participants were instructed to take their time and listen to each track as many times as they needed.

To assess the results I have used the same statistical testing as in Chapter 6. I will also use some basic methods of coding to assess the qualitative questions (see Chapter 4). The questionnaire and results can be seen in Appendix M and Appendix N. The results of the survey have been summarised in Table 12 which shows how the responses to each question have been analysed, what charts are associated with it, the type of statistical test used and whether we can reject the null hypothesis or not. The calculation tables for the statistical tests can be seen Appendix O.

Table 12: Results of the questionnaire, the statistical test used to analyse it and the chart the data can be seen in

Question	Statistical test	Chart	Track number	Voice	H_0	H_1	Significance level	Calculations	X^2_{calc}	x^2_a	
1	x^2	Chart 32	1	Female	the distribution of responses of those with a visual element to those without	the distribution of responses of those with a visual element to those without	0.05	Table 28 & Table 28	$X^2_{cal c}$ = 2.435 07	x^2_a = 9.48 773	H_0

					a visual element to the Auralization each of the source positions is not different.	a visual element to the Auralization each of the source positions is different.				9	
2	x^2	Chart 33	2	Male	the distribution of responses of those with a visual element to those without a visual element to the Auralization each of the source positions is not different.	the distribution of responses of those with a visual element to those without a visual element to the Auralization each of the source positions is different.	0.05	Table 30 & Table 31	$X^2_{cal c} = 1.500635$	$x^2_a = 9.48773$	H_0
3 & 5 a	KS	Chart 34	3&4 13&14	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to reverberation.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to reverberation.	0.05	Table 32	$D_{maxobs} = 0.2$	$D_{max0.05} = 0.497$	H_0
3 & 5 b	KS	Chart 35	3&5 13&15	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to reverberation.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to reverberation.	0.05	Table 33	$D_{maxobs} = -0.267$	$D_{max0.05} = 0.497$	H_0
3 & 5	KS	Chart 36	3&6	Female	There is no difference in responses to	There is a difference in responses to	0.05	Table 34	$D_{maxobs} =$	$D_{max0.05} =$	H_0

c			13 &16		the auralization of the Great Hall when a visual is applied with respect to reverberation.	the auralization of the Great Hall when a visual is applied with respect to reverberation.			0.267	0.497	
3 & 5 d	KS	Chart 37	3&7 13&17	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to reverberation.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to reverberation.	0.05	Table 35	$D_{maxobs} = -0.133$	$D_{max0.05} = 0.497$	H_0
4 & 6 a	KS	Chart 38	8&9 18&19	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility.	0.05	Table 36	$D_{maxobs} = -0.133$	$D_{max0.05} = 0.497$	H_0
4 & 6 b	KS	Chart 39	8&10 18&20	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility.	0.05	Table 37	$D_{maxobs} = -0.133$	$D_{max0.05} = 0.497$	H_0
4 & 6 c	KS	Chart 40	8&11 18&21	Female	There is no difference in responses to the auralization of the Great Hall when a visual is	There is a difference in responses to the auralization of the Great Hall when a visual is	0.05	Table 38	$D_{maxobs} = -0.133$	$D_{max0.05} = 0.497$	H_0

					applied with respect to intelligibility.	applied with respect to intelligibility.					
4 & 6 d	x^2	Chart 41	8& 12 18 &22	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility.	0.05	Table 39	D_{maxobs} = -0.133	$D_{max0.05}$ = 0.497	H_0
7 & 10	KS	Chart 42	23 &24 25 &26	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to sense of space or reverberation.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to sense of space or reverberation.	0.05	Table 42	D_{maxobs} = -0.133	$D_{max0.05}$ = 0.497	H_0
7 & 10	x^2	Chart 42	23 &24 25 &26	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to sense of space or reverberation.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to sense of space or reverberation.	0.05	Table 40 & Table 41	$X^2_{cal c}$ = 3.44444	x^2_a = 9.48773	H_0
8 & 11	KS	Chart 43	23 &24 27 &28	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with	There is a difference in responses to the auralization of the Great Hall when a visual is applied with	0.05	Table 45	D_{maxobs} = -0.133	$D_{max0.05}$ = 0.497	H_0

					respect to timbre or tone.	respect to timbre or tone.					
8 & 11	x^2	Chart 43	23 &24 27 &28	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to timbre or tone.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to timbre or tone.		Table 43 & Table 44	$X^2_{calc} = 1.73333$	$x^2_a = 9.48773$	H_0
9 & 12	KS	Chart 44	23 &24 29 &30	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility.	0.05	Table 48	$D_{maxobs} = -0.4$	$D_{max0.05} = 0.497$	H_0
9 & 12	x^2	Chart 44	23 &24 29 &30	Female	There is no difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility.	There is a difference in responses to the auralization of the Great Hall when a visual is applied with respect to intelligibility.	0.05	Table 46 & Table 47	$X^2_{calc} = 6.6$	$x^2_a = 9.48773$	H_0

In none of the cases can we reject the null hypothesis as the results were not conclusive enough.

Questions 1 and 2 assessed recognition of localisation of the source in the great hall. Unlike in the previous questionnaire subjects were provided with a photo of the hall instead of the model. Chart 32 and Chart 33 shows the

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responses by participants and the difference between the male and female auralization.

Chart 32: Results for question 1 seeing if people can locate the speaker better or worse with an added visual element when the auralization is produced by a female voice
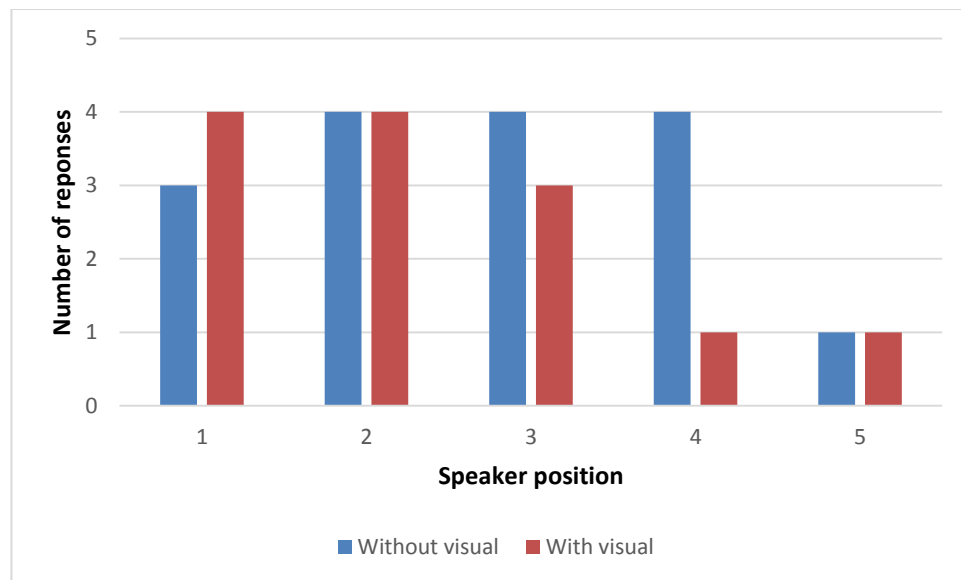
Chart 33: Results for question 1 seeing if people can locate the speaker better or worse with an added visual element when the auralization is produced by a male voice
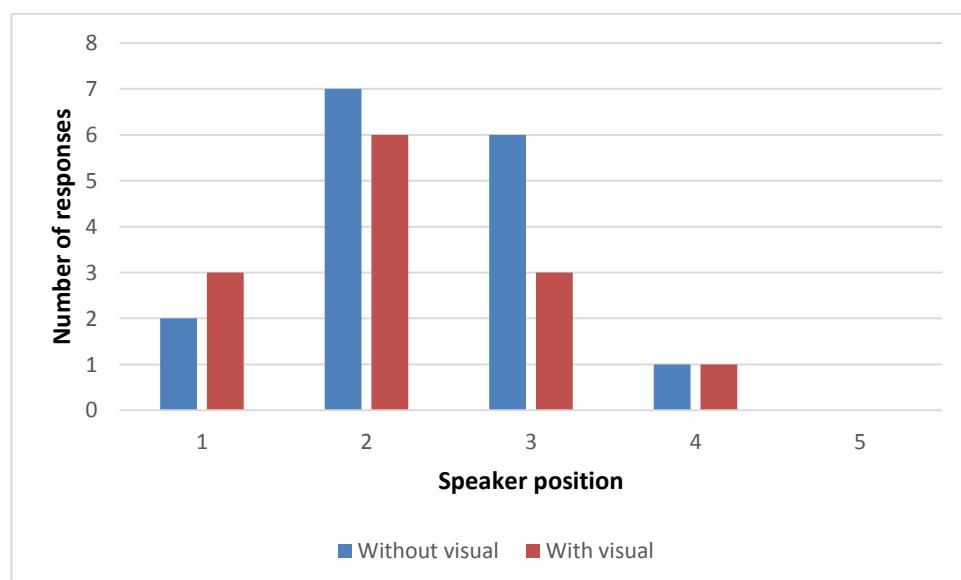
The results of the auralization were not affected with the addition of a visual element: in both cases we cannot reject the null hypothesis. I compared the results of question 1 and 2 with those discussed in chapter 6. I have only used

the responses of those without an acoustical background for the statistical test as I felt those trained in the study of sound featuring only in one group would bias the results. This means we must accept that the distributions are not different. I think it is important to state that a result of "not different" does not mean that they are the same. It merely means that we cannot explain the difference as statistically significant.

Question 3 and 5 look at the differences in the experience of reverberation. I took each part of the question and compare listeners response before a visual was provided and after. I used a KS 2 sample test to compare the distributions and the results can be seen in Chart 34, Chart 35, Chart 36 and Chart 37.

Chart 34: Simulated and filtered auralization compared to the measured auralization according to how the listener perceives reverberation
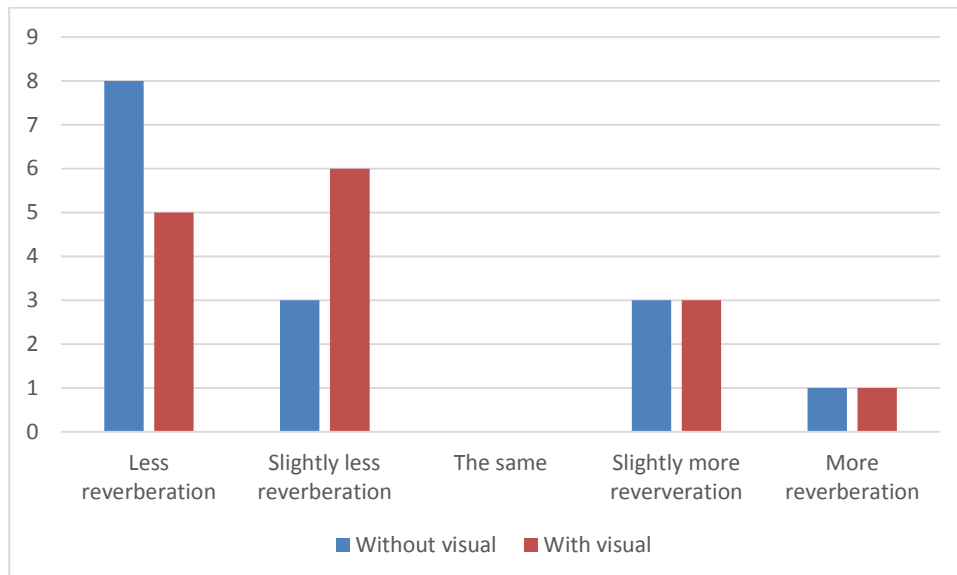
Chart 35: Simulated auralization compared to measured auralization according to how the listener perceives reverberation
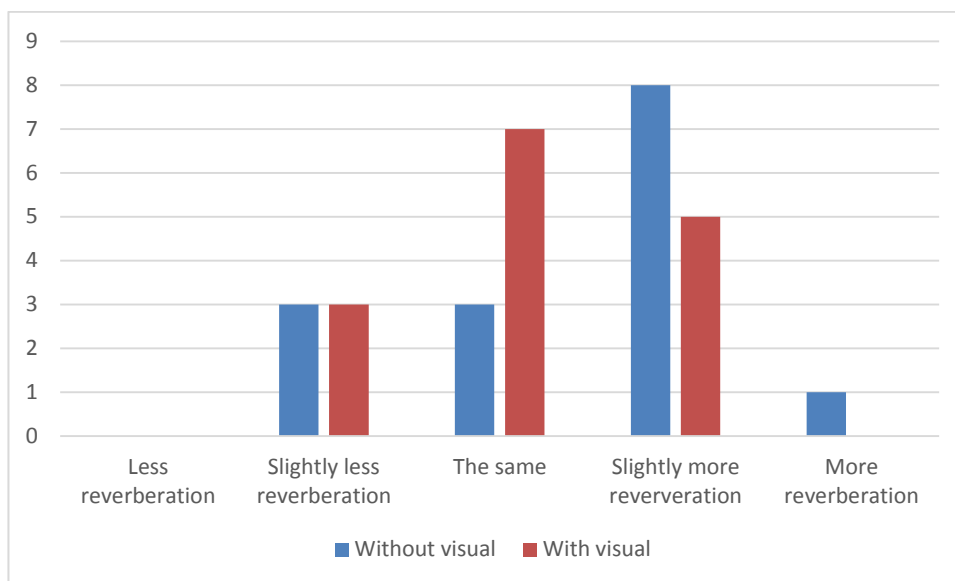
Chart 36: Measured auralization compared to measured auralization according to how the listener perceives reverberation
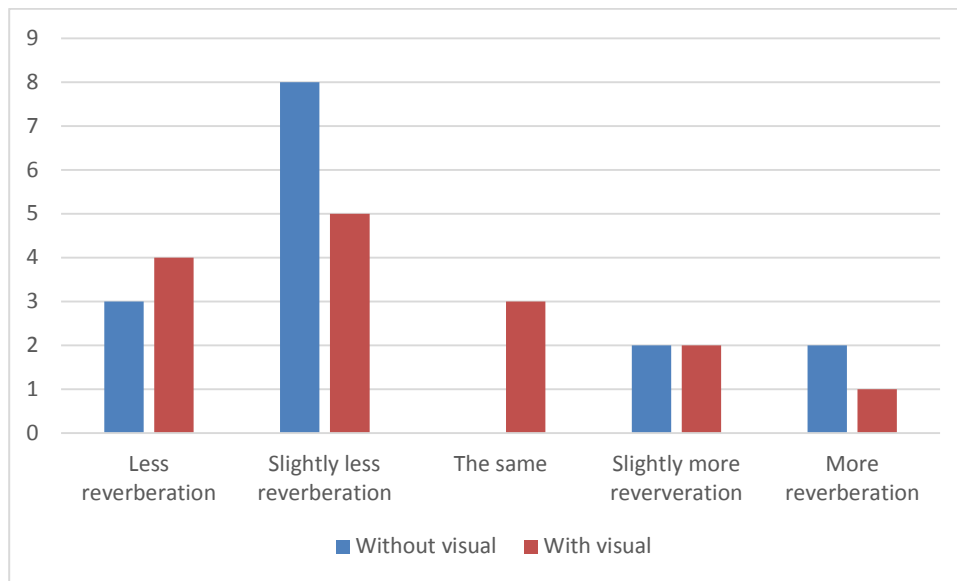
Again none of the results displayed above allowed us to reject the null
hypothesis. Again we are not seeing a difference in the responses before and
after a visual was added.

Question 4 and 6 do the same but instead of reverberation they explore
intelligibility, or how easy it is to understand what is being said. I took each
part of the question and compared listeners response before a visual was
provided and after. I am using a KS 2 sample test to compare the distributions
and the distributions can be seen in Chart 38, Chart 39, Chart 40 and Chart
41.

Chart 38: Measured and filtered auralization compared to measured auralization according to how the listener perceives intelligibility
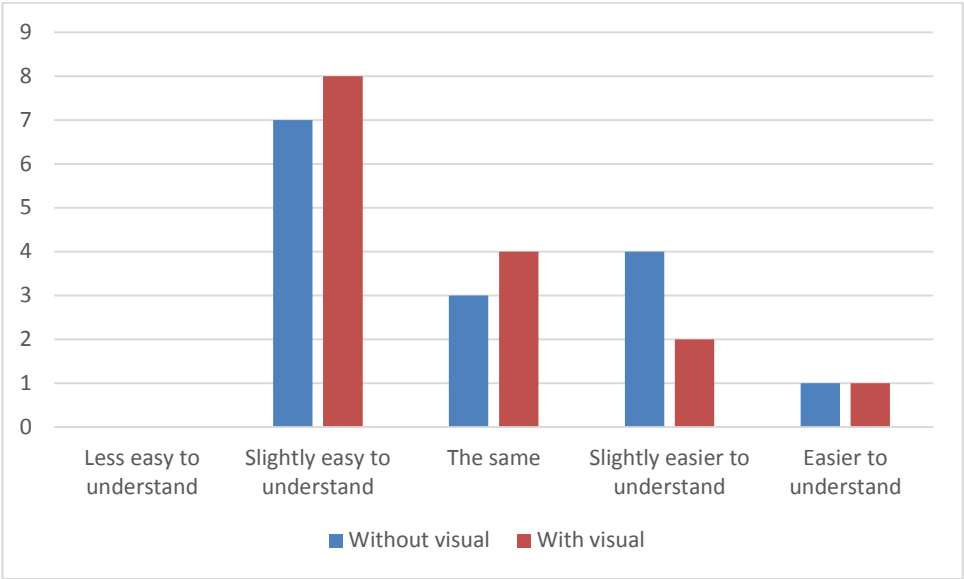
Chart 39: Measured auralization compared to measured auralization according to how the listener perceives intelligibility
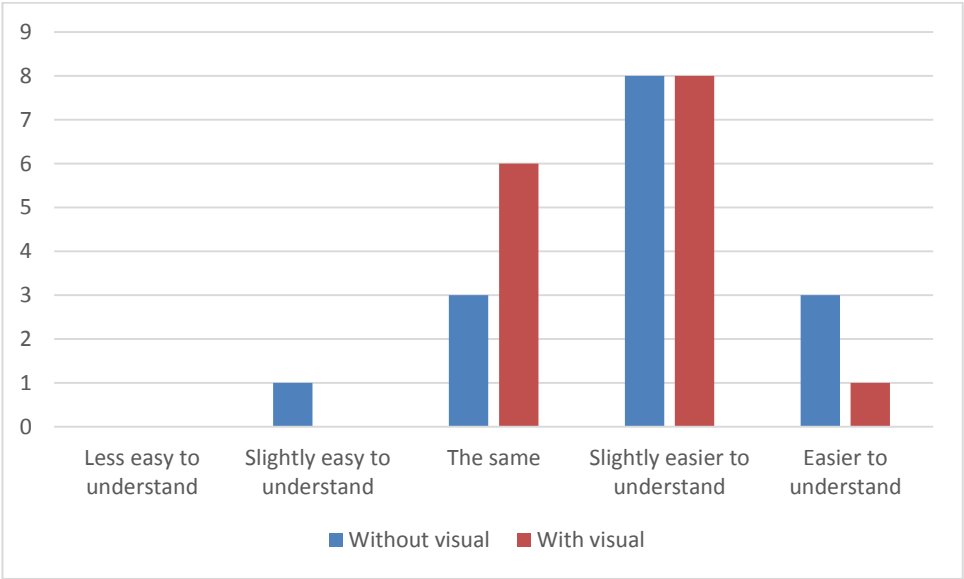
Chart 40: Simulated and filtered auralization compared to measured auralization according to how the listener perceives intelligibility
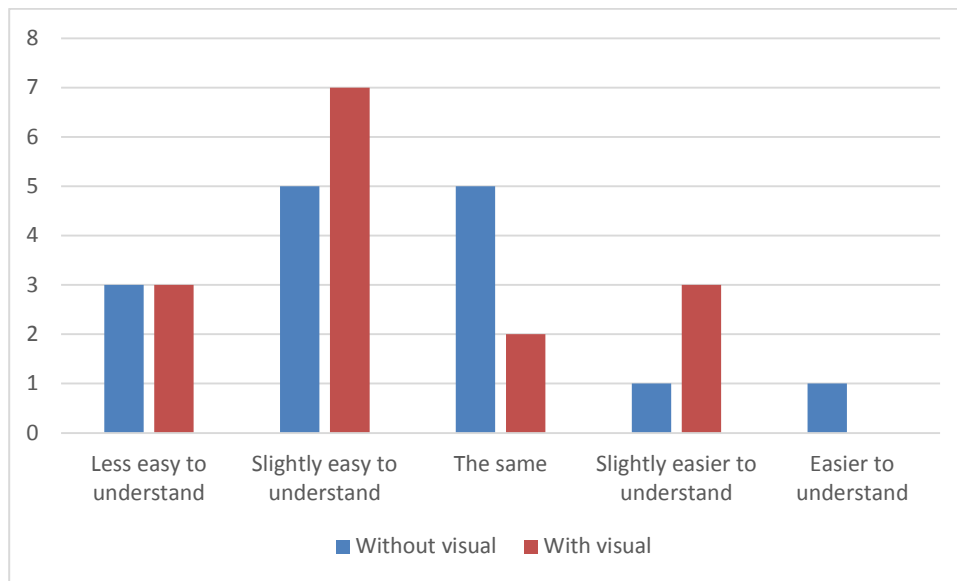
Chart 41: Simulated auralization compared to measured auralization according to how the listener perceives intelligibility
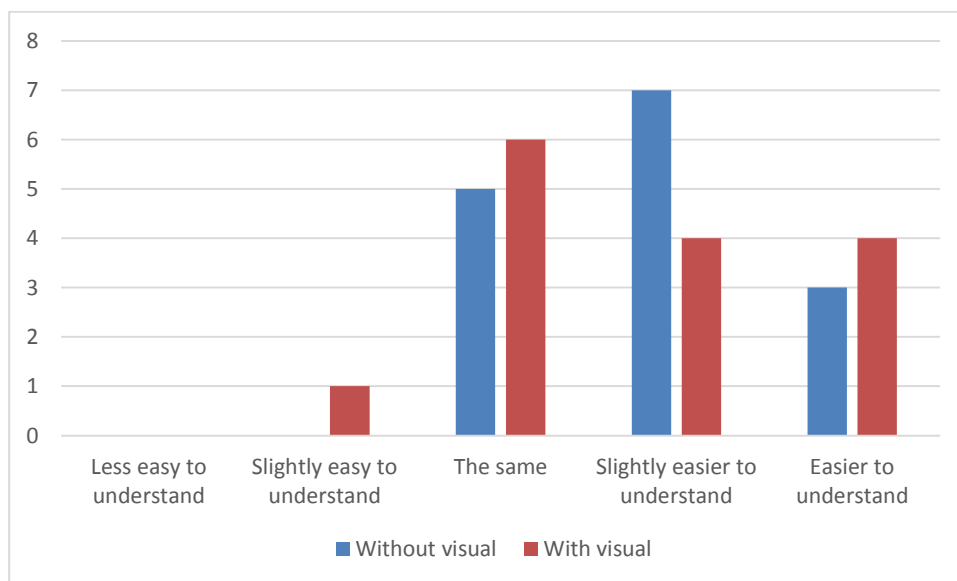
The results do not suggest a strong enough difference in distribution to reject the null hypothesis.

Questions 7-12 look more closely at the relationship between the filtered auralizations. Again they ask the same question twice, once without and once with a visual stimulus. They are also phrased in a way that is much more similar to the questions being asked in chapter 4 allowing us more of an area

to compare. Here I have undertaken both the Chi-squared and KS test the distributions can be seen in Chart 42, Chart 43 and Chart 44.

Chart 42: How the addition of a visual affects listener's responses to the sense of space or reverberation of a simulated and filtered auralization
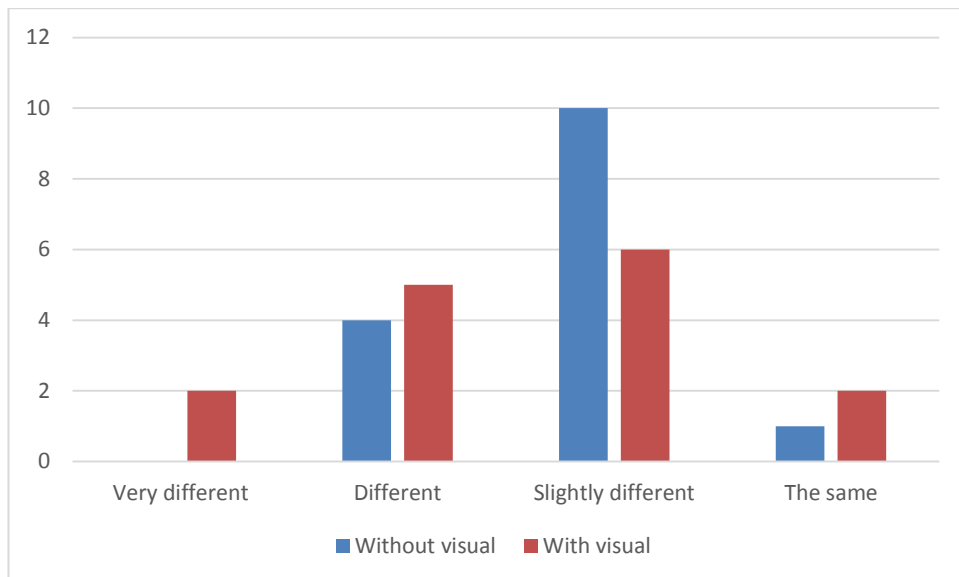
Chart 43: How the addition of a visual affects listener's responses to the sense timbre or tone of a simulated and filtered auralization
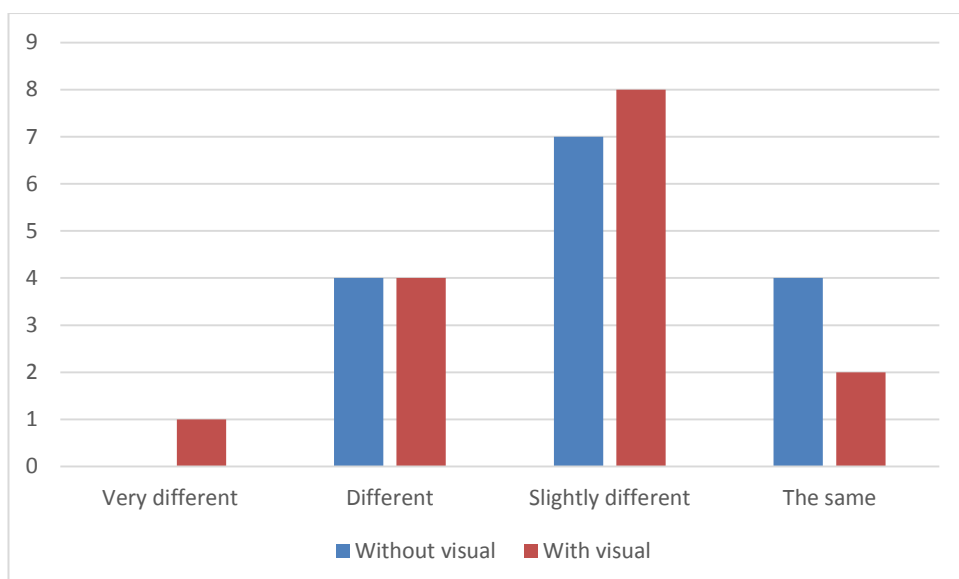
Chart 44: How the addition of a visual affects listener's ability to understand what is being said when listening to a simulated and filtered auralization
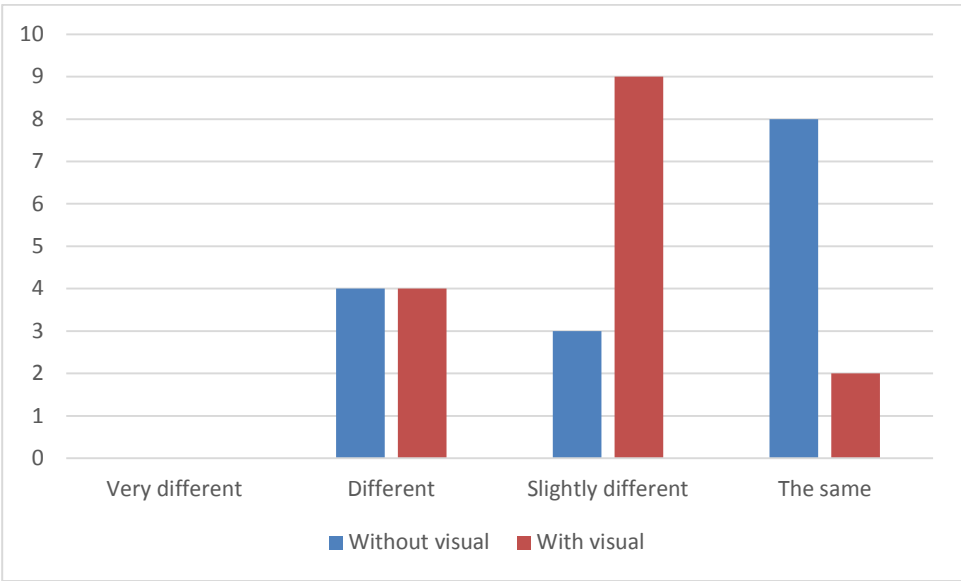
7.4   Results

The results of the statistical analysis were inconclusive. In none of the cases could we dismiss the null hypothesis and state that the datasets were different. As we knew when devising the tests that the datasets were the same this suggest that the addition of a visual element has not affected the results. The tests ideally should have been conducted with a larger group of subjects, however, this was not possible. Even in a small sample it is not possible to see any correlation in the responses.

7.4.1   Qualitative analysis

I have also looked to the comments in the final question of the listening test which asked listeners to discuss how the addition of a visual affected their experience. As with the visualisation project I adopted techniques appropriate for qualitative analysis to investigate this. I have coded the responses for this question according to two different criteria: not using the visual images while the test was being undertaken and an acknowledgement that the visuals are and could be useful in an understanding of the space (Table 13 shows the responses).

Table 13: Qualitative coding of responses shows participants who considered the visual element important to the understanding of the space and those who did not use the visual element during the listening test.

Participant number	Comment	Comment
1	-	Visual element helped with answering the questions
2	Concentrating really hard on the sounds and so didn't pay much attention	-
3	Found images confused my perception	-
4	Preferred to close my eyes	-
5	I was very focused on listening to the tracks and didn't really pay too much attenstion to the visual elements	It was useful to have pictures included
6	If I used them	Pictures would/ do influense your hearing
7	-	The visual element helped to better understand how the reverberation of the recordings could have occurred
8	tha lack of the visual element helped and closing my eyes helped more	-
9	I was concentrating on the headphones, I'm not sure to have taken account of	-

	the picture properly	
10	-	Visual images certainly helped place the listener in a setting and informed expectations of the sound
11	The visual elements did not make much of a difference	-
12	-	The addition f the visual element was useful for questons 1 and 2
13	It did not help	-
14	I did not pay much attention to the visuals	-
15	-	Yes the photos helped

10/15 of the participants suggested that they didn't find the visuals provided were helpful for this test, but 7/15 suggested that the use of a visual helped them understand the space they were in or found them useful for the test. I think the very nature of a listening test makes one concentrate totally on what one is listening to; and some participants (2) suggested they found it easier to do so when they closed their eyes.

However, some participants suggested that the visuals helped to place them in the test. It gave them an understanding of the space "*Visual images certainly helped place the listener in a setting and informed expectations of the sound*" (Participant 8). I suggest that if the audio was an added element which was being consumed equally with that of the visual it enriches the experience of the space.

7.5   Conclusions

This case study did not provide me with the results I was expecting. I had assumed that the addition of the visual element would improve the results of the listening test particularly with the first questions on localisation.

However, the qualitative answers suggest that the addition of the visual helps to engage the listener with the space and offers a better understanding of the space. If we are interested in using auralization as a way to understand a space and use it to engage with the experience of the medieval period it should be consumed alongside the images. The way the questionnaire was presented and the questions asked did not consider these elements and instead focussed the listener towards the audio element ("*I was concentrating really hard on the sounds and so didn't pay much attention" (*Participant 2)).

To further embrace a multisensory engagement with space I suggest that the research into audio and visual experience be undertaken in combination i.e. use the combination of the background research and survey to discuss the experience of a space.

Chapter 8:   Conclusion

My thesis shows how digital techniques can be used to explore lived experience in late medieval buildings. I present two case studies that implement two different techniques to investigate living within late medieval buildings.

Chapter 1 introduced what late medieval secular buildings were and how they have been studied by a number of disciplines. I concluded by discussing how the phenomenological way of thinking has developed from prehistoric studies and is now being applied to the medieval period. It has been criticised as being too subjective, which is not entirely true. The phenomenological way of thinking encourages the individual to engage critically with how our own experiences have affected our interpretations of the past. By acknowledging the subjective elements of our understanding we can identify how these affect our interpretations of data, sites and artefact.

Digital techniques have developed extensively in the last twenty years and in the last ten they have been rigorously critiqued which I discuss in detail in chapter 2. Visualisations, when undertaken systematically, can be the result of a continual dialogue bringing together groups of experts (potentially from numerous disciplines) to develop a model which they feel enhances their understanding of the material evidence. The discussion surrounding visualisation has also to some extent grown stale. In the same way that we cannot know what late medieval buildings mean and we cannot access exactly what a late medieval person experienced in everyday life we cannot find a perfect method of presenting uncertainty in the past. Uncertainty is present in every single visualisation of the past, each one is an interpretation based on more or less material evidence, experts input and artistic talent. Representing this uncertainty through a single image and maintaining a level of authenticity is not possible. Instead through my first case study I demonstrate a technique which allows us to explore the everyday experience of Bodiam Castle through the creation process of making a 3d model.

My case study at Bodiam Castle is presented as a narrative for the creation and decision making process of creating a three dimensional model. The resulting creation can be seen as an interpretation of the experience of living in the

private apartments at Bodiam castle. It has drawn together expertise and elements of different bodies of research to create a final image. However, as discussed at the end of chapter 3, I decided to present it alongside some of the elements which formed its creation. I assessed these images to try to determine how people today engage with three dimensional models and see how this affects their conception of the experience of a medieval building. The assessment highlighted that the participants did not feel the stand alone renders worked effectively alone. The results demonstrate that, in order to access a lived experience of site, more than just a digital interpretation needs to be presented. The presentation of digital models is particularly relevant to heritage bodies. In an age where 3d models, reconstructions and visualisations of the past are considered a popular method for interpretation my thesis highlights that this is not necessarily true. Viewers like to see the digital models but are naturally sceptical of them. Instead they are interested in the evidence behind their construction. Presenting the models via a series of mood boards allows these interpretations and evidence to be detailed alongside the 3d images.

A digital visualisation can envision the past but it cannot realise a truly authentic experience of the past. Phenomenology has contributed a significant amount to the discussion of a multisensory past. The second part of chapter 2 brought together the extent of the research to date exploring the options for an acoustical engagement with the space. Its impact has yet to be taken up by those working in archaeological computing. Most studies are undertaken either through a theoretical mind-set or by teams of archaeologists and acousticians who have not developed a complete dialogue about each discipline's intellectual perspective, structures and traditions. Matthew Johnson discusses this as an issue in interdisciplinary studies approaching the medieval period (Johnson 2012b). In fact I think this is a deeper issue relating to collaborations as a whole. Project partners need to understand and engage fully with different disciplines' techniques to understand their capabilities. However, at the same time engaging with experts means taking advantage of expertise and must be acknowledged as a sensible methodology.

In reference to acoustical approaches to the past, neither acousticians nor archaeologists nor theoretical archaeologists have taken the methodology to its full potential; as with visualisation. Nor has it been critiqued as intensively

as visualisations (discussed in Chapter 2). In my second case study I provide an assessment of the accuracy of acoustical modelling at the Great Hall in Ightham Mote. I have taken the time to familiarise myself with the study of building acoustics to undertake an informed engagement with the methodology. By undertaking an assessment of the modelling technique I have demonstrated how archaeologists struggle to engage with what the technique is capable of doing. I have then used it to begin to question how the soundfield would have affected the lived experience of the space in the medieval period. Through this methodology I have sought to understand how the construction of the building would have affected the experience of the acoustical space. Thinking about the building in this context rather than a purely visual way allows us to engage with the personal experience of a space which is often departed from when consuming visualisations. The exploration of which elements of a building affects the soundfield allows us to think about decisions the builders may have made during construction which, whether they knew it or not, affected how the space sounded. The exploration of these elements also allowed me to question the use of the space. I have highlighted how documentary evidence (discussed by Woolgar [2006]) suggests a quiet formal understanding of the medieval gentry hall; while the acoustical properties of the building suggest that this would be difficult to realise. However, to understand this more fully a wider study discussing a range of different sizes and shapes of spaces would be necessary.

This thesis demonstrates the advantages of two separate methodologies for exploring lived experience in late medieval buildings. It provides new ways to think about the experience of a building beyond a written narrative. However, as I discussed in my final chapter: to some extent these methodologies taken independently do not allow us to access the lived experience of a medieval building. Both case studies in fact isolate a single sense when in fact experience is multisensory.

Chapter 7 details a short project which highlights how the senses work in combination. The results of the questionnaire suggest that how the senses work in combination is actually far more complicated than we assume. At the start of the case study I assumed that adding a visual element to an auralization would give more accurate results when comparing auralizations. In fact the opposite was true. Therefore to understand how we think about lived

experience using digital techniques ideally needs to be undertaken in a multisensory way. Studies of synthesia in relation to game design highlighted this. Sound systems are used towards a deeper immersive experience in game play through both diegetic (sounds relating to the actions of the player) and non-diegetic sound (background music) (Collins 2008). However, what game design has learned and what archaeologists are catching up to is that the relationship between vision and sound contributing towards immersive experience is more complex than just the inclusion of sound improving engagement (Hulusic et al. 2012).

In fact as McMahan discusses total photo and audio realism is not necessary for encourage a sense of immersion and it is the balance between the two that needs closer examination (McMahan 2003; Southern et al. 2009). Critically this thesis provides a starting point of combining two different methodologies with the aim of exploring multisensory experience. Although the results were not obviously advantageous they provide a starting point for discussing the complexity of experience. There is obvious potential for combining these two techniques towards multisensory engagement and a wider understanding of the use of space within these buildings.

The work has been presented to the National Trust Archaeologist for the south-east and the property managers at both Bodiam and Ightham. Some of the findings (particularly the outcomes of the *Elite Landscapes in South Eastern England* project) have aleady been incorporated into the onsite interpretation and narratives of the places. A monograph detailing the results of the *Elite Landscapes in South Eastern England* project is in progress for publication in 2016 with input from the Trust: the results of this thesis are the focus of one chapter and detailed in another.

8.1   Future work

My thesis is just a starting point for engaging with lived experience and digital techniques applied in combination. There are a whole range of projects which could implement these techniques both independently and in combination.

In terms of visualisation, displaying the results of the modelling process through mood boards can be applied in other ways not solely based on a three dimensional model. In chapter 3 I discussed the study of heraldry at Bodiam.

The placing of heraldry is more complex than simply ownership. In placing coats of arms at the gates of Bodiam, Dallingridge is making statements about his social network. The use of heraldry can be read in different ways by different people and makes up a visual language that is understood in a specific way in medieval life. A mood board bringing together these different coats of arms with a series of the meanings and uses of heraldry can begin to draw together different ideas about the consumption of heraldry in medieval life.

In the first instance it would be good to take the work at Ightham Mote further by creating a more complex version of the Great Hall. The case study discussed in this thesis was the first step in modelling, we have since created a more complex model using a total station to record the complex detail of the roof. We need to undertake a second listening test to explore how the resulting auralizations compare the originals and see if a more accurate survey creates a more accurate model to start with. The modelling stage in the auralization process is the most important if we are to accurately calibrate a model before making changes to room to represent it accurately in the past. I also feel that we can ask questions about the use of halls across buildings of different social status. By undertaking the same modelling techniques in halls of different sizes, such as Penshurst, which is much larger and the Bayleaf Hall would provide a good way to begin to understand them as a feature at the centre of a medieval household.

Moving beyond the scope of these projects there are a series of other applications for acoustical techniques. I have demonstrated a methodology for exploring sound within the Great Hall at Ightham Mote and how this could be used to discuss the experience of that space. I suggest that this work could be taken further to explore the understanding of ownership throughout the building. Archaeologists have used different methodologies for exploring movement and space within a building. I suggest that we consider the same with sound. I suggest modelling how sound moves through a building i.e. which spaces can be overheard from where. The aim being to see how these relationships fit with our understanding of the space.

Throughout this thesis I have focussed entirely on secular buildings. I have avoided church architecture as I believe that the study of ecclesiastical sites

isn't necessarily able to inform us on what is relevant to households. As the focus of this thesis is on secular buildings we must ask different questions of religious buildings. While ecclesiastical sites are concerned with different types of living, the questions I am asking in this thesis on secular sites are to do with use of space between public and private, and how medieval society perceived these differences, which are fundamentally different in religious contexts. However, I think there are a large number of projects in ecclesiastical architecture to which acoustical techniques would lend themselves; particularly in the placing of rood screens in medieval churches affecting the experience of sound throughout the building. Modelling the acoustical properties of a space to compare how services are heard in different parts of the building would provide an interesting starting point to discussions on a status based understanding of a church. This could be a very interesting place to produce a series of visualisations as well. Medieval churches were brightly painted and often covered in different types of graffiti. A model of the space of buildings such as these would provide an interpretation of the interior of a building rarely seen.

Finally this project was made possible as part of a collaboration with the National Trust. It is easy to understand how they can use the results of the visualisation project, but acoustics is more of a challenge. I suggest that a useful engagement for visitors would be a series of GPS logged auralizations that could be downloaded and explored when visiting outdoor sites. At Bodiam an auralization of the mill allowing the visitor to explore its constraints and listen to the sound of a building of that type would be a useful implementation.

These are just some of the many possible implementations of the methodologies this thesis suggests. Visualisation is an established methodology within archaeology but it has yet to be fully embraced as a research tool, recording technique or as a style of presentation. Embracing the creation process can lead to a well-developed methodology for understanding the experience of place from all the material evidence available, documentary, art historical and archaeological.

In contrast, archaeacoustics is an exciting emerging field. It shows the beginning of a move towards full multisensory engagements of space and lets us question our understanding and interpretation of the archaeological record

to date. However, it needs to be undertaken with the rigour seen in visualisation for the potential for projects, which there are many, to be fully realised. A strong grounding in both theory and practise is needed for projects to be undertaken successfully.

As such a project exploring interdisciplinarity to draw out how teams with different backgrounds can work together would be appropriate to encourage stronger collaborations and set a practise for working that will benefit both teams.

Appendices

Appendix A License to Crenellate

"

The king to all men to whom etc. greeting. Know that of our special grace we have granted and given license on behalf of ourselves and our heirs, so far as in us lies, to our beloved and faithful Edward Dalyngrigge Knight, that he may strengthen with a wall of stone and lime and crenellate and may construct and make into a Castle his manor house of Bodyham, near the sea, in the County of Sussex, for the defence of the adjacent country, and the resistance to our enemies, and may hold his aforesaid house so strengthened and crenellated and made into a Castle for himself and his heirs for ever, without let or hindrance of ourselves or our heirs, or of any of our agents whatsoever. In witness of which etc. The King at Westminster 20 October. (Blaauw 1861)"

Appendix B Dallingridge Family Tree

Dallingridge family tree

Legend:
- Dallingridge
- Owned Bodiam
- Married into the family

Family tree entries:

- Sir Roger
- Alice
- Sir Roger / John 1315-1380
- Joan
- Sir Edward 1346-1395 inherits 1377
- John 1383?-1407 inherits 1395
- Alice d. 1447 inherits 1407
- Elizabeth
- Margaret
- Sackville
- William
- Walter
- Richard d. 1469 inherits 1447
- Philippa inherits 1469
- Thomas Lewknor
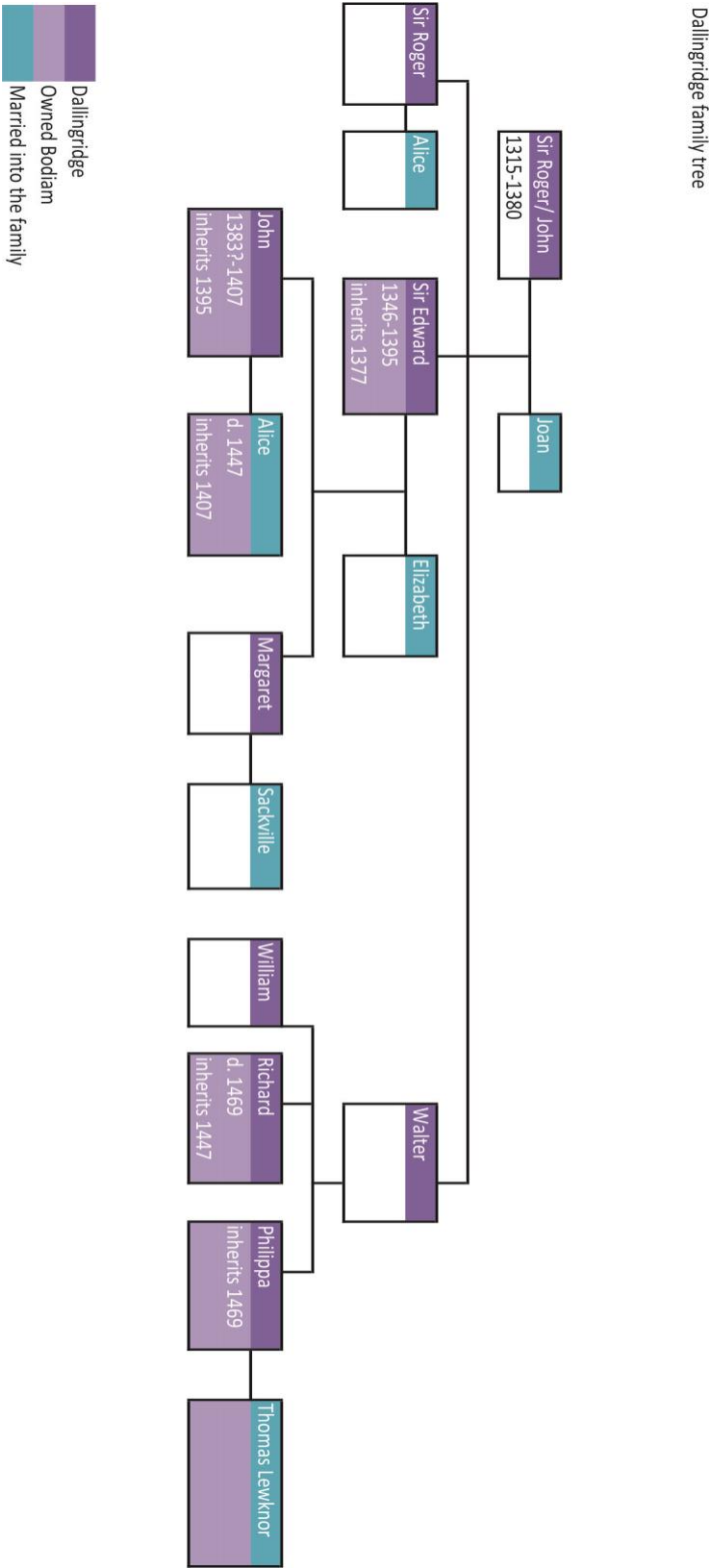
Appendix C Blog Posts

Throughout this thesis I have blogged on various elements which have influenced the modelling process to allow people to comment on and discuss my decision making process. They have not been added to this paper document but can be referred to via the blog itself at http://catrionacooper.wordpress.com or in the folder of supporting materials titled "blog".

Appendix D Finds from Bodiam

The following spreadsheet is a list of finds from Bodiam Castle that could date to the 14th century. It is compiled from a catalogue of finds listing all the material held within the Bodiam archive (Gardiner et al. 1994). Material comes from three sources:

- The clearance work undertaken by Lord Curzon in the early 20th century
- Finds collected in the locality
- Excavations undertaken in the 1970s.

Details of the appearance of the pottery fabrics are as follows other information on form was not available.

Bohemia Kilns

Fabric colour is variable and ranges from full grey through to pink. Occasionally brick red fabrics are present (Gardiner et al. 1994: 4).

Rye Ware

No description

Winchelsea Black Ware

Reduced fabric giving a black colour?

Surrey Type White Ware

Off-white to buff fabric surfaces range from off-white to pinkish or light orange. The glaze is patchy and external and usually green with yellow patches.

Medieval grey sandy ware

Grey

Medium sand and grog: grog-rich variant
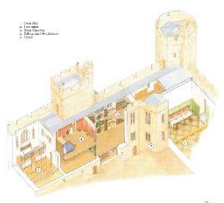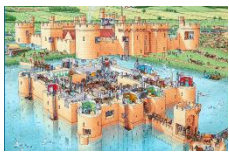
Surfaces are usually pinkish buff with dull red or orange margins and cores. Glaze is rare and when present is patchy on and found on the interior of the vessel usually brown in colour. Brown slip is occasionally present as well.

Siegburg salt-glazed stoneware

Fabric is fine, compact and off-white to light grey- in colour. Most vessels appear to be long-necked jugs with heavily rilled bodies and frilled bases.

Bodiam Castle finds from c14th century

Box	Group	Type	Object?	Description	Date	Other information
Box 1	B3	Siegburg salt-glaxed stoneware	Jug	Body sherd	C14th-16th	
Skip 1	F7	Medieval Grey sandy ware	Cooking pot	2 body sherd	C13th-14th	
Skip 3	L22	Bohemia kilns	Cooking pot	Rim sherd	C13th-14th	
Skip 4	M28	Winchelsea Black	Jug	Handle	C14th	Black
Skip 4	O32	Medium sand and grog: grog-rich variant	Jug	Base sherd	C14th-15th	
Skip 5	P38	Medieval Grey sandy ware	Cooking pot	Body sherd	C14th	Grey
Skip 5	P38	Rye fabric	unknown	Body sherd	C14th-15th	Red-buff
Skip 5	P39	Rye ware	unknown	Body sherd	C14th-15th	Dark brown-grey
Skip 5	P39	Medium sand and grog: grog-rich variant	unknown	Body sherd	C14th-15th	Splash of glaze
Skip 5	P41	Rye ware	unknown	Body sherd	C14th-15th	Grey face
Skip 5	p41	Medium sand and grog: grog-rich variant	unknown	Body sherd	C14th-15th	Oxidised with pitted exterior
Skip 5	P41	Medium sand and grog: grog-rich variant	unknown	Body sherd	C14th-15th	Oxidised fabric with slight rilling on interior grog protruding from surface
Skip 5	P46 A	Rye ware	Jug	Neck	C14th-15th	
Skip 5	P47	Surry white ware	Jug	Body sherd	C14th-15th	Fine white ware
Skip 5	p47	Rye ware	Jug	Body sherd	C14th-15th	
Skip 5	Q50	Fine sandy late medieval	Jug		C14th-15th	external green glaze
Box 1	Well in silt	Medieval Grey sandy ware	Jug/pitcher	22 sherds	C14th-15th	Some glazed with incised line dull green
Box 1	Cutting 2	Norwegian ragstone	Whetstone fragment		C12th-17th	Square-sectioned with shaper taper to stone one point sharpening groove on one face
Box 2	Cutting 3	Medieval Grey sandy ware	unknown	Body sherd	C13th-14th	Black sand and iron ore inclusions

Appendix E Critique of different visualisations of Bodiam Castle

Visualisation	Created by/ use	Critique	Figure
	Trust/ Goodall	Viewpoint from above means that understanding of the space is designed as an overview not a personal perspective. Lack of people presents it as a site not as a place.	Figure 64
	Still	Lack of soft furnishings, lack of gaudy decoration. No people. The ceiling is not open as one would expect from the upper apartment which is where the fireplace is from.	Figure 72
	Still	Taken from above, designed to give understanding of the layout of the site, but not from the medieval psyche as it is not a view which would have been possible during this period.	Figure 70
	Still	Courtyard does not provide a known access point to the cellars and in fact cuts windows across.	Figure 71
	Stephen Biesty/ Hodder	The castle is presented as a whole, not how it would have been understood in the past as it is from a viewpoint you could	Figure 75

		not access. Cannot really see what is happening in the space	
	Mark Needham	Allows interactivity but spaces are unfurnished and undecorated meaning that the site is not presented to give an understanding of the medieval space.	Figure 76
	Physical Model	Cannot view the internal spaces.	Figure 73

Appendix F Will of James Peckham

JAMES PEKHAM of Wrotham. Wednesday in the Feast of Saints Nerei, Achillei and Pancras, martyrs, 1400. To be buried in the churchyard of St. George the martyr of the parish church of Wrotham. To the high altar 13s. 4d. To the fabric (fabrice) of the said church 26s. 8d. To the light of Blessed Mary 2 cows. To the Sacrist 3s. 4d. To two clerks of the said church each 3s. 4d. To the high altar of Igtham 6s. 8d, and to the fabric 10s. To the light of Blessed Mary there a cow. To the high altar of Kemsynge 6s. 8d, to the fabric 10s a cow (sic ?last for St. Mary's light as previously).

To a chaplain to celebrate in the church of Wrotham 5 years for my soul and the souls of Margery and Lora my wives and for the souls of John and Elen my father and mother, of William and Alice de Pekham, Agnes and Joan my sisters, John my brother, Martin and Margery de Pekham, Thomas Chanus, Simon Jekyn, Thomas Eouene (?), Jam Bokeland and Joan his wife and for the souls of all my kinsfolk and benefactors and all faithfully departed 45 marcs. On the day of my burial to be distributed between poor folk to each coming to pray 1d, and on my year's day 1d.

To Elizabeth my daughter a bed of 'Northfoke' with tester, celur, with tapestry of green and powdered with 'popyngaies' and with 'curteyns de blewairde'.

To Robert Frounceys 20s, Thomas Conk chambirleyn 100s, John Honte 20s, Katherine Frounceys wife of Thomas Tourns 6s. 8d, Lawrence Eyton 40s. To all foreign (forencis) servants at Aldham and Goldsymthes each 3s. 4d. To John Bechet 13s. 4d. To the Prior and Convent of Rochester to pray for me my parents etc., 40s. To each house of Friars in Kent 13s. 4d. and in London 13s. 4d. To John Carter 20s.

To Thomas my son a bed of 'Northfolk' red and black with three curtains of the same suit with a celure and two tapestries of 'tapestwerke' of the same suit and with costers of of the same suit. To the said Thomas a bed of 'Tapestrie-werk' with a tester in which is made a Castle and in the Castle sitting a Lady. Also a coverlet and a tester of 'Northfolk' powdered with leaves and flowers, three curtains of with tester and celur complete, a piece of silver with cover, 6

silver spoons, six "doseyngum de vessell de peuter garnysshid" with four 'chargeours' a basin and ewer, three brass pots of the best, two best dishes, a 'gredhirne' of iron, 4 iron spits (brocha) a "hall" with costers and bankers and guysshons of black and red worsted. If the said Thomas departs From this life, quod absit, then they shall remain to Reginald his brother, and if he die then to James brother of the said Reginald.

I leave to Reginald my son a coverlet with the tester of green with 'chapelett' and roses three curtains and a celdure complete of "bleweared", four silver spoons, a hauberk and basinet with 'le venraill' a pair of gloves (cerotecarum) of 'platys' and my best sword, a materas and a blanket.

I leave to James my son a bed of 'Blewet' with 'chavelett and roses de plonkett' with the tester of the same suit a materas and blanket two silver spoons and a sword.

I leave to Thomas my son a long fur of 'calabri' and a fur of 'foyns'. I leave to Reginald my son a long fur of 'foynes', a long fur of 'calabr' and a short fur of 'calabr'. [probably furred gowns or coats]. To James my son a long fur of foyns and a long fur of calabr. I will that the garments of my body be distributed amongst my attendants (famulos). I leave to Stephen Nortone a silver girdle which he has and was Rogers Dygg's. To Alice wife of Stephen Norton a pair of silver and gilt 'bedes' and a maser cup. To the Prior and Convent of Tunbregge 40s to pray for my suol. To Sir William Tanner, master of the College of Cobham 40s. To 4 perpetual priests of the same college each 13s. 4d. To each other priest there 6s. 8d.

To John my bastard son called Wrotham 40s.   To Jenicus 'famulo meo' 20s, John Kyng 20s and Stephen Norton 10 marcs if he will be supervisor of my will. To the Prioress and Convent of Nuns of Hegham 40s.

To Alice my daughter nun there 20s. To Sir John Thorston chaplain 10 marcs if he will be executor of my will. To John Kirkely Lord of Hortone outhe same condition.

To Elizabeth my daughter a piece of silver with cover. To Richard Sewer husband of the same Elizabeth a "doseyn de vessel peuter engarnysshed". I will my executors ordain four rings of gold of the finest work in each ring to be written "Pense de moy" each ring worth 40s to be given to John de

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Frenyngham, John Culpepir of Oxonode, William Makenade and Thomas Brokehill if they are alive after my death that they may help to fulfil my will. I leave to find another chaplain to celebrate in the parish church of Wrotham six years for the soul of Edmund Stepilgate and for the souls of all those to whom I am in any way bound, £6 per annum. To Hugh Frentor 40s, Sir John Thorston chaplain a gown of black worsted furred with "Bewer" (beaver).

Executors: Sir John Norton chaplain of the Collegiate Church of Cobham, John Kirkeby Lord of Horton and supervisor Laurence Eyton.

Codicell. I James de Pekham seeing the day of my death approaching I do not revoke my testament but rather it should be fulfilled. The last day of September 1400. I leave to William Atte Hothe 20s, Sir John Thorston chaplain 5 marcs, to Reginald my son of my goods at Chyuenyngg 10 oxen 200 sheep a plough with all the belongings. I leave to Elizabeth my daughter a white gown furred with 'menyuer'. To Johan wife of Robert Chamberleyn a qr. of wheat and a cheese (caseum).

I leave for two stones to be bought of which one to be placed upon the bodies of my sons buried in the cemetery of the church of Cobham and the other over my body 20 mrcs. To each clerk in the church of Cobham 12d. To each boy serving in the same 4d. I will that my executors distribute all my French books to those knowing them with the intention they shall pray for me.

It is the intention and will of James de Pekham that it should be performed by those who hare his executors and those enfeoffed of his lands and tenements at Aldham. Monday next after the Feast of the Assumpcion of Our Lady in the first year of the reign of our Lord the King Henry the Fourth since the Conquest.

First the said James wishes that his feoffees hold in their hands all lands and tenements with their appurtenances of which they are enfoeffed by him for six years next after his death to fulfil his will. And the said James wishes his executours to take the profits of all his said lands and tenements for the term of six years to perform his will and testament.

After the six years his feoffees to enfeoff Reyginald his son in the manor of Aldham and all the lands and tenements of Blakesole and Goldsmythes and all the lands in Everhamme, Stonpette and Fotes and all the lands and tenements and rents in Igtham and all the lands and tenements and rents of Wynnefeld and Hegherouche and all the lands etc. called 'le Sole' and all the lands etc. which the said James has in Wrotham and wish la pree en Pekham to have and to hold to him and his heirs males on condition that the said Reginald make a state to James his brother of all his part of all the lands and tenements etc. which fall to him after the death of Lora his mother in the manor of Chyuynyg and in the manor of Werehorne.

And if the said Regnold die without heires males the remainder of all the said lands etc. to the said James his brother his feoffees to enfeoff James his son and his heirs males in all the lands etc. called Newenham and al the lands called Romschede and all le pree called Gretenerssh in Otteforde and all the tenements called Pelesholte in Wrotham. If James dies without heirs male then Newenham Romschedde Gretenerssh in Otteford and Polesholte in Wrotham to remain to Reginald, brother of the said James and if Reginald die then to the right heirs of James Pekham father of the said Reginald.

His feoffees to make an annual rent of 13s. 4d to Goberd Fraunceys for the term of his life of the tenement 'de la Sole' and the annual rents to Alys his daughter and to Goterd Fraunceys are to be annexed to the feoffments made to Reginald and James.

And the aforesaid James wishes his executors to sell the wood called Le Hoke to perform his will. If James and Reginald die without heirs then Elizabeth his daughter to be enfeoffed in all lands to her and her heirs called Wynefield and the mill called Sole in Wrotham and all other lands etc. to be sold and the profits distributed in alms for him his father mother and friends.

Proved (fol 176b) 11 October 1400 by William Tannere Master of the College of Cobham and Master John Appelton vicar of Watryngbury and Commission issued to John Thorston chaplain perpetual of the College of Cobham, John Kirleby Lord of Horton executors and Stephen Norton supervisor. Dated Cobham 20 November 1400. (KentArchaeologySociety 2004) (Lambeth, Arundel, v1, f 170 v)

Appendix G Will of Sir Thomas Couen

"This is the Will and intention of Sr. Thomas Couen, Kt., with regard to the feoffment made of all his lands and manors, to Sr. Thomas Moraunt, Kt., James de Pecham, Robert Atte Beche, Rector of the Church of Eyghtham, John Langhere, Rector of the Church of Mereworth and John Hasleden, Vicar of the Church of Wrotham, as appears in a certain deed. First: after his death, the aforesaid shall enfeoff Lora, his wife in the manors called Aldham, Hastynglegh, Werhorn, and Snave, with all their pertinances, for the term of her life. Also, when Robert, his son, shall come to the age of 21 years, he being six years old at the date of these presents, they shall enfeoff the foresaid Robert in the Manor called La Mote with all the lands which he had in the parishes of Seele, Eyghtham, and Shiborne, to the foresaid Robert, and the heirs of his body lawfully begotten; and, in like manner, when Thomas, son of the aforesaid Thomas, shall come to the age of twenty-one years, being now three years old at the date of these presents, they shall enfeoff the said Thomas in the manors of Crofton and Berstede, to the foresaid Thomas, and the heirs of his body lawfully begotten.

And, if the foresaid Lora, wife of the said Thomas, keep herself sole and chaste without a husband married to her, she shall have the wardship of the foresaid Robert and Thomas, his sons, and of all his sons, with all the profits of the foresaid tenements and manors of La Mote, Croftone, and Berstede, until the said Robert and Thomas come of age; and if she do not keep herself sole, the said feoffees shall have the wardship of the said Robert and Thomas; and all the profits of the foresaid manors of Mote, Croftone, and Berstede, over and above the maintenance of the foresaid Robert and Thomas, shall be delivered to the aforesaid Robert and Thomas, when they shall come of full age. And after the decease of the said Lora, all the foresaid manors of Aldham, Hastynglegh, Werehorn, and Snave, shall remain to Robert, son of the foresaid Thomas, when he is of full age, and to the heirs of his body lawfully begotten; and if it happen that the said Robert die without heirs of his body, all the foresaid manors of Mote, Aldham, Hastynglegh, Werhorn, and Snave, shall remain to Thomas, his brother, son of the foresaid Thomas Couen, and the heirs of his body lawfully begotten. And if it happen that the foresaid Thomas

die without heirs of his body, the foresaid manors of Croftone and Berstede shall remain to Robert, his brother, son of Thomas Couen, and the heirs of his body lawfully begotten.

And if it happen that the foresaid Robert and Thomas die without heirs of their bodies lawfully begotten, all the foresaid manors shall remain to the heirs of the said Sir Thomas Couen, Kt., lawfully begotten; and if there be no heir of his body, Lara his wife surviving, the said Lora shall have all the foresaid manors, for the term of her life; and, after the decease of the said Lora, all the foresaid manors shall be sold by the said feoffees, and £200 shall be distributed among the poor relations of the foresaid Thomas Couen, at their disposal; and, in like manner, £200 among poor labourers, neighbours of the said Thomas, who have little to maintain themselves. Also £200 to be distributed among the religious brotherhoods of London and Kent, to celebrate masses for his soul, and the souls of all the faithful. Item, he ordained, for one window to be made in the north part of the Church of Eyghtham, near the altar of St. Mary xx li. Item, for repairing a road from Crepehourste … as far as Colverden crouche, xl li. The remainder of the sale of all the fore said manors, to be distributed for the soul of the foresaid Thomas. (Taylor 1863)

Appendix H Results of the Visualisation Questionnaire

The results of the acoustics project subjective analysis questionnaire can be accessed via the supporting documents as VisualisationProjectResults.xslx

Appendix I   Documents relating to the mill at Ightham Mote

Ightham Mote watermill - doc evidence of a messuage & watermill (Grofherst)

Temp EIII: Alice, who was the [previous] wife of John Kenewy, sued John Kenewy and his [present] wife Margaria for 38a land, 1a wood and 6s 5d rent as well as one messuage with appurtenances in Eghteham. John and Margaria and the heirs of Margaria admit it is the right of Alice and her heirs and receive 60M for the concession. (no mill is mentioned but the transaction relates to the next in the series)

1324: John Kenewy and his wife Margaria made a plea against Bertinus Ruffyn regarding a moiety of one messuage with appurtenances, 38a land, 1a wood, *a mill,* and 6s 5d rent at Ighetam. The property was found to be the right of Bertinus (for the concession of 60M) but he regranted it immediately to John and Margaria Kenewy. Presumably Bertinus Ruffyn was the heir of John's previous wife, Alice, and the plea was made in order to allow Bertinus to grant the lands back to the Kenewys. I don't know why the mill wasn't mentioned in the previous plea - I assume it was part of the property all along as the rents and lands are the same in both pleas.

1325: John and Margaria Kenewy's right to a moiety of *a watermill* with appurtenances, 1a land and 2a ossier *by the way the Hegteham* was challenged by a Richard de Grofherst. This is evidently the same mill as was sued for in the above 1324 plea. Richard won his right, paying a concession of 100s.

1326: Richard sued William Heuyhatche and his wife Agnes for a messuage with appurtenances and 50a land in Eytham and Shipbourne. He paid a concession of 40M to claim his right. Although it is not certain that this messuage is one and the same with that sued for in 1324, the name Heuyhatche is an early rendering of the place name Ivy Hatch, the cross road upon which Ightham Mote lies, and Richard's earlier interest in the mill indicates that it is all one place. The previous moieties of the manor sem to

have rejoined at this point because there is no mention in this document that the Heuyhatches only held a part, and the lands are in both Ightham and Shipbourne where previously they were just in Ightham. Either way, it's fairly clear that today's Ightham Mote at Ivy Hatch is the same estate as the one in these transactions, and that the mill and the Mote are part of the same property.

Appendix J Acoustical Survey Questionnaire

Ightham Mote Acoustics Test

This question we will be discussing Localisation of a source in the Great Hall.

1. Below are four images of the same room from different perspectives. You are standing in the sphere and sound is coming from one of the loudspeakers. Which loudspeaker you think the sound is coming from? **Track 1**

A   B   C   D   E
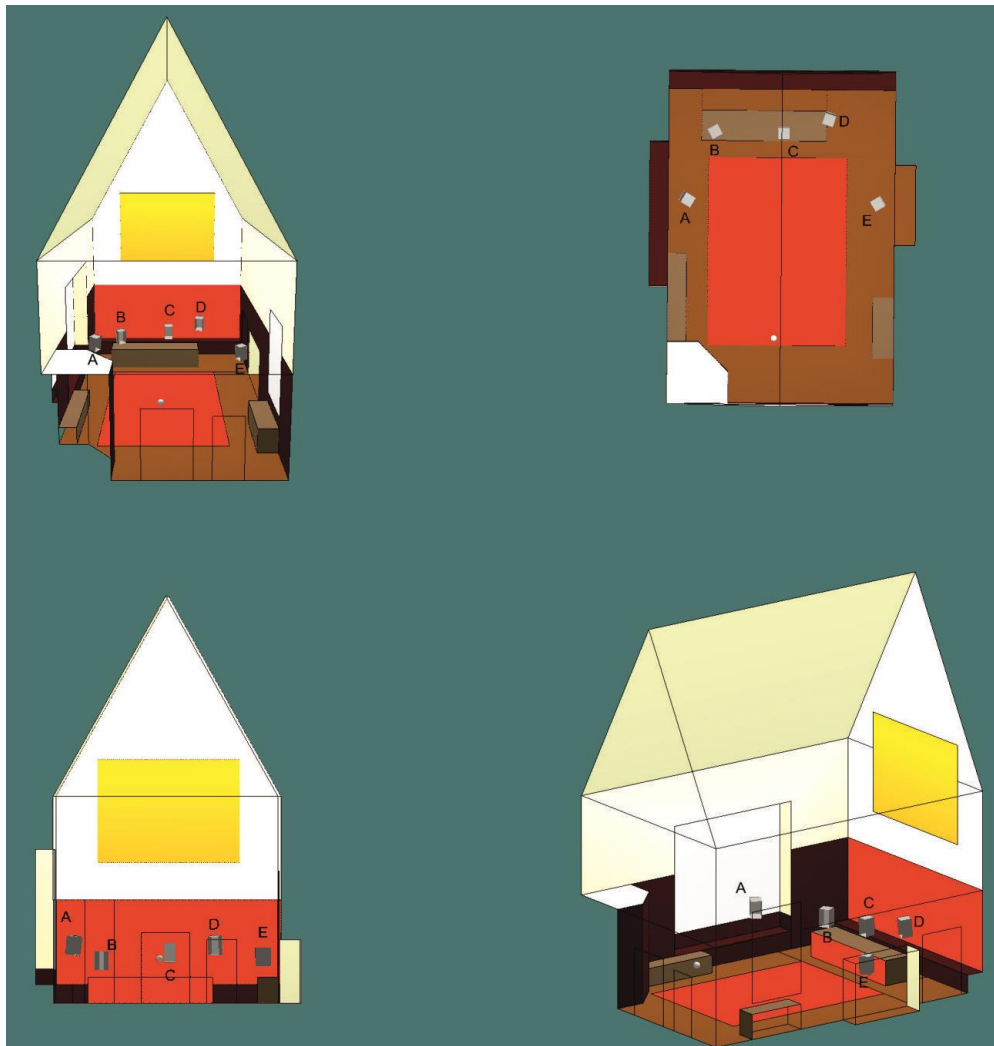
2. Above are four images of the same room from different perspectives. You are standing in the sphere and sound is coming from one of the

loudspeakers. Which loudspeaker you think the sound is coming from?

Track 2

A   B   C   D   E

3. In this question we are asking you to compare 4 spaces, please order them on a scale of 1 to 5 according your sense of reverberation   (**RATE THEM AFTER TO LISTEN THE 3 SPACES**).

Less reverberation   **More reverberation**

Track 3

1   2   3   4   5

Track 4

1   2   3   4   5

Track 5

1   2   3   4   5

Track 6

1   2   3   4   5

Hard to understand the speech   **Easy to understand the speech**

Track 7

1   2   3   4   5

Track 8

1   2   3   4   5

Track 9

441

	1	2	3	4	5

Track10

	1	2	3	4	5

We are now asking you to compare track 4 with track 5

4. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same   Don't know

5. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same   Don't know

We are now asking you to compare track 7 with track 9

6. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same   Don't know

7. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same   Don't know

8. In this question we are asking you to compare 4 spaces, please order them on a scale of 1 to 5 according your sense of reverberation   (**RATE THEM AFTER TO LISTEN THE 3 SPACES**).

Less reverberation   **More reverberation**

Track11

	1	2	3	4	5

Track12

	1	2	3	4	5

Track13

| | 1 | 2 | 3 | 4 | 5 |

Track14

| | 1 | 2 | 3 | 4 | 5 |

Hard to understand the speech **Easy to understand the speech**

Track15

| | 1 | 2 | 3 | 4 | 5 |

Track16

| | 1 | 2 | 3 | 4 | 5 |

Track17

| | 1 | 2 | 3 | 4 | 5 |

Track18

| | 1 | 2 | 3 | 4 | 5 |

We are now asking you to compare track 12 with track 13

9. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same Don't know

10. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same Don't know

We are now asking you to compare track 16 with track 18

11. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same Don't know

12. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same Don't know

In this question we are asking you to compare 2 spaces,

13. Please order them on a scale of 1 to 5

Less reverberation   **More reverberation**

Track 19(old)

    1   2   3   4   5

Track 20(New)

    1   2   3   4   5

Hard to understand   **Easy to understand**

Track 21(new)

    1   2   3   4   5

Track 22(old)

    1   2   3   4   5

Very fake   **Very real**

Track 23(old)

    1   2   3   4   5

Track 24(new)

    1   2   3   4   5

We are now asking you to compare track 25 with track 26

14. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same Don't know

15. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same Don't know

We are now asking you to compare track 25 with track 27

16. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same   Don't know

17. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same   Don't know

We are now asking you to compare track 26 with track 27

18. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same   Don't know

19. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same   Don't know

We are now asking you to compare track 28 with track 29

20. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same   Don't know

21. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same   Don't know

We are now asking you to compare track 28 with track 30

22. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same   Don't know

23. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same   Don't know

We are now asking you to compare track 29 with track 30

24. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same   Don't know

25. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same   Don't know

We are now asking you to compare track 29 with track 4

26. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same Don't know

27. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same Don't know

We are now asking you to compare track 26 with track 4

28. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same Don't know

29. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same Don't know

About you

30. What is your area of expertise? (Acoustics, Archaeological Computing, Visualisation, Medieval)

……………………………………………………………………………………………………
…………………………………………………………..

Appendix K Acoustical Survey Results

The results of the acoustics project subjective analysis questionnaire can be accessed via the supporting documents as ighthamacousticresults.xslx as well as on the next page.

Questions

Participant	1	2 3 (a b c d e f g h)	4	5	6	7 8 (a b c d e f g h)	9	10	11	12 13 (a b c d e f)	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1a d	4	5 2 2	4 different	different	same	5 3 3 4 same	same	different	slightly di	different	2 4 5 5 5 3 same	slightly di different	slightly di very diffe	same	same	different	same	same	different	different	slightly di	same	very diffe	slightly di different	different	very diffe	archaeological computing
2b a	4	5 2 3	slightly di	slightly di	same	3 2 4 5 4 same	same	different	slightly di	different	2 4 2 3 same	slightly di	slightly di same	same	sa	slightly di	slightly di	slightly di	slightly di	slightly di	slightly di	very diffe	different	different	different	medieval archaeology
3e b	2	5 4 1	slightly di	slightly di	same	3 5 4 3 same	same	slightly di	different	slightly di	2 5 3 same	slightly di	slightly di same	same	same	same	slightly di	slightly di	different	slightly di	same	slightly di	different	slightly di	different	medieval archaeology
4b b	5	4 1 2 1	4 slightly di	different	different	2 4 3 4 same	very diffe	slightly di different	slightly di	3 5 4 2 same	slightly di different	slightly di same	different	same	very diffe	slightly di	different	very diffe	different	very diffe	different	acoustics
5a b	2	4 3 3	5 different	slightly di	same	5 4 3 5 different	different	different	slightly di same	3 5 4 2 same	different same	same	same	slightly di	slightly di same	slightly di	slightly di	very diffe	different	acoustics
6b b	4	4 3 3	3 same	slightly di	slightly di	4 3 4 3 slightly di	same	different	different	same	2 5 3 slightly di	slightly di same	slightly di	same	same	same	slightly di	slightly di	different	very diffe	different	acoustics
7c c	1	5 5 4	3 different	slightly di different	different	1 5 4 1 different	slightly di	different different	2 5 3 2 4 same	4 same	same	different same	sa	different same	slightly di same	slightly di	slightly di	different	archaeological computing
8c d	4	5 4 2	5 very diffe very diffe	slightly di	same	5 1 1 5 same	slightly di	different different	4 2 2 5 4 same	slightly di same	same	different slightly di	same	different slightly di	very diffe	acoustics
9d a	3	1 4 4	4 different	same	slightly di	2 4 3 4 same	same	different different	2 4 4 5 same	3 same	same	slightly di same	same	very diffe slightly di	very diffe	acoustics
10a a	4	1 2 4	5 slightly di same	slightly di	same	4 4 4 2 very diffe different	slightly di different	3 4 3 4 5 different	different slightly di	slightly di	same	slightly di same	different	slightly di	different	archaeological computing
11c b	2	4 2 5	5 slightly di same	slightly di	slightly di	4 2 5 5 same	slightly di	slightly di different	2 5 4 2 same	slightly di different	same	slightly di same	slightly di	slightly di	very diffe	archaeological computing
12b b	3	2 2 3	3 different same	different	same	4 3 4 2 same	slightly di	slightly di same	3 4 2 4 same	slightly di same	same	slightly di same	same	slightly di	very diffe	acoustics
13b b	4	2 2 4	2 different different	same	same	2 3 3 2 1 different	very diffe	slightly di slightly di	3 4 3 same	same	same	same	different	different	acoustics
14c d	1	3 4 4	1 slightly di same	slightly di	slightly di	4 2 4 3 2 same	slightly di di different	3 4 4 same	different same	sa	same	different same	different	slightly di	engineering
15a b	2	4 4 4	same	slightly di	same	4 2 4 5 3 same	same	slightly di same	4 5 same	slightly di same	different	slightly di same	same	same	different	archaeological computing
16b b	2	4 5 1 3	4 slightly di	same	same	4 3 4 5 4 same	different	different same	3 4 5 4 same	slightly di same	same	different same	same	same	different	archaeological computing
17b a	3	2 5 2	5 very diffe different	slightly di	same	4 3 4 3 3 different	slightly di	very diffe different	2 3 4 3 4 different	slightly di same	same	slightly di same	same	slightly di	different	archaeological computing
18c c	4	2 2 3	4 different slightly di	slightly di	slightly di	5 3 2 4 different	slightly di different	very diffe	2 4 3 2 same	different same	same	slightly di same	same	slightly di	different	archaeological computing
19b c	1	4 4 5	4 very diffe slightly di	slightly di	same	5 4 3 5 4 different	slightly di very diffe same	1 3 4 4 4 different	different same	same	slightly di same	same	slightly di	visualisation
20b b	3	2 4 4	3 slightly di slightly di	slightly di	same	3 2 4 5 2 4 same	slightly di	very diffe	2 4 5 2 4 same	slightly di same	different	slightly di same	same	slightly di di	medieval archaeology
21a a	3	2 4 2	5 different very diffe	slightly di	same	3 4 3 4 2 different	slightly di	slightly di slightly di	3 5 4 3 same	slightly di slightly di same	different	slightly di same	same	very diffe	acoustics
22a b	4	4 3 2	5 slightly di same	slightly di	same	1 3 3 4 5 different	slightly di	different different	2 3 4 4 same	slightly di slightly di same	different	slightly di same	same	very diffe	archaeological computing
23a b	4	5 2 3	3 slightly di very diffe	slightly di	same	2 2 5 3 4 same	different	different different	2 4 3 2 slightly di	slightly di slightly di same	slightly di	slightly di same	same	very diffe	acoustics
24b b	2	4 2 2	4 different slightly di	slightly di	same	4 3 5 3 4 slightly di	slightly di	different	1 4 3 2 4 different	slightly di slightly di same	slightly di	slightly di same	same	different	acoustics
25d c	3	5 5 5	5 different very diffe	different	slightly di	2 2 3 3 5 different	different	different	4 5 3 4 5 same	same	slightly di same	same	slightly di di	very diffe	archaeological computing
26b b	3	4 3 4	5 slightly di slightly di	slightly di	same	3 3 4 3 2 same	slightly di di slightly di different	3 2 4 4 3 slightly di di different	slightly di same	same	slightly di	very diffe slightly di different	different	acoustics

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Appendix L Statistical tests for acoustical survey listening tests

Table 14: Calculation table for obtaining chi-squared value for peoples responses to placing the source position of the auralization of a female voice.

Category	Oi (Observed count)	% of responses	Ei (Expected count)	Oi-Ei	(Oi-Ei)2	(Oi-Ei)2/Ei
a	7	20	5.2	1.8	3.24	0.623077
b	10	20	5.2	4.8	23.04	4.430769
c	6	20	5.2	0.8	0.64	0.123077
d	2	20	5.2	-3.2	10.24	1.969231
e	1	20	5.2	-4.2	17.64	3.392308
	26	100	26			10.53846

Table 15: Calculation table for obtaining chi-squared value for peoples responses to placing the source position of the auralization of a male voice

Category	Oi (Observed count)	% of responses	Ei (Expected count)	Oi-Ei	(Oi-Ei)2	(Oi-Ei)2/Ei
a	5	20	5.2	-0.2	0.04	0.007692
b	15	20	5.2	9.8	96.04	18.4692

						3
c	3	20	5.2	-2.2	4.84	0.930769
d	3	20	5.2	-2.2	4.84	0.930769
e	0	20	5.2	-5.2	27.04	5.2
	26	100	26			25.53846

Table 16: Working data for a chi-squared test, source position of the speaker cross-tabulated against female and male voice used in the Auralization with the expected values for each category shown in brackets

	a	b	c	d	e	Total
Female	7 (3)	10 (6.25)	6 (2.25)	2 (1.25)	1 (0.25)	26
Male	5 (3)	15 (6.25)	3 (2.25)	3 (1.25)	0 (0.25)	26
Total	15	31.25	11.25	6.25	1.25	117

Table 17: Calculation table for obtaining chi-squared value for the difference in distribution between auralization of a male and female voice

Category	O_i (Observed count)	E_i (Expected count)	$O_i - E_i$	$(O_i - E_i)^2$	$(O_i - E_i)^2 / E_i$
Female| a	7	3	4	16	5.333333
Female	b	10	6.25	3.75	14.0625	2.25

Female | c	6	2.25	3.75	14.0625	6.25
Female | d	2	1.25	0.75	0.5625	0.45
Female | e	1	0.25	0.75	0.5625	2.25
Male | a	5	3	2	4	1.333333
Male | b	15	6.25	8.75	76.5625	12.25
Male | c	3	2.25	0.75	0.5625	0.25
Male | d	3	1.25	1.75	3.0625	2.45
Male | e	0	0.25	-0.25	0.0625	0.25
					$X2 =$ 33.06667

Table 18: Table showing the calculation of the Dmax for the KS test for exploring the application of a filter to the experience of reverberation with a female voice.

	Not filtered	Proportion	Cumulative proportion	Filtered	Proportion	Cumulative proportion	Dmax
Very Different	4	0.16	0.16	0	0	0	0.16
Different	10	0.4	0.56	3	0.115385	0.115385	0.444615
Slightly Different	9	0.36	0.92	12	0.461538	0.576923	0.343077
The same	2	0.08	1	11	0.423077	1	0
Total	25	1		26	1		

Table 19: Table showing the calculation of the Dmax for the KS test for exploring the application of a filter to the experience of reverberation with a male voice.

	Filtered	Proportion	Cumulative proportion	Not filtered	Proportion	Cumulative proportion	Dmax
Very Different	1	0.04	0.04	3	0.12	0.12	0.08
Different	5	0.2	0.24	9	0.36	0.48	0.24
Slightly Different	10	0.4	0.64	10	0.4	0.88	0.24
The same	9	0.36	1	3	0.12	1	0
	25	1		25	1		

Table 20: Table showing the calculation of the Dmax for the KS test for exploring the application of a filter to the experience of timbre or tone with a male voice.

	Filtered	Proportion	Cumulative proportion	Not filtered	Proportion	Cumulative proportion	Dmax
Very Different	0	0	0	1	0.04	0.04	0.04
Different	3	0.12	0.12	13	0.52	0.56	0.44
Slightly Different	8	0.32	0.44	8	0.32	0.88	0.44

	Not filtered	Proportion	Cumulative proportion	Filtered	Proportion	Cumulative proportion	Dmax

The same	14	0.56	1	3	0.12	1	0
	25	1		25	1		

Table 21: Table showing the calculation of the Dmax for the KS test for exploring the application of a filter to the experience of timbre or tone with a female voice.

	Not filtered	Proportion	Cumulative proportion	Filtered	Proportion	Cumulative proportion	Dmax
Very Different	4	0.16	0.16	0	0	0	0.16
Different	5	0.2	0.36	2	0.076923	0.076923	0.283077
Slightly Different	10	0.4	0.76	12	0.461538	0.538462	0.221538
The same	6	0.24	1	12	0.461538	1	0
	25	1		26	1		

Table 22: Table showing the calculation of the Dmax for the KS test exploring the difference in reverberation between models of the Great Hall as it stands today (new) and how it might have sounded in the past (old)

	Old	Proportion	Cumulative proportion	New	Proportion	Cumulative proportion	Dmax
1	3	0.12	0.12	0	0	0	-0.12

2	13	0.52	0.64	1	0.04	0.04	-0.6
3	8	0.32	0.96	2	0.08	0.12	-0.84
4	1	0.04	1	14	0.56	0.68	-0.32
5	0	0		8	0.32	1	1
	25	1		25	1		

Table 23: Working data for a chi-squared test, Auralization of old hall cross-tabulated against new hall with the expected values for each category shown in brackets

	a	b	c	d	e	Total
Old	3 (1.5)	13 (7)	8 (5)	1 (7.5)	0 (4)	25
New	0 (1.5)	1 (7)	2 (5)	14 (7.5)	8 (4)	25
Total	3	14	10	15	8	50

Table 24: Calculation table for obtaining chi-squared value from data in Table 23

Category	O_i (Observed count)	E_i (Expected count)	$O_i - E_i$	$(O_i - E_i)^2$	$(O_i - E_i)^2 / E_i$
Old | Less Reverberation	3	1.5	1.5	2.25	1.5

Old | Slightly less Reverberation	13	7	6	36	5.142857
Old | The same	8	5	3	9	1.8
Old | Slightly more Reverberation	1	7.5	-6.5	42.25	5.633333
Old |More Reverberation	0	4	-4	16	4
New | Less Reverberation	0	1.5	-1.5	2.25	1.5
New | Slightly less Reverberation	1	7	-6	36	5.142857
New | The same	2	5	-3	9	1.8
New | Slightly more Reverberation	14	7.5	6.5	42.25	5.633333
New |More Reverberation	8	4	4	16	4
					X2=36.15238

Table 25: Table showing the calculation of the Dmax for the KS test exploring the difference in clarity between models of the Great Hall as it stands today (new) and how it might have sounded in the past (old)

	Old	Proportion	Cumulative proportion	New	Proportion	Cumulative proportion	Dmax
1	0	0	0	1	0.04	0.04	0.04
2	4	0.16	0.16	1	0.04	0.08	-0.08

							-0.44
3	11	0.44	0.6	2	0.08	0.16	
4	6	0.24	0.84	8	0.32	0.48	-0.36
5	4	0.16	1	13	0.52	1	0
	25	1		25	1		

Table 26: Working data for a chi-squared test, Auralization of old hall cross-tabulated against new hall with the expected values for each category shown in brackets

	a	b	c	d	e	Total
Old	0 (0.5)	4 (2.5)	11 (6.5)	6 (7)	4 (8.5)	25
New	1 (0.5)	1 (2.5)	2 (6.5)	8 (7)	13 (8.5)	25
Total	1	5	13	14	17	50

Table 27: Calculation table for obtaining chi-squared value from data in

Table 26

Category	Oi (Observed count)	Ei (Expected count)	Oi-Ei	(Oi-Ei)2	(Oi-Ei)2/Ei
Old | Less easy to understand	0	0.5	-0.5	0.25	0.5
Old | Slightly less easy to understand	4	2.5	1.5	2.25	0.9

Old | The same	11	6.5	4.5	20.25	3.115385
Old | Slightly easier to understand	6	7	-1	1	0.142857
Old | Easy to understand	4	8.5	-4.5	20.25	2.382353
New | Less easy to understand	1	0.5	0.5	0.25	0.5
New | Slightly less easy to understand	1	2.5	-1.5	2.25	0.9
New | The same	2	6.5	-4.5	20.25	3.115385
New | Slightly easier to understand	8	7	1	1	0.142857
New | Easy to understand	13	8.5	4.5	20.25	2.382353
					X2=14.08119

Appendix M Visualisations and Acoustics Questionnaire

This question we will be discussing Localisation of a source in the Great Hall.

1. Below is an image of the Great Hall at Ightham Mote, where do you think the sound is coming? Track1

Extreme left   slightly left   Middle of the room   Slightly right   Extreme right

2. Below is an image of the Great Hall at Ightham Mote, where do you think the sound is coming? Track 2

Extreme left Slightly left   Middle of the room   Slightly right   Extreme right

3. In this question we are asking you to compare 4 spaces, please listen to Track 3 then rate the spaces in comparison to this track on a scale of 1 to 5 according your sense of reverberation

Less reverberation   **More reverberation**

Track 4

                     1   2   3   4   5

Track 5

                     1   2   3   4   5

Track 6

                     1   2   3   4   5

Track 7

                     1   2   3   4   5

4. In this question we are asking you to compare 4 spaces, please listen to Track 8 then rate the spaces in comparison to this track on a scale of 1 to 5 according your ability to understand the speech

Hard to understand the speech   **Easy to understand the speech**

Track 9

                     1   2   3   4   5

Track 10

                     1   2   3   4   5

Track 11

                     1   2   3   4   5

Track 12

                     1   2   3   4   5

5. In this question we are asking you to compare 4 spaces, please listen to Track 13 then rate the spaces in comparison to this track on a scale of 1 to 5 according your sense of reverberation

Less reverberation   **More reverberation**

Track 14

<div align="center">

1   2   3   4   5

</div>

1   2   3   4   5

1   2   3   4   5

Track 17

1   2   3   4   5

6. In this question we are asking you to compare 4 spaces, please listen to Track 18 then rate the spaces in comparison to this track on a scale of 1 to 5 according your ability to understand the speech

Hard to understand the speech   **Easy to understand the speech**

Track 19

	1	2	3	4	5

Track 20

1 2 3 4 5

Track 21

1   2   3   4   5

Track 22

1   2   3   4   5

In this question we are asking you to compare 2 spaces (Track23 and 24)

7. How would you compare with respect to sense of space or reverberation?

Very different   Different   Slightly different   The same Don't know

8. How would you compare with respect to the timbre or tone?

Very different   Different   Slightly different   The same Don't know

9. How would you compare the ability to understand what is being said?

Very different   Different   Slightly different   The same Don't know

10. How would you compare with respect to sense of space or reverberation?
   Track 25 and 26

Very different   Different   Slightly different   The same Don't know

11. How would you compare with respect to the timbre or tone? Track 27
and 28

Very different   Different   Slightly different   The same Don't know

12. How would you compare the ability to understand what is being said?
Track 29 and 30

Very different   Different   Slightly different   The same Don't know

About you

13. What is your area of expertise? (Acoustics, Archaeological Computing, Visualisation, Medieval)

....
....

14. Can you make any comments about your listening and viewing experience? Did you find the addition or lack of the visual element helped you answer the questions?

-

....

....

Appendix N Visualisations and acoustics results

The results of the acoustics project subjective analysis questionnaire can be accessed via the supporting documents as visualacousticresults.xslx as well as on the next page.

Participant number	1	2	3	4	5	6	7	8	9	10	11	12	13
1	3	4	1	2	4	3	3	4	3	3	2	3	Archaeoic Visual elements helped with answering the questions
2	4	3	1	3	1	4	3	5	2	4	3	2	Archaeoic Didn't consciencly pay attention to the visual
3	4	2	4	2	3	4	2	3	2	2	2	2	Archaeoic Images confused the participant
4	2	4	2	3	4	5	3	4	4	2	2	4	Archaeoic Closed eyes to help distinguish the tracks
5	4	1	5	2	1	5	3	2	1	4	4	3	Archaeoic Pictures useful to place tests but focus on listening meant didn't pay attention to the visual elemets
6	3	2	1	3	4	2	3	4	2	1	2	3	Archaeoic Pictures did inflence her understanding of the test
7	1	3	1	2	3	1	4	1	4	3	4	3	Archaeoic The visual element helped to better understand how the reverberations of the recording could have occurred
8	3	3	2	4	3	3	3	4	2	4	3	2	Archaeoic Closed eyes to more clearly here the test
9	2	1	4	3	2	4	5	2	4	3	4	3	Landscape Focus on the audio that didn't pay much attention to the pictures
10	3	2	5	2	4	2	1	5	2	4	3	2	Archaeoic Visual images helped place the listener in a setting and informed expectations of sound
11	4	3	5	1	4	2	1	4	5	4	3	2	Maritime Visual elements didn't make much of a difference
12	5	3	2	4	5	5	3	2	4	1	1	1	Medivea: Useful
13	2	2	1	3	2	5	4	3	4	3	3	3	Archaeoic Visuals didn't affect the test
14	2	1	4	2	2	3	4	2	4	3	2	4	Archaeoic Didn't pay much attention to the visuals
15	2	1	1	4	3	2	4	1	2	3	2	3	Archaeoic Photos helped

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Appendix O Statistical tests for visualisations and acoustics questionnaire

Table 28: Working data for Chi-squared test. Test compares the results of both listening tests question on localisation of the auralization. It explores whether a visual element affects the result or not. (female voice)

	1	2	3	4	5	Total
Visual	2	4	4	4	1	15
	3.103448276	4.137931034	4.137931	2.586207	1.034483	15
No visual	4	4	4	1	1	14
	2.896551724	3.862068966	3.862069	2.413793	0.965517	14
Total	6	8	8	5	2	29

Table 29: Calculation table for obtaining chi-squared value from data in Table 28

Category	Oi (Observed count)	Ei (Expected count)	Oi-Ei	(Oi-Ei)2	(Oi-Ei)2/Ei
Visual | 1	2	3.103448276	-1.10345	1.217598	0.392337
Visual | 2	4	4.137931034	-0.13793	0.019025	0.004598

Visual	3	4	4.137931034	-0.13793	0.019025	0.004598
Visual	4	4	2.586206897	1.413793	1.998811	0.772874
Visual	5	1	1.034482759	-0.03448	0.001189	0.001149
No visual |1	4	2.896551724	1.103448	1.217598	0.420361
No visual |2	4	3.862068966	0.137931	0.019025	0.004926
No visual |3	4	3.862068966	0.137931	0.019025	0.004926
No visual |4	1	2.413793103	-1.41379	1.998811	0.828079
No visual |5	1	0.965517241	0.034483	0.001189	0.001232
					X2=2.435079

Table 30: Working data for Chi-squared test. Test compares the results of both listening tests question on localisation of the auralization. It explores whether a visual element affects the result or not. (male voice)

	1	2	3	4	5	Total
Visual	2	6	6	1	0	15
	2.586206897	6.206896552	4.655172	1.551724	0	15

No visual	3	6	3	2	0	14
	2.413793103	5.793103448	4.344828	1.448276	0	14
Total	5	12	9	3	0	29

Table 31: Calculation table for obtaining chi-squared value from data in Table 30

Category	Oi (Observed count)	Ei (Expected count)	Oi-Ei	(Oi-Ei)2	(Oi-Ei)2/Ei
Visual | 1	2	2.586206897	-0.58621	0.343639	0.132874
Visual | 2	6	6.206896552	-0.2069	0.042806	0.006897
Visual | 3	6	4.655172414	1.344828	1.808561	0.388506
Visual | 4	1	1.551724138	-0.55172	0.3044	0.196169
Visual | 5	0	0	0	0	0
No visual |1	3	2.413793103	0.586207	0.343639	0.142365
No visual |2	6	5.793103448	0.206897	0.042806	0.007389
No visual |3	3	4.344827586	-1.34483	1.808561	0.416256
No visual |4	2	1.448275862	0.551724	0.3044	0.210181
No visual |5	0	0	0	0	0

					1.500635

Table 32: Calculations of the Dmax for a KS test comparing Simulated and Filter auralization to measured auralization with and without a visual with respect to reverberation.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Less reverberation	8	0.533333	0.533333	5	0.333333	0.333333	0.2
Slightly less reverberation	3	0.2	0.733333	6	0.4	0.733333	0
The same	0	0	0.733333	0	0	0.733333	0
Slightly more reverberation	3	0.2	0.933333	3	0.2	0.933333	0
More reverberation	1	0.066667	1	1	0.066667	1	
Totals	15	1		15	1		

Table 33: Calculations of the Dmax for a KS test comparing Simulated auralization to measured auralization with and without a visual with respect to reverberation.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Less reverberation	0	0	0	0	0	0	0
Slightly less	3	0.2	0.2	3	0.2	0.2	0

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
reverberation							
The same	3	0.2	0.4	7	0.466667	0.666667	-0.26667
Slightly more reverberation	8	0.533333	0.933333	5	0.333333	1	-0.06667
More reverberation	1	0.066667	1	0	0	1	
	15	1		15	1		

Table 34: Calculations of the Dmax for a KS test comparing measured auralization to measured auralization with and without a visual with respect to reverberation.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Less reverberation	1	0.066667	0.066667	1	0.066667	0.066667	0
Slightly less reverberation	1	0.066667	0.133333	1	0.066667	0.133333	0
The same	8	0.533333	0.666667	4	0.266667	0.4	0.266667
Slightly more reverberation	2	0.133333	0.8	5	0.333333	0.733333	0.066667
More reverberation	3	0.2	1	4	0.266667	1	
	15	1		15	1		

Table 35: Calculations of the Dmax for a KS test comparing Measured and Filter auralization to measured auralization with and without a visual with respect to reverberation.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Less reverberation	3	0.2	0.2	4	0.266667	0.266667	-0.06667
Slightly less reverberation	8	0.533333	0.733333	5	0.333333	0.6	0.133333
The same	0	0	0.733333	3	0.2	0.8	-0.06667
Slightly more reverberation	2	0.133333	0.866667	2	0.133333	0.933333	-0.06667
More reverberation	2	0.133333	1	1	0.066667	1	
	15	1		15	1		

Table 36: Calculations of the Dmax for a KS test comparing Measured and Filter auralization to measured auralization with and without a visual with respect to Intelligibility.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Harder to	0	0	0	0	0	0	0

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
understand speech							
Slightly harder to understand speech	7	0.466667	0.466667	8	0.533333	0.533333	-0.06667
The same	3	0.2	0.666667	4	0.266667	0.8	-0.13333
Slightly easier to understand speech	4	0.266667	0.933333	2	0.133333	0.933333	0
Easier to understand speech	1	0.066667	1	1	0.066667	1	
	15	1		15	1		

Table 37: Calculations of the Dmax for a KS test comparing Measured auralization to measured auralization with and without a visual with respect to Intelligibility.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Harder to understand speech	0	0	0	0	0	0	0
Slightly harder to understand speech	1	0.066667	0.066667	0	0	0	0.066667
The same	3	0.2	0.266667	6	0.4	0.4	-0.13

							333
Slightly easier to understand speech	8	0.533333	0.8	8	0.533333	0.933333	-0.13333
Easier to understand speech	3	0.2	1	1	0.066667	1	
	15	1		15	1		

Table 38: Calculations of the Dmax for a KS test comparing Simulated and filtered auralization to measured auralization with and without a visual with respect to Intelligibility.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Harder to understand speech	3	0.2	0.2	3	0.2	0.2	0
Slightly harder to understand speech	5	0.333333	0.533333	7	0.466667	0.666667	-0.13333
The same	5	0.333333	0.866667	2	0.133333	0.8	0.066667
Slightly easier to understand speech	1	0.066667	0.933333	3	0.2	1	-0.06667
Easier to understand	1	0.066667	1	0	0	1	

	speech						
	15	1		15	1		

Table 39: Calculations of the Dmax for a KS test comparing Simulated auralization to measured auralization with and without a visual with respect to Intelligibility.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Harder to understand speech	0	0	0	0	0	0	0
Slightly harder to understand speech	0	0	0	1	0.066667	0.066667	-0.066667
The same	5	0.333333	0.333333	6	0.4	0.466667	-0.13333
Slightly easier to understand speech	7	0.466667	0.8	4	0.266667	0.733333	0.066667
Easier to understand speech	3	0.2	1	4	0.266667	1	
	15	1		15	1		

Table 40: Working data for Chi-squared test. Test compares the simulated filtered and measured filtered. It explores whether a visual element affects the result or not with respect to reverberation or sense of space.

	1	2	3	4	5	Total
Visual	2	5	6	2	0	15
	1	4.5	8	1.5	0	15
No visual	0	4	10	1	0	15
	1	4.5	8	1.5	0	15
Total	2	9	16	3	0	30

Table 41: Calculation table for obtaining chi-squared value from data in

Table 40

Category	Oi (Observed count)	Ei (Expected count)	Oi-Ei	(Oi-Ei)2	(Oi-Ei)2/Ei
Visual | 1	2	1	1	1	1
Visual | 2	5	4.5	0.5	0.25	0.055555556
Visual | 3	6	8	-2	4	0.5
Visual | 4	2	1.5	0.5	0.25	0.166666667
Visual | 5	0	0	0	0	0
No visual |1	0	1	-1	1	1
No visual |2	4	4.5	-0.5	0.25	0.055555556
No visual |3	10	8	2	4	0.5
No visual |4	1	1.5	-0.5	0.25	0.166666667
No visual |5	0	0	0	0	0

						3.444444444

Table 42: Calculations of the Dmax for a KS test comparing filtered auralizations with and without a visual with respect to reverberation and sense of space.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Very different	0	0	0	2	0.133333333	0.133333	-0.13333
Different	4	0.266666667	0.266667	5	0.333333333	0.466667	-0.2
Slightly different	10	0.666666667	0.933333	6	0.4	0.866667	0.066667
The same	1	0.066666667	1	2	0.133333333	1	0
	15	1		15	1		

Table 43: Working data for Chi-squared test. Test compares the simulated filtered and measured filtered. It explores whether a visual element affects the result or not with respect to timbre and tone.

	1	2	3	4	5	Total
Visual	1	4	8	2	0	15
	0.5	4	7.5	3	0	15
No visual	0	4	7	4	0	15

	0.5	4	7.5	3	0	15
Total	1	8	15	6	0	30

Table 44: Calculation table for obtaining chi-squared value from data in

Table 43

Category	Oi (Observed count)	Ei (Expected count)	Oi-Ei	(Oi-Ei)2	(Oi-Ei)2/Ei
Visual | 1	1	0.5	0.5	0.25	0.5
Visual | 2	4	4	0	0	0
Visual | 3	8	7.5	0.5	0.25	0.033333333
Visual | 4	2	3	-1	1	0.333333333
Visual | 5	0	0	0	0	0
No visual |1	0	0.5	-0.5	0.25	0.5
No visual |2	4	4	0	0	0
No visual |3	7	7.5	-0.5	0.25	0.033333333
No visual |4	4	3	1	1	0.333333333
No visual |5	0	0	0	0	0
					1.733333333

Table 45: Calculations of the Dmax for a KS test comparing filtered
auralizations with and without a visual with respect to timbre and tone.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Very different	0	0	0	1	0.066666667	0.066667	-0.06667
Different	4	0.266666667	0.266667	4	0.266666667	0.333333	-0.06667
Slightly different	7	0.466666667	0.733333	8	0.533333333	0.866667	-0.13333
The same	4	0.266666667	1	2	0.133333333	1	0
	15	1		15	1		

Table 46: Working data for Chi-squared test. Test compares the simulated filtered and measured filtered. It explores whether a visual element affects the result or not with respect to intelligibility.

	1	2	3	4	5	Total
Visual	0	4	9	2	0	15
	0	4	6	5	0	15
No visual	0	4	3	8	0	15
	0	4	6	5	0	15
Total	0	8	12	10	0	30

Table 47: Calculation table for obtaining chi-squared value from data in

Table 46

Category	Oi (Observed count)	Ei (Expected count)	Oi-Ei	(Oi-Ei)2	(Oi-Ei)2/Ei
Visual | 1	0	0	0	0	0
Visual | 2	4	4	0	0	0
Visual | 3	9	6	3	9	1.5
Visual | 4	2	5	-3	9	1.8
Visual | 5	0	0	0	0	0
No visual |1	0	0	0	0	0
No visual |2	4	4	0	0	0
No visual |3	3	6	-3	9	1.5
No visual |4	8	5	3	9	1.8
No visual |5	0	0	0	0	0
	30	30			6.6

Table 48: Calculations of the Dmax for a KS test comparing filtered auralizations with and without a visual with respect to intelligibility.

	No visual	Proportion	Cumulative Proportion	Visual	Proportion	Cumulative Proportion	Dmax
Very different	0	0	0	0	0	0	0
Different	4	0.266666667	0.266667	4	0.266666667	0.266667	0
Slightly	3	0.2	0.466667	9	0.6	0.866667	-

							0.4
different							
The same	8	0.53333333	1	2	0.13333333	1	0
	15	1		15	1		

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