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Interpretation at the Controller's Edge: The Role of Graphical User Interfaces in Virtual Archaeology

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Abstract

The important role of graphical user interfaces (GUIs) as a medium of interaction with technology is well established in the world of media design, but has not received significant attention in the field of virtual archaeology. GUIs provide interactive capabilities and contextual information for 3D content such as structure-from-motion (SFM) models, and can represent the difference between “raw data” and thoughtful, skilled scholarly publications. This project explores the implications of a GUI created with the game engine Unity 3D (Unity) for a series of SFM models recorded at a structure known as the Area B House at the ancient central Italian city of Gabii. Unity’s capabilities as a game engine allow for an embodied, reflexive, and design-centered approach to archaeological content. This presents some challenges to a strict interpretation of the New Materialism, and its call for “unmediated” interaction with archaeological things. On the contrary, design oriented thinking encourages us to balance human factors (i.e., the user experience) with the representations of things that constitute our content. The Area B House interface thus embraces a “symmetrical” view of materiality, wherein humans and things are equally important agents in entangled, recursive relationships. This is particularly true as entanglement, a key concept in symmetrical archaeology, manifests in the “emergent systems” of gameplay that arise out of embodied experiences with archaeological sites. This thesis will situate the theoretical implications of our interface within some longstanding debates about archaeological objectivity, representation, and communication.

Acknowledgements

I would like to offer the highest thanks to all of those who offered advice, criticism, or inspiration during the course of my research and studies over the past several years.

Dedication

I dedicate this work to my friends and family, who continue to make my life interesting and rewarding, and especially to Shelby.

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Chapter 1

Introduction

This thesis will show how graphical user interfaces (GUIs) can be used to contextualize archaeological visualizations and provide a reflexive user experience with ancient materials. As an experimental case study, I outline one approach to designing archaeological interfaces, using as an example data from a middle republican Roman house from Gabii, Italy. The case study attempts to engage reflexivity by exploring the game engine Unity 3D (Unity) as an interface platform. Reflexive archaeology is a multifaceted idea, and in this paper I use it to denote the type of "recursive, interactive web of interpretation and discussion" that helps us remain critical of our "assumptions and taken-for-granteds" (Chadwick, 1997; Hodder, 1997, p. 10). Because of the emotional, interactive way they engage users, interfaces developed through game engines are especially able to encourage self-awareness, relational thinking, interactivity, and interpretation, important aspects of reflexive archaeology (Hodder, 1997). Meanwhile, as a set of guiding principles, the theory of *reflective design* also emphasizes self-awareness and alternative ways of interacting with technology. Our case-study thus takes a design-oriented approach to virtual archaeology, one that places weight on both the things we choose to represent and the people who will interact with them. It is also an approach that resonates with *symmetrical archaeology*, the assertion that humans and things are not "radically" separate ontological beings, but are both entangled in the same complex, recursive existence. We are not only conducting a practical exercise, but a theoretical one, situated at the intersection of interface design, archaeological theory, and game criticism.

Three central arguments will unfold in the course of this thesis. First, if archaeologists wish to elevate 3D content to a serious medium for research and interpretation, we must strive to bridge the divide between conventional archaeological illustration and digital visualization. Interfaces are key to doing so, since they can provide the kind of contextual information usually conveyed by illustration conventions. Second, archaeological interfaces, because they are inherently connected to the representations of things, should respond to the theoretical imperatives of the "New Materialism" (Hodder, 2011/2012; Olsen, 2007/2010/2012a/2012b; Olsen et al., 2012; Pétursdóttir, 2012; Webmoor & Witmore, 2008; Witmore 2007/2010; Witmore and Shanks, 2013). The New Materialism is a recent theoretical turn in archaeology which is summarized by the assumptions that "things are assemblages" (i.e., they do not just represent but *are* collections of achievements in the past), "things are participants" (i.e., they both act and are acted upon; they possess agency), and "things are things" (i.e., their importance lays in their materiality, not simply their symbolic function; Witmore 2014, 203). On the whole, this turn conceptualizes archaeological things as chiefly material objects and not social constructs, but makes the problematic assumption that researchers should strive for "unmediated" interaction with the objects they study (Olsen, 2010). Meanwhile, "symmetrical archaeology" - an idea which is closely related to the New Materialism - warns against the risk of creating too simple of a dichotomy between humans and non-humans (Witmore, 2007). In this work, I challenge the notion that that interfaces can represent things in an objective, unmediated way, or that things can indeed be reduced to essential qualities whatsoever. Rather, as agents in cultural "entanglements" (i.e., between humans, between humans and things, between things),

things both create and are created by rules which preface the way we interact with them (Hodder, 2011). In other words, our interface will make the case for a symmetrical approach to archaeological things, if not a strictly New Materialist one. Third, because there is always a corporeal component to the way users interact with interfaces for game-based virtual environments, I will explore the intersection between "game-embodiment" and "archaeological-embodiment." Embodiment is a function of both the physical environment and the identities of players, and so provides an important lens for understanding how our interface relates to symmetry and reflexivity. Most importantly, being embodied in a game-space entails physical collision with 3D models and structured movement throughout an environment. This gives rise to a *system* of interaction with archaeological things, actors, and spaces, further challenging the possibility of unmediated interaction with objects.

User interfaces entail the aspects of a computer system or program with which users interact, including onscreen displays, command prompts, characters, and even physical objects like mouses and keyboards (Landsdale & Ormerod, 1994). In its graphical form, user interfaces rely on the use of icons and condensed representations of complex systems. When Widows users wish to close a browser window, for example, they click on an "X" icon, rather than directly manipulating the computer system via code. Since the early 1980s, GUIs have emerged as the *de facto* standard for interface development, replacing the earlier command line or text-based user interfaces (Landsdale & Ormerod, 1994). Archaeologists continue to show interest in digital media (Bonde & Houston, 2013), yet the role GUIs should play in the way we structure and communicate archaeological content is notably under treated in contemporary literature.

GUIs can help us visualize, research, and explain archaeological information, and like conventional print illustration, provide a degree of contextualization and annotation to otherwise “raw” images or figures.

Archaeological thinking (and practice) about illustration has always tended to reflect broader societal attitudes about science, visual conventions, and information (Piggott, 1978). If we want to take a lesson from our field’s intellectual past, an appropriate part of understanding GUIs involves understanding their role in content outside of archaeology. Video game interfaces are particularly relevant sources of inspiration. Games, like archaeological visualizations, are functionally compelled to encourage critical examination of virtual environments and narratives, with interfaces often serving to communicate information that is not immediately obvious (Stonehouse, 2014).

In one sense, then, archaeologists share the challenge of game-interface designers. GUIs should help create a user experience which is predictable enough to meet the expectations and experiences of our audience, but innovative enough to engage our specific needs and encourage exploration, critical examination, and fun (Landsdale & Ormerod, 1994; Hunicke et al., 2004; Stegemann & Fiore, 2006). On the other hand, interface design raises several uniquely archaeological questions as we begin to think about the role interfaces might play in how archaeological knowledge is shaped from field to publication. Olsen et al. (2012) connect archaeology with the practice of design, inasmuch as it is a process of “pulling together whatever is necessary to attend to a problem needing solution” (p. 5). Especially as field data are increasingly collected with an eye toward dissemination via online databases (Carver,

2006), GUIs can be a useful way of selectively representing archived data for the purpose of crafting interpretations and narratives.

GUIs also offer significant opportunities to provide a pleasurable, emotionally rewarding user experience (Hassenzahl et al., 2006; Shneiderman, 2004; Stegemann & Fiore, 2006; Scollan, 2007). While the benefits of reader-centered, clear, and formal publications in academy are widely assumed (Hall, 2007), *fun* can be an essential element in game-based archaeological content, and is closely connected to the "problem-solving" aspects of games and archaeology. The way games invite players to uncover, internalize, and even struggle with narratives or environmental changes (often based on limited evidence) has affinities with the process of archaeological interpretation (Frost, 2012; Reinhard, 2015). Frost (2012), for example, makes the case that approaches to phenomenology in visualizations should take a lead from the independent game *Dear Esther,* which ties "symbolic imagery within the visual and sensual environment to what is described - in a way that is evocative and involving" (para. 2). The appeal of archaeological mystery and fragmentation has been elegantly described by Shanks (2005), while Olsen et al. (2012) paint archaeologists as "bricoleurs" who "collect bits and pieces of things" (p. 4) in an attempt to make sense of ancient activities and things. Bricolage is a term of fairly common usage in structuralism, and Levi-Strauss used it to describe the way cultures must create meaning using the "extensive, if nevertheless limited" structural "tools" which are available to them (Levi-Strauss, 1962). Archaeological bricolage is thus a process of "making do" (c.f. De Certeau, 1984) with the evidence that we have, of adapting to the paucity and messiness of the archaeological record. Creative interfaces could adapt the way games

invite players to overcome environmental challenges to the practice of archaeology. Attention to design variables such as fun, pleasure, and challenge means that we are embarking upon a new approach to 3D archaeology: one that is design-centered and theoretically self-aware about how design choices may shape user experiences.

The questions raised by game-based archaeology are not wholly idiosyncratic, but are relevant to some current trends in broader archaeological theory. Creating interfaces that try to contextualize and explain the diverse and sometimes unstable characteristics of archaeological things defies the notion that data can be presented purely and objectively. Depiction and elaboration are always interpretive. But drawing a direct (albeit reflexive) connection between the qualitative material evidence and the interpretation of broader practices or activities would seem to challenge the somewhat interpretation-averse sentiment of the New Materialism (Hodder, 2011/2012; Olsen, 2007/2010/2012a/2012b; Olsen et al., 2012; Pétursdóttir, 2012; Webmoor & Witmore, 2008; Witmore 2007/2010; Witmore and Shanks, 2013). In chapter 3, I will explore how the New Materialism is at least partially a reaction to post-processual archaeology's emphasis on the human agent, as well as situate it with respect to the broader "spatial turn" in the humanities. The major contribution the New Materialism makes to spatial thinking is its conception of things not as spatially static, but as gatherings of achievements over time and space. If things are in fact gatherings of achievements, it requires a discerning archaeological mind to elucidate those achievements, and this is necessarily an interpretive - and culturally/intellectually provisional - practice. Here, my response to the New Materialism - and this is something I wish this project's GUI to

reflect - is that all archaeological knowledge is interpretation, and that an archaeological interface must foreground the fluidity of what we know/think about objects.

Emphasizing GUI elements is also one way to respond to the New Materialist proclamation that photorealism and mimetic representation are merely futile substitutes for the “thingness of a thing.” Olsen et al. (2012) argue that virtual reality experiments can shift attention away from “visuality per se” (and the presumably false surrogacy it implies) and toward “the specifics of how the traces of the past connect with the present” (p. 85). While I understand this argument, I would add that nevertheless, especially when we are representing as-excavated sites, visual accuracy is not always something to be shied away from. The combination of highly accurate SFM models with contextualizing GUI elements is in fact synergistic, and while I acknowledge the artifice that goes into designing a visualization, I do not think this means 3D models and GUIs need to fully reject archaeological reality. It is difficult to ignore the sometimes precarious nature of interpretation when confronted with (highly realistic representations of) the weathered stones, barely distinguishable soil variations, and scattered detritus upon which it is founded. On the other hand, any perceived “visual fetishism” - the “eye candy” of visualization - resulting from realistic 3D models is checked by the need to read, understand, and challenge interpretations presented through GUI (Shanks & Webmoor, 2013, p. 89). Because they are both realistic and contextual, game-based visualizations of SFM models, as opposed to more abstracted renderings such as 3D PDFs, do a good job of acknowledging some of the “messiness” of archaeological objects and information, tied up as they are in “superimposed structures, artifacts and debris mixed together, different pasts and different dates” (Olsen, 2012a, p. 25). At a

less tangible level, game experiences even convey some of the more ephemeral, emotive sensations that result from “direct encounters with the very material past we study,” underscoring the elements of excavation that transcend simply “collecting data” (Olsen, 2012a, p. 26; Shanks, 1992; Tringham & Joyce, 2007).

In this sense, I am wary of the suggestion that things, including in the form of photorealistic models, can entirely speak for themselves, as this is one possible reading of Olsen’s (2012, p. 22) call for a “farewell to interpretation.”[1] In fact, the notion that things are ontologically discrete entities which defy the need for hermeneutical analysis is an extremely “asymmetrical” take on the relationship between people and things. The benefit of a “(re)turn to things” is not actually realized by indiscriminately sacrificing “the imperatives of historical narratives, sociologies, and hermeneutics” (Olsen, 2012a, p. 11), but by clarifying the triple dialectic (or fourfold hermeneutic) between things, the people who experienced them, and ourselves as interpreters. This is also an opportunity for reflexive self-awareness, since, unlike a strictly positivist conception of materiality, it underscores that knowledge of the past is a result of a dialectic that includes ourselves as archaeologists.

An important aspect of this dialectic includes the *contexts* in which things functioned or were recovered. Context is a vital aspect of the evidence we use for interpreting objects, and no amount of photorealism can replace the need for descriptions that arise out of engagements with the material past. Olsen et al. (2012) present a strong criticism of emphasis on the “mimetic and representational qualities” of

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[1] In fairness, Olsen (p. 22) says “Predicting a farewell to interpretation is not about abolishing interpretation in its modest and inevitable form,” yet the very notion that interpretation is in some way an obstacle to “objective” truth is, as I will argue, unrealistic.

objects (p. 79), while Shanks & Webmoor (2013) argue for archaeological images as mediation between “the material remains, the evidence, and their stand-ins or proxies, the texts or visuals” (p. 105). In 3D environments, this can sometimes be best served by schematic representations which “remain faithful to the fragmented remains” (Shanks & Wemboor, 2013, p. 90), and in chapter 4 I will indeed consider the benefit of simplistic, non-textured reconstructions. Photorealistic models, however, are not entirely without merit, and do in fact provide a unique form of mediation between users and material remains. GUIs are a good way of elucidating photorealistic models, of lending additional context to visually rich representations without undermining the material (virtual-)reality of things in question.

Our project attempts to design a GUI for a game-like experience with photorealistic models, both as excavated and in the form of schematic reconstructions. Users are provided the option of “walking around” the site with a first-person camera, a common approach to navigation in games. This raises the question how embodied interaction with data might contribute to a reflexive experience, as well as how it pertains to the New Materialist notion of objectivity (Flynn, 2008; Olsen, 2010; Shinkle, 2003). As all excavators know, the experience of walking around a site it in-person is different than studying it using images or textual descriptions. Virtual experiences with a site (including movement, collision-based interaction with walls and floors, and other sensory exchanges) are also different than a real-life ones, but game-engine based visualizations complete with GUI interaction expand the possibilities for what we can communicate using virtual representations. While studies on embodiment in virtual worlds are well attested in both game criticism and archaeology, these usually address

"immersive" or reconstructed environments and tend to focus on the phenomenological aspects of game/historical places (Champion, 2010; Flynn, 2003; Fredrick, 2013; Shinkle, 2008). In this work, however, my primary goal is not related to representing the experiential nature of sites during their time of habitation and use. Instead, I wish to focus on the embodied component GUI-based, first-person models of archaeological features "as excavated." Schematic reconstructions in our scene serve as interpretational representations of what kind of structure, we think, the material remains suggest (Olsen, 2013). Constraining user movement according to these representations (i.e, by not allowing the user to move "through" walls), I argue, provides a corporeal element to this form of representation. In chapter 4, I will argue that interactive archaeological experiences like this entail a unique combination of game embodiment and archaeological embodiment. The results of corporeally "feeling" materials in a virtual space, especially including the effects of "running into" walls and having one's movement constrained by archaeological features, raise some criticisms of the New Materialist ideal of "unmediated" interaction between people and things. Meanwhile, choosing to embrace embodiment as a design-element implies a certain symmetry between users and their material environment. The user experience becomes entangled with the walls, floors, and doorways (i.e., the *things* that shape space) that constitute the site in question. This is the type of recursive, ontologically linked nature between people and things described by symmetrical archaeology (Witmore, 2007).

As an experimental case study in these ideas, I will draw upon the dataset of one mid-Republic Roman house (the Area B House) from Gabii, Italy, recording during the excavations of the Gabii Project in 2009-2011. In the 2009 season, surveyors with the

project began recording features using structure-from-motion (SFM). This technique uses algorithms and survey data to produce high resolution, geo-referenced (i.e., containing coordinate data so that it can be positioned correctly relative to other objects) 3D models from photographs, and has since become an integral part of documentation at Gabii. SFM presents several advantages, including its relative ease of use, accuracy, and suitability for most types of archaeological features, making it an accessible, cost-effective way of producing high-resolution models and textures of remains (Dell'Unto et al., 2013; De Reu et al., 2013; Kjellman, 2012; Lerma et al., 2010; Opitz & Nowlin, 2012). While the series of models produced between 2009-2011 is not fully comprehensive (not every stratigraphic unit or architectural feature was modeled), it is representative enough to form the basis of an interactive reconstruction of the Area B House, as excavated. In addition to SFM recording, the limits of each stratigraphic unit were surveyed and logged into a GIS, while data from context sheets for each stratigraphic unit was entered into theory Gabii Project's Ark database, where it continues to be hosted on the web.

Unity's capabilities as a game engine accommodate this combination of visual, spatial, and textual information. This software allows the benefit of creating a contextually intuitive, interactive, and attractive experience. Meanwhile, because the definition of what is fun, rewarding, and useful is always context- and user-dependent, the elusiveness of a neutral or objective presentation of data becomes apparent. Intended as an open-ended tool for game design, Unity does not bind designers to this or the other form of representation. As a result, it invites us to consider the rather subjective nature of cognitive, emotional, and intellectual responses to interface

elements and data in general (Scollan, 2007). This is an opportunity to integrate a reflexive approach into the design of our interface. We should seek to understand the effect that both our users' and our own expectations and assumptions might have on our representation of the Area B House (Hodder, 1997).

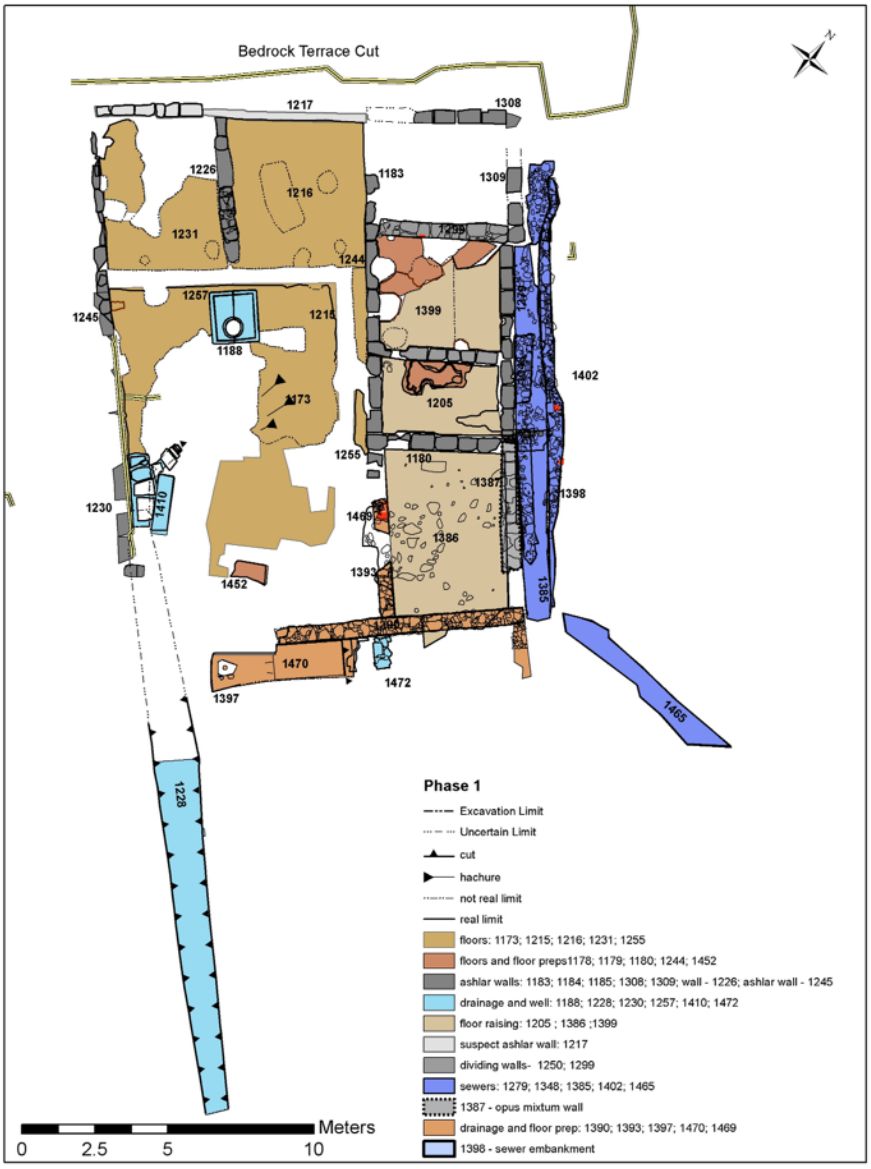

Figure 1*: Area B House, phase 1 plan*

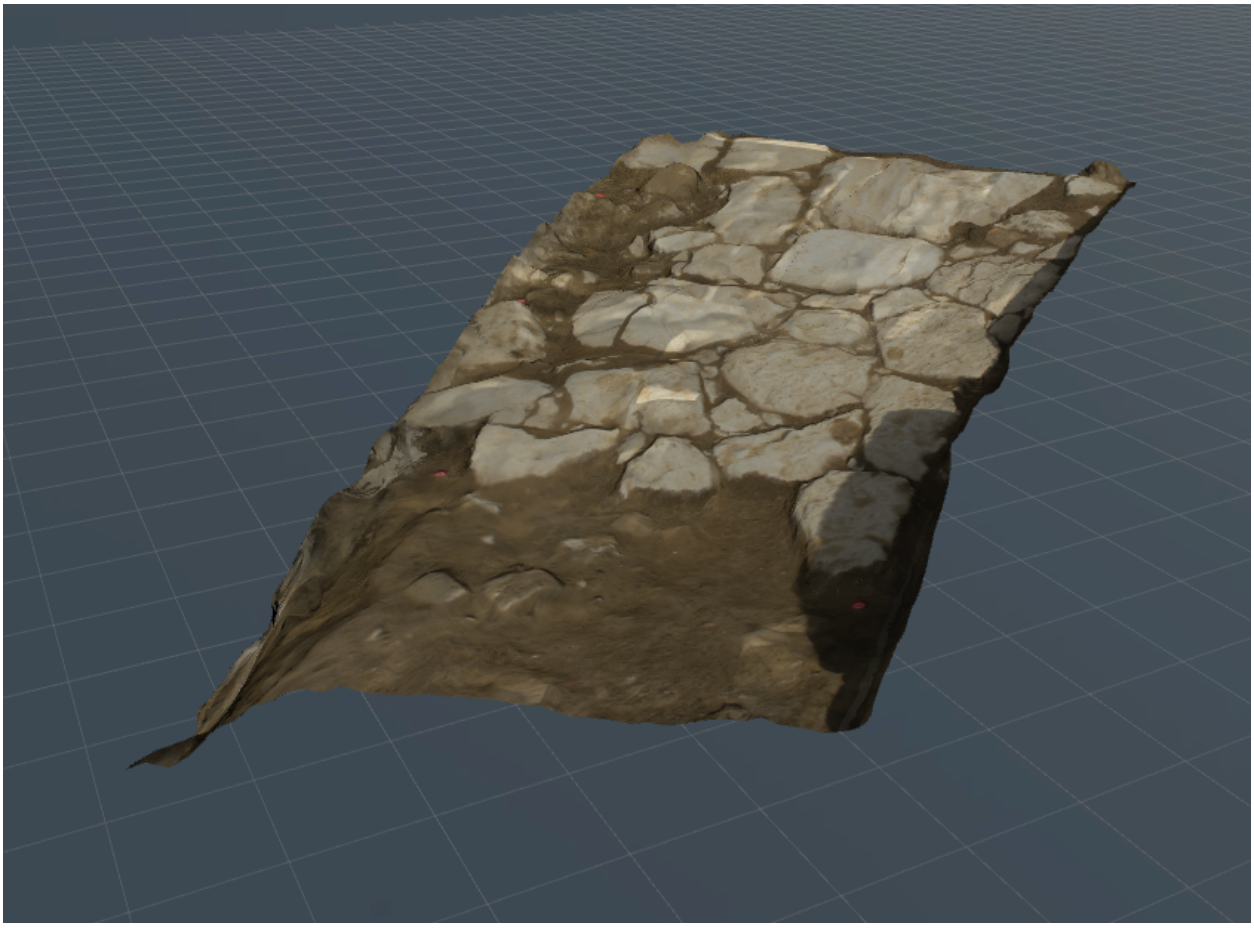

Figure 2: *SFM model of the entrance ramp to the Area B House.*

Unity's flexibility is also beneficial at a more practical level. Its tools for interface design place few constraints on layout, appearance, or functionality, so finished GUIs are almost entirely dependent on the goals, creativity, design sense, and coding know-how of the developer. This allows for flexibility and the opportunity to shape our design in response to uniquely archaeological priorities. Meanwhile, Unity scenes can easily be integrated into HTML Web pages, meaning that we can display our content alongside explanatory prose, and even program the scene to respond to hyperlinks within a document of text. Unity-based content, then, need not be a replacement for traditional (i.e., print) forms of publication, but can serve as a complement to textual narratives

(Figure 3). Thus, if SFM constitutes part of our method at Gabii for collecting data, Unity provides several benefits at the level of interpretation and publication.

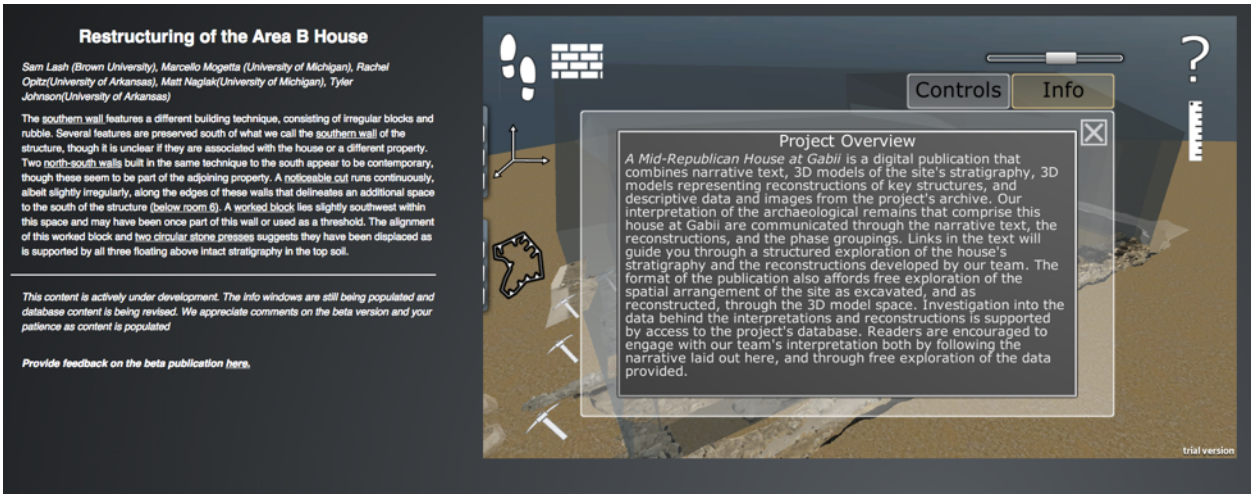

Figure 3: *The Area B House Unity scene embedded into an HTML webpage, alongside a sample of narrative text to the left.*

The structure of this paper will follow the five steps of the so-called “waterfall model” of design, as laid out by Landsdale and Ormerod (1994, p. 214). Because I am attempting to initiate a formal connection between interface design and archaeology, the relative simplicity of the waterfall model is attractive. While this simplicity means that it is rather limited in comparison to more fully elaborated approaches to interface design (and not without criticism; McConnell, 1993), it is an appropriate starting point for archaeological interface design. The waterfall model used in this project includes five steps (Landsdale & Ormerod, 1994, p. 214):

1. Project planning: determine the project’s scope, platform, organization, etc.
2. Specification: identify the specific functions the content should contain.
3. Design: identify the best way to implement the required functionality.
4. Evaluation: test the content and improve any design issues.
5. Maintenance: monitor for and address technical problems.

Despite its name, most applications of this model do not include an entirely orderly succession of stages (Landsdale & Ormerod, 1994, p. 215). It is more common to allow for iteration between stages, for instance, if requirements raised in the specification stage cause designers to seriously rethink the project. A major benefit of the waterfall model as applied here is adaptability, and almost all projects involve an iterative loop between design and evaluation. Rather than governing the specific design choices we might make, or even in what order we make them, the model helps us understand how our choices at different stages of the design process relate to one another. This is suitable for the practice of game design, which emphasizes iteration and playtesting (Hunicke et al., 2004; Schell, 2008). Archaeologically, we can relate the process of design and revision to Hodder's (1991) "hermeneutic spiral," which refers to the act of beginning with an initial interpretation, and then reworking that interpretation to adjust for its possible shortcomings or errors. In these ways, the waterfall model is appropriate for both our practical and theoretical needs.

In chapter 2 (Project Planning), I will explain the benefits of Unity as a platform for this project's interface as well extend the concept of visualization as illustration, situating the methods used in this project within the history of conventional archaeological representation. Chapter 3 (Specification) will problematize the seemingly clear distinction between the virtual and the real in archaeology, showing how virtual encounters with archaeological things compare with "real" ones in some unexpected but theoretically important ways. This will lead me to consider the conceptual trajectory of the New Materialism, especially as it relates to the processual and post-processual approaches which arose in the second half of the 20th century, as well as structuralism

and spatial theory in general. Chapter 3 will then provide an outline of some of the specific types of functionalities a reflexive archaeological interface should offer. In chapter 4, I will address the technical, theoretical and aesthetic challenges of implementing the features described in chapter 3. Given that this project seeks to design a reflexive archaeological experience, some of the approaches developed by reflective design, which is an attempt to explicate some of the underlying assumptions and implications in design processes and user experiences, will be relevant. This chapter will continue the theme of virtuality vs. reality, this time arguing that a key to designing archaeological visualizations and interfaces is acknowledging the role of embodiment - and its challenge to the New Materialism - in shaping virtual experiences. Chapter 5 (Evaluation and Maintenance) will report the findings of the first round of "playtesting" for this project's interface, in which several users (both archaeologists and non-professionals) tested the content and provided feedback. Important here will be the way that user expectations and demands uncover unforeseen problems of both a technical and theoretical nature, as well as lead to iteration in design. I will conclude by proposing, in light of the previous chapters, some possible future directions for 3D publications in archaeology. Here, I will be especially interested in how visualizations demand a form of revision and rapport between users and producers that is not native to the existing infrastructure for print publication. This will be linked to ongoing work in the Gabii Digital Project, which seeks to make inroads into developing a system of peer review for visualization-based publications.

Chapter 2

Project Planning

The first step of the waterfall model requires us to think generally about the project in both conceptual and practical terms. I will begin this chapter by offering a theoretical justification for interfaces as a form of mediation between archaeologists and realistic virtual objects. We will see how interface design, in this light, can become an aspect of archaeological practice. Next, I will consider how users might engage with a reflexive interface, sketching some of the possible functionalities we might expect our interface to offer. I will then explain the advantages Unity offers over GIS, a popular software option for recording and visualizing spatial and landscape data, as a platform for delivering such an interface. This chapter will end by stressing the need for an interdisciplinary approach to interface-focused archaeological projects.

The notion that computers might have an effect on the way we document, share, and explain archaeological information has long been recognized (Reilly, 1990). Nevertheless, while archeology has developed a rather consistent approach to print interfaces, including illustration conventions and the structural organization of site reports (Adkins & Adkins, 1989; Brodbribb, 1970; Dillon, 1981; Grinsel et al., 1974; Perry, 2015) we continue to lack an accepted paradigm for publishing research using digital media. I wish to use this project to suggest that we can better experience (i.e., understand, explain, and debate) archaeological data, especially 3D models, through purpose-made user interfaces which arise not from a single canonical approach to designing such interfaces, but rather a paradigmatic set of design and review practices. Interfaces are powerful tools for organizing and contextualizing spatial data,

representing the difference between “raw” models and skilled illustrations of archaeological features. GUIs can draw attention to themselves, providing a degree of reflexive explicitness to designers’ assumptions about how users will interact with their content, as well as the archaeological implications of what the scene represents.

Lacking a clear model for digital interfaces, archaeologists frequently wonder how we can harness the communicative benefits of online and digital content, which often takes the form of 3D renderings and reconstructions, while still maintaining the authority and rigor of peer reviewed academic discourse (Denard, 2009; Perry, 2015; Pletinckx, 2009; Richardson, 2014). Discussion in this realm often sees archaeological visualization (and digital content in general) as a “problem,” either “of credibility and scientific rigor,” “of long-term preservation of its results,” or of “understanding and recognition” (Denard, 2009*,* p. 2; Pletinckx, 2009, p. 33). By no means are these concerns completely unreasonable. The amount of time we spend using games, mobile applications, and browsing the web continues to increase (Khalaf, 2013), meaning that all of us (archaeologists included) are becoming more discerning judges of digital content in general (Oswald, 2013). At a point when users tend to judge the trustworthiness of a website almost instantly based on simple design elements (Wilson, 2011), there is a real demand for archaeologists to think about how the look, feel (in both a haptic and emotional sense), and structure of our content are closely linked to how it will be received by our peers, not to mention non-professionals. Archaeological interfaces, then, must communicate professionalism, care, and usability. This is not simply a response to anxiety over “losing control” of the archaeological record once it enters the digital domain (Richardson, 2014). Rather, it is about an ethical responsibility

to our sites, materials, and the people they represent. Beyond this, good interfaces also encourage collegiality and exchange both among archaeologists and with other professionals.

This project is partially a response to a dearth of discussion about archaeological interfaces in contemporary literature. Bonde & Houston (2013), for instance, a volume attempting to represent some of the most recent ideas in archaeological representation, contains no explicit treatment of interface design. Documents intended to establish standards in archaeological visualization, most notably the *London Charter*, have yet to seriously engage the question of interfaces whatsoever. Instead, emphasis remains on "documenting" and "evaluating" visualizations via presumably separate (i.e., not directly integrated into the visualization itself), standard routes of publication (Denard, 2009, p. 9). The shortcoming of this approach is that it separates what makes a visualization credible and useful from the visualization itself. Publications which have gone through the familiar peer-review process of print scholarship would seem to be the only way of validating the scholarly contributions of visualizations. Yet, as I will explore in chapter 5, traditional peer-review is not well suited to the iterative, trial-and-error, feedback-rich way in which digital content is generally developed, nor to the speed at which digital tools and approaches evolve (Hunicke et al., 2004; Stonehouse, 2014). The need to fit visualizations into existing modes of publication probably reflects an inherent uneasiness in archaeology about the supposed illegitimate and seductive persuasiveness of realistic virtual environments (Favro, 2013; Lowenthal, 1996; Olsen, 2010; Olsen et al., 2012; Shanks & Webmoor, 2013). Documentation and standardization are thus seen as a sort of check on the potentially misleading nature of

hypothetical or enticingly “immersive” reconstructions. While I agree that visualizations should strive “to ‘correlate’ the sources” (i.e., transparently show upon what evidence they are based; Pletinckx, 2009, p. 35), I think we should acknowledge that visualizations can exist as discrete pieces of scholarship that communicate their own terms of credibility through GUI elements. The credibility and “scholarly value” of visualizations, then, becomes less about adherence to standards which, in all likelihood, are developed in a separate context than the one in which content itself is created, and more about their relative usefulness to specific research questions.

Absolute standardization of archaeological GUIs is simply not well suited to the dynamic nature of content design and use, and thus in this project I will not be concerned with proposing interface standards. In fact, researchers in the field of interface design tend to emphasize intra-content over cross-content consistency (Landsdale & Ormerod, 1994). Following the lead of the game industry, standardization is by no means necessary for a rigorous and effective peer review mechanism. The review process of many commercial games involves internal prototyping and iteration, external testing of beta releases, full releases, patching, and industry “postmortems” (critical post-release reviews, often created in conjunction with the design team itself of the game in question; Fisch, 2009). The game review site Gamasutra (Gamasutra, 2015), for example, a leading source for postmortems of both professional and independently produced games, is a testament to the way that games undergo a high-level of scrutiny at all phases of design and release without relying on heavy-handed standards. Due to the financial risks involved in the professional game market, a rigorous review process is seen as vital to the success of games as consumer

products. Although game “peer review” obviously exists for a different reason than academic peer review, in chapter 5 of this project I will show how borrowing some elements of this review cycle can help create academic content that is more impactful, responsive, and relevant.

Meanwhile, archaeological discussions about digital standardization, best practices and credibility are almost always limited to the context of reconstructions, representing a rather narrow view of the range of applications afforded by visualization (Bentkowska-Kafel, 2013; Georgiou & Hermon, 2011; Goodrick & Gillings, 2000; Kuroczyński et al., 2014; Pavlidis et al., 2007; Pletinckx, 2009). This preoccupation with reconstructions is probably connected with a desire to distinguish archaeological visualization from the sort of “popular” visualizations which might be produced for video games, films, websites, television, or even museums. The risk in constructing such a rigid dichotomy is that we might insulate ourselves from the interesting and iterative patterns of development which have led to the interface conventions of websites, games, and mobile applications (Stonehouse, 2014). If we want to develop new ways of experiencing archaeological data, we must acknowledge that the unpredictability of the design process is often responsible for the most creative, robust features a product offers (Fisch, 2009; Hunicke et al., 2004; Schell, 2008). Furthermore, recent approaches show that reconstructions of past environments are but one specific component of the broader application of archaeological visualization, and we should thus expand our definition of the range of questions for which archaeological visualizations might be useful.

Particularly, this project will take a lead from researchers who increasingly hypothesize the theoretical value of using visualization for accessing the "physical reality of existing material remains" (Olsen et al., 2014; Opitz, 2015; Rabinowitz, 2015, p. 28). My aim is to construct a dynamic and not-exclusively-visual representation of the Area B House, as excavated. Beyond the sense of spatial context provided by models alone, GUIs offer a way of consolidating the "highly detailed archive of observations and related…records" created during excavation and making interpretations more explicit and therefore available for scrutiny (Tsipidis et al., 2011, p. 86). Visualizations can help make sense out of the fragmented, dense collection of data generated by any excavation. However, this outcome cannot be fully realized unless we develop meaningful user interfaces for our content, yet publications on technologies like laser scanning and SFM (intended to record the "physical reality" of sites) rarely attempt to show how photorealistic models might be used in a research setting, perhaps exacerbating the impression of 3D modeling as an ocularcentric form of representation (Barsanti et al., 2013; Chandler et al., 2007; Dell'Unto et al., 2013; De Reu et al., 2012; Lerma et al., 2010; Pavlidis et al., 2007).

On one hand, I take a lead from conventional archaeological illustrators who argue that the image (or the thing it depicts) *per se* is not sufficient. The skilled illustrator "selectively portrays the details that the reader needs to see and edits out irrelevant details" (Akins & Adkins, 1989, p. 7). Illustrations, by this conception, are more than simple drawings of how an object looks, but "faithful construction[s]" of "relational model[s]" representing "what is *known* about an object" from a specific interpretive, cultural, and disciplinary perspective (Carlson, 2014, p. 273; Piggot, 1978, p. 7). In this

project, interface fulfills this explanatory function of illustration. On the other hand, the move toward 3D illustration is an opportunity to address some of the shortcomings of print conventions: namely, that they are too inflexible and unclear about how the illustration relates to the raw thing it depicts. 3D models, and the user's embodied interaction with them, also elicit an intuitive sense of the house's spatial context. As users navigate this context in real time, accessing descriptive and interpretational information along the way, they become actors in a "system" created by placement of the house's features (especially walls and other architectural features which divide or partition space, and thus exert a particularly notable type of agency over human perception and movement). Direct interaction with this system, which is necessarily more than sum of its constituent parts, is itself a unique way of communicating archaeological information, and this challenges certain elements of the New Materialism (discussed further in chapters 3 and 4). One promising potential area of research would also consider how the systemic properties of interactive visualizations intersect with archaeological theories relating to structure and agency (Dobres, 2000).

The approach I am establishing here seeks consciously to bridge visualization and illustration, but also directly addresses the suspicion that 3D models, especially photorealistic, interactive (and thus corporeally affective) ones such as the type produced by SFM, can be more deceptive than revealing (Lowenthal, 1996). Like producers of conventional archaeological illustrations, I make no claim at producing "a replica…a surrogate or replacement for an original" (Reilly, 1990, p. 133), but acknowledge that 3D models "have their own independent reality as objects or works requiring their own documentation and explanation" (Rabinowitz, 2015, p. 33). I am also

cognizant of the idea that illustration is “a subjective process that presents not only descriptive information, but also an interpretation of that information” (Carlson, 2014, p. 273). 3D models explained with GUI elements and subject to user interaction are more than “superficial views of objects” (Carlson, 2014, p. 270), representing a false impression of completeness, essentiality, and *physicality*. In chapter 4, I will address the implications of an embodied experience with archaeological models. Furthermore, if hyperrealistic images run the risk of emphasizing surface level details over analytical or interpretational information, interfaces have a responsibility to rein in that effect, contextualizing and explaining what the user experiences. Another way of putting this is that embodied interaction and interface elements challenge the supposedly ocularcentric nature of virtual environments as suggested by, for example, Carlson (2014).

Now that I have made the case for interface design as an archaeological practice, I will attempt to sketch a general view of how a reflexive interface might function. In order to “place the thing to be understood…more and more fully into its context” (Hodder, 1991, p. 8), we must have access to basic descriptive information about individual features and also interpretations relating to those features. Keeping in mind that our scene will include a collection of photorealistic models, it will be helpful to divide the models up by stratigraphic unit, grouping descriptive data for each in single entries. Yet, in the interest of responding to the New Materialism, care should be taken not to abstract features too much into textual descriptions and interpretations; constant or near-constant access to 3D models themselves should be a priority. Meanwhile, free movement throughout the site allows for nonlinear and embodied interaction with our

descriptions, interpretations, and 3D models, perhaps providing for alternate (multivocal) readings and uses, a key aspect of reflexive archaeology. Accordingly, we should plan for a mechanism for responding to or challenging descriptions and interpretations contained within these entries.

Free exploration and response can also allow for what is referred to in the field of game design as “emergent systems.” These are simply the results of structures which allow for unpredictable patterns of use, and are praised by some designers for their power to place emphasis on the creativity of players themselves, instead of game creators (Alexander, 2013; Tekinbas & Zimmerman, 2003). If part of reflexive archaeology involves “decentering…the author” (Hodder, 1997, p. 6), allowing for emergent systems should be a priority. Emergent systems are notoriously unpredictable, and by definition cannot be explicitly designed. Tekinbas & Zimmerman (2003), emphasizing the nonlinear nature of emergent systems, observe that emergence is “a product of coupled, context-dependent interactions” (p. 159). Emergent systems are thus an interesting way of thinking about our relationship to archaeological things-qua-things. According to symmetrical archaeology and the New Materialism, things are always part of entanglements with other things and humans (Hodder, 2011; Witmore, 2007). We can relate entanglement to this idea that interactions producing emergence are coupled and context-dependent. Entanglements are coupled because they are comprised of humans and things that are “linked recursively;” they are context-dependent because their interactions “depend on what else is happening in the system at any given moment” (Tekinbas & Zimmerman, 2003, p. 160). Interaction with this system in the form of an embodied player might be a powerful way of understanding

how things in conjunction with other things provide archaeological information which is more than the sum of its parts.

As designers, this means that we should be careful not to place too many constraints on how users will interact with our models and interface dialogues. Providing tools for toggling features, switching modes of viewing, or freely moving between the "screen space" and an accompanying textual narrative might be a good way of encouraging players to interact with the Area B House in an emergent, creative way. At the same time, care must be taken to provide a system which is coherent and predictable enough to meet basic "usability" standards (Landsdale & Ormerod, 1994). Chapter 3 will show how movement throughout the house reflects an emergent system of gameplay which, if not directly an interface element, has important repercussions for how users interact with the interface.

In the next chapter, I will extend a more nuanced definition of what kind of functionalities this project will include, but at the moment it is important to consider how Unity is a platform that can meet these interface demands. As a game engine, Unity offers some unique capabilities. An inherent overlap exists between games and archaeological visualization, which has only very recently become a nascent area of interest (Reinhard, 2014; Politopoulos, 2014). At a technical level, both are tasked with the creation of compelling environments that often demand assets of high fidelity but usable resolution, as well as attention to ambient factors like light and acoustics. Theoretically, there is a shared concern about how users will interpret and respond to virtual environments, some of the main points of which I reviewed in chapter 1. Since

Unity responds to these needs in a game design context, its application to archaeological questions has received some attention (e.g., Eve, 2014).

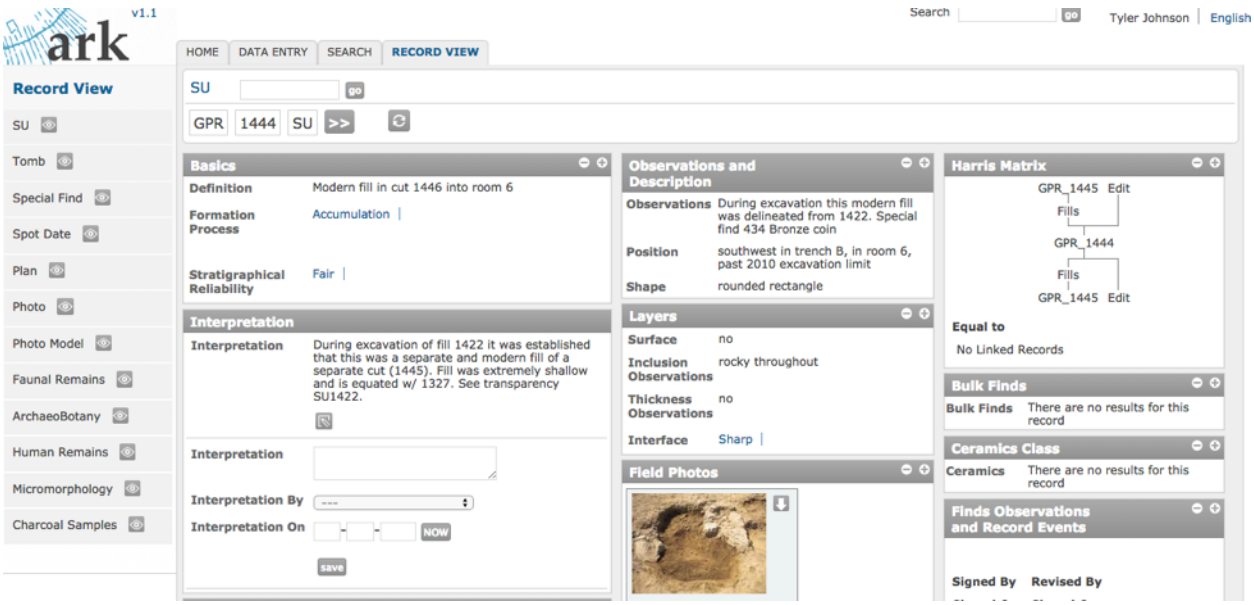

Figure 4: *The Gabii Project's own Ark database interface.*

While tools like Unity offer promising design features, few archaeological datasets contain a formal interface. Online archaeological databases, such as those created with the open source Ark toolkit (Eve & Hunt, 2008), make up a significant portion of archaeological interfaces, but the degree to which these represent theoretically informed design choices is unclear (Figure 4). Otherwise, archaeologists who work with spatial data most often interact with the interfaces of GIS applications (Kanter, 2008; Katsianis et al., in press.; McCoy & Ladefoged, 2009; Tsipidis, 2011). In archaeological literature, GIS interfaces are typically treated only incidentally to larger theoretical or methodological questions about GIS itself (McCoy & Ladefoged, 2009; Peterman, 1992; Sharon et al., 2004). Because GIS packages tend to brand themselves as scientific tools (Wright et al., 1997), and because they genuinely do possess

remarkable capabilities for cataloging and analyzing spatial data, they are an attractive platform for field archaeologists whose primary concern is accurate and organized spatial information.

However, an important aspect of reflexive archaeology is “reuniting” field documentation and the processes of interpretation. While GIS packages may help us construct highly organized information architectures (especially for spatial data like the kind with which I am concerned in this project), their interfaces are not typically user-centered, and their lack of flexibility does not invite critical reflection about how their design could affect the archaeological work we do (Figure 5). The ArcGIS interface, for instance, is stylistically rather cold, even clinical. Its tools for navigation, querying, and feature description convey the impression that we are dealing with static, descriptive information, not engaging in the dynamic, often destabilizing process that is archaeological interpretation. Its busy approach to toolbars and menus, loaded as they are with text and icons, recalls an interface aesthetic of years past, and does not communicate to the user a sense of learnability and reliability. Still less does it promote a sense of curiosity, experimentation, and fun, which, as recent interface design studies show, can be a crucial element of the user experience (Hunicke et al., 2004; Scollan, 2007). These factors, although superficially less tangible than the procedural tasks one executes while using GIS, are serious obstacles to archaeologists who need to access data fluidly in an information-rich but effectively responsive environment during the interpretive process. They are also impediments to elevating general interest and trust in digital tools for archaeology.

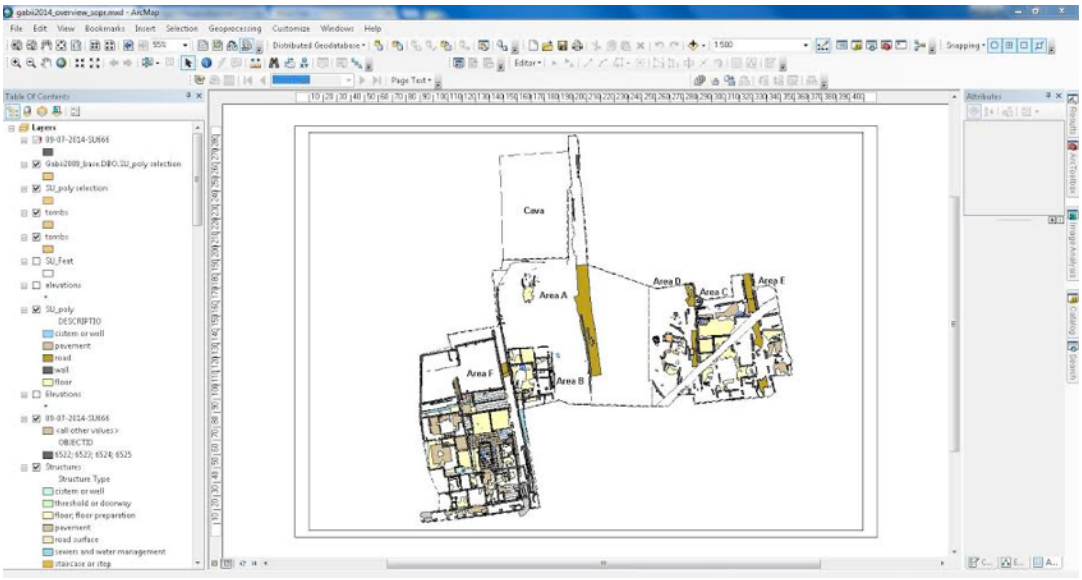

Figure 5: *A sample of the ArcGIS interface.*

To conduct reflexive archaeology during post-excavation work, users need to easily access both descriptive and interpretive information about 3D models. Currently, game engines are the most suitable platform for this task. Although GIS software is used in a variety of excavation and research contexts (McCoy & Ladefoged, 2009), its capabilities for 3D and interface customization are limited. Meanwhile, game designers have worked closely with 3D models as art assets for over two decades. Techniques for texturing, lighting, and rendering virtual environments continue to evolve, and Unity provides some of the most important tools designers rely on for these purposes. These include a simple drag-and-drop interface for adding 3D models to scenes, advanced options for texture rendering (including normal maps, which cut down on processing by converting small geometric details into textural effects), light baking, global illumination, and ambient occlusion, but also: flexible interface design plugins, a responsive and experienced online support community, and a variety of customizable, prepackaged assets of various kinds.

While these benefits of Unity might seem rather practical, its theoretical applications potentially pertain to some of the more controversial questions in digital archaeology. I have already discussed how the Area B House, a game-like 3D environment which constrains the embodied movement of players and can expose relationships between features, implies the possible of emergent systems. In the next chapter, I will show explicitly how this idea might challenge a hard-line interpretation of the New Materialism. Otherwise, a customizable GUI helps us address the need for increased transparency about how our interpretations, especially reconstructions and models, relate to what we record in the field (Denard, 2009; Wylie, 2002). This is a concern raised frequently in literature about archaeological visualization in general, but is also a major demand of reflexive archaeology (Hodder, 1997). My choice here is to emphasize GUI elements as tools for explaining and contextualizing interpretations. Meanwhile, I argue that realistic game environments (such as ones containing SFM models), because they refuse to hide archaeological details in highly abstracted forms of representation, foster a critical evaluation of how interpretive decisions relate to specific pieces of evidence. Moreover, embodied interaction with the 3D models which are the basis of our interface, although a challenge to the rather empirical epistemology of the New Materialism, is a fundamentally different than traditional illustration because of the way it can induce a sense of self-awareness among users (Keogh, 2014). In this way, Unity is an excellent platform for a reflexive and symmetrical interface.

Finally, expertise requirements and time-cost are important to anticipate during project planning. For our project, consideration of these factors raises the need for an interdisciplinary approach to interface design. Familiarity with even the basic principles

of interface design demands a considerable investment of time and effort. It is true that several plug-ins for Unity (e.g., NGUI, used in this project) strive to streamline the most technical aspects of interface design. However, the wider the designer's understanding of programming, the more options are available for tackling design challenges and building creative features. Non-archaeologists were not officially integrated into the team for this project, but the benefit of developing relationships with programmers and computer artists who can provide informal help cannot be overstated. Access to technical training (or non-archaeologists with relevant skills) is perhaps the biggest obstacle to any digital archaeology project. In all cases, we should seek to maximize rapport between experts/content producers and archaeologists. The precedent set by traditional archaeological illustrators shows that "outsiders" can often contribute to the interpretation process in meaningful, unexpected ways (Piggott, 1978; Perry & Johnson, 2014). Because they bring fresh perspectives to archaeological problems, interdisciplinary approaches to interface design also encourage multivocality, a major priority of reflexive archaeology. Yet the challenge of fostering interdisciplinary relationships is significant. For archaeologists, it not only requires learning technical skills, but communicating our own needs and priorities to non-archaeologists in a way that is clear and understandable (Carver, 2006).

The brunt of the work for this project itself was undertaken in an academic game studio (Tesseract: Game Design and Immersive Environments), and this rather unusual professional setting not only meant near constant access to training and advice from peers, but a unique exposure to fresh, critical perspectives on games and other media. The Tesseract studio encompasses a diverse range of activities, including game design

instruction, historical visualization and 3D modeling, database construction, and the design of game-centered course development modules. My personal participation with this lab has proven to be a major influence on the way I have chosen to approach 3D archaeology and interfaces. Namely, the institutional requirements of building an educational game lab “from the ground up” have meant that all members of Tesseract must take an interdisciplinary, non-specialist, and self-critical approach to learning and developing skills.

The planning phase of this project has extended the idea of visualization as illustration, and of interface as a way of mediating between archaeologists and virtual objects. I have offered a broad concept of what kind of features a reflexive, thing-centered interface would provide, and explained why Unity is an appropriate choice over alternatives like GIS for this project’s platform. The primary benefit of Unity is its ability to present SFM models in a spatial context with an interface that allows reflexive considerations of the evidence to be pursued, without necessarily distracting from the materially rich environment represented by the models. Lastly, I have underscored the interdisciplinary nature of 3D archaeology. The next chapter will create a well defined plan for what types of features this project’s interface should support, and this requires that we take a more involved look at some theoretical questions underlying both reflexive archaeology and the New Materialism.

Chapter 3

Specification

User interface specification in a professional context is an involved task which can follow a variety of methods for determining what types of functions the final product should contain. This paper will not include a formal user interface specification document, but in this section I aim to summarize a list of possible user functions. These should suit both the nature of our data and the priorities of a reflexive approach. Since this project's interface primarily deals with 3D models of archaeological features, it will first be necessary to consider some important questions in current archaeological theory about the nature of things and our epistemological relationship to them. I will extend context and embodiment as concepts which raises some challenges to the New Materialism, but which, due to their importance to reflexive approaches, should be emphasized by our interface. Since this project attempts to prolong the opportunity for reflexive archaeology into the post-excavation experience, we will see how building working interpretations onsite compares with doing so using 3D environments. This raises some questions about virtual reality and the nature of objectivity as defined by hard-line New Materialism. Accordingly, I will include a broader treatment of the theoretical roots of the New Materialism, emphasizing its connection with processual and post-processual archaeology, as well as structuralism and the spatial turn in humanities. Having established a firm theoretical basis for our interfaces choices, I will end the chapter by specifying a variety of features which should comprise a reflexive and cautiously thing-centered interface.

A widespread sentiment in most of archaeology is that archaeological things only have meaning in context - spatial (where it is in relation to other things), typological (what is it like in comparison to other things), social (how was it used/what uses did it contribute to), or otherwise. This is theoretically significant in terms of interface design for several reasons. First of all, from a strictly rationalist point of view, context is not a physical property of objects in the way that, for example, color or composition is. Rather, determining an object's context requires that we abstract its materiality into an assemblage, or relation with other materials. Inevitably, this involves ascribing *meaning* to objects, and this contradicts a pervasive idea in the New Materialism that emphasizing meaning risks ignoring "things qua things, and the possibility that they themselves might be indispensable constituents of the social fabric that is studied" (Olsen, 2010, p. 38). But embracing the contextual meaning behind things should not be seen as an undervaluing of materiality. On the contrary, materiality is inseparably linked to the context through and within which it signifies, and a refusal to place "a restriction on interpretation, signification, or meaning" is an important contribution of symmetrical archaeology to the New Materialism (Olsen et al., 2012, p. 13). According to symmetrical archaeology (and with this sentiment I agree), things can have meaning beyond their importance to people (Olsen et al., 2012). In other words, things can be important not only because of their relationship with other things, but because of their "inherent properties," and these properties can often be the reason things have a particular symbolic or functional meaning (Olsen et al., 2012, p. 13). As an example, Olsen (2010, p. 146) cites Latour's (2005) consideration of silk and nylon stockings. Without the inherent differences between silk and nylon, the social difference

attributed to them would not exist; the materiality of silk and nylon precedes any interaction with humans. Therefore, a thing-centered interface should not shy away from the things' relational properties with humans (or other things for that matter), but should be cognizant of how the materiality of things contributes to their contextual meanings. What an interface does challenge, however, is that materiality can be experienced "in an unmediated way" (Olsen 2010, p. 156).

Just as I am wary of the notion that things can speak for themselves, I am not convinced of the possibility of unmediated human-thing interaction. Although I understand the New Materialism's desire to move beyond a conception of things as purely reducible to their function as signifiers or symbols, the assertion that things can exist in a purely essential form - divorced from signifying properties or our subjective conceptions of them - is equally extreme. On the other hand, and I think this is the view which symmetrical archaeology would support, a definition of things as the tension between materiality and signification (of symbolic meaning or spatial context) is more balanced and less tied to hard-line theoretical stances.

Context is also relevant to the pursuit of reflexive archaeology. Especially while conducting onsite reflexive criticism, the more information we have about the features we analyze, including context, "the more is immediate interpretation facilitated" (Hodder, 1997, p. 4). I believe we can extend this concept to virtual environments, and indeed, Hodder's 1997 paper is somewhat prescient in this regard (p. 6 - 7). But just as 3D models cannot be surrogates for real archaeological things, a virtual experience with an archaeological site - no matter how context rich - is different than a real one in some important ways.

Because interfaces can foreground interpretive assumptions, qualitative data, and areas of special interest, visualizations can actually be more context-heavy than "in-person" experiences. Onsite, this kind of information can be difficult to access fluidly (equipment, proper servers, and remote internet access can all be costly and of sometimes limited access). But taking archaeology to be more than the physical reality of what we excavate (i.e., also comprised of knowledge or thoughts about that reality and information about its context), it is important to integrate into the interpretive process some of the aspects of sites and features which are less tangible than what we see, touch, and move around (Witmore 2007). We can safely assume that to a certain extent this integration already occurs "in the heads" of experienced excavators. Indeed, the physical acts of seeing, touching, or moving around an archaeological thing are vital to the process of forming interpretations and understanding context. The more time one has spent digging, documenting, and studying sites, the easier it is to make connections and form interpretations "at the trowel's edge," and this suggests a corporeal element of reflexive archaeology that Hodder implies without making explicit. Olsen (2010) himself nods to the phenomenological argument that habit is "acquired through and stored in our bodies" (p. 7). The very notion that we learn about objects by interacting with them through the systemic (and therefore mediated) practices and relationships of excavation reveals a further weakness of a hard-line New Materialist ontology of things.

There are several benefits to externalizing at least part of this physical and mental process into GUI elements. In the interest of reflexivity, it helps us be more clear about why, precisely, we have formed specific archaeological opinions. Even (or especially) for skilled excavators, experiencing a site virtually can be mentally

disorienting. Being comfortable making interpretations and assumptions onsite depends on the daily routines of site operations. The performance of archaeology is a social, sensory, and (culturally conditioned) interpretive action which activates personal memories and lessons-learned, helping excavators to predict outcomes and relate new stratigraphy to previous experiences. In a 3D environment such as the one with which this project is concerned, the familiar cues of these daily actions are absent as the archaeological body is swapped for a “game body.” Using the GUI to capture the unspoken analyses that happen internally onsite is a helpful way of reorienting ourselves in virtual environments, mentally and physically. Also, while we are limited onsite to what we experience and think, interfaces can incorporate alternate descriptions and distillations of post-excavation analysis. Easy access to these kinds of entries for different features should thus be a top priority of our design. Unlike print publications, information displayed in digital interfaces should also be easy to edit and update. Given the right design, this could help archaeologists rapidly respond to user input and criticism. Interactivity of this sort - both on the screen and off - allows us to continue the “momentary, fluid and flexible” reflexive interpretive experience well after the field season has ended (Hodder, 1997, p. 4). It answers the call for archaeologists to be more reflexive about how “archaeological knowledge has been produced,” and perhaps invites further scrutiny of how visual images - including photorealistic SFM models - “shape knowledge in ways of which the viewer, as well as the illustrator, is often not aware” (Hamilton, 2000, p. 119; Leibhammer, 2000, p. 129). Reflexive archaeology, by this conception, is not limited to the practice of onsite reflection, but includes an ongoing scrutiny about how the nature of documentation can shape the way

we define the evidence. Due to the programmability and flexibility of 3D content, I argue that they can sometimes offer an even greater versatility in forming and evaluating interpretations than onsite reflection.

The idea that we can potentially understand the context of a site more easily from within a visualization would seem to be contrary to much thinking about virtual reality as well as a strictly empirical understanding of epistemology. Virtual reality studies often suggest that "experiential fidelity" (i.e., the "subjective experience of 'being there'") is the most important criterion of visualizations (Stoffregen et al., 2003, p. 120). On the contrary, despite its emphasis on 3D models that are realistic and accurate, this project does not attempt to simulate any specific "real-life" activity, and actually refutes the idea that 3D models can be depicted in an absolutely objective manner. Rather, like viewers of conventional archaeological illustrations, users of archaeological interfaces are experiencing more than visual depictions of physical things, but representations of *ideas* about those things. A context-rich interface attempts to take advantage of the ways that visualizations provide an extension of spatial reality, a "*different* mode of sensing our environment" that can allow us to understand and interpret it in new ways (Zona 2015, para. 5-6). In response to the New Materialism, the benefits of a context-heavy interface and embodied interaction dispute that the ideal way to interact with things should not involve mediation. In fact, an emphasis on context - where things exist in relation to other things and humans, including ourselves, in both the real and virtual world - undermines the possibility of unmediated contact with things or a completely objective representation of a past environment.

The intersection between the New Materialism and reflexive archaeology is thus an important matter to investigate for the purposes of specifying features. I propose that a "thing-centered" *and* reflexive approach to interface design actually demands both realism in the 3D representational approach and consciousness of non-physical aspects of objects, including context. This is despite the fact that one implication of the New Materialism deemphasizes the symbolic quality of things. On one hand, the New Materialism asks us to "trust in our own perception" and the "peculiar material manner" of things over theory-laden interpretations (Olsen, 2012a, p. 24). On the other hand, the theoretical conception of things as "gatherings of achievements" (i.e., physical manifestations of diverse human actions that occurred at a distance in space and time; Witmore, 2007, p. 558) indeed requires us to trust more than our immediate sensory experience of objects, to analytically parse them out into descriptions and interpretations of their trajectory. Context, and the relations an object has to the people it interacted with, *is* a (contemporary) symbolic function of archaeological materials. Interpreting context is an intellectually/culturally provisional practice, and this is one of the primary contributions of reflexive archaeology, but is often overlooked by hard-line New Materialism (Hodder, 1997).

As we attempt to understand the interface-design implications of the New Materialism, an interesting opportunity arises to fit this recent theoretical turn into the larger trajectory of archaeological theory. An interface which is designed under the assumption that objects contain inherent truths (Olsen, 2012a) could do a poor job of communicating unintuitive information to users, and, problematically, would rehash the major epistemological assumptions of processual archaeology. This school of thought

arose as a response to the dearth of explicit theory in archaeology in the decades leading up to the 1960s, and its supporters wished to trade in the old social-historical methods of understanding ancient cultures for more rigorous, scientific ones (Johnson, 2010). Emphasis was on the development of specific hypotheses about processes of cultural evolution which could be "tested" against the archaeological evidence (Binford, 1962). Processualists wanted to know what sort of factors induce change in a given society, and whether general trends are evident which could be applied to different cultures at similar levels of development (Binford, 1962; Flannery, 1972; Hegmon, 2003; Schiffer, 1988). Underlying all of these questions was an emphasis on "systems thinking," or how cultures, like properties of the physical world, function as complete systems which tend to abide by certain rules of procedure (Flannery, 1972; Kohler, 2011; Johnson, 2010). Processualists stressed that cultural systems adapt to their external environments, leaving traces in the material record which, if examined with the proper analytical tools, would reveal the underlying currents that led to cultural changes (Binford, 1962; Johnson, 2010). In other words, they tended to endorse a positivist view of objectivity and perception (Johnson, 2010).

By the 1980s, some archaeologists began to argue that processualism actually took a myopic view of how cultures change and how this might be reflected in the archaeological record, but that it often treated its conclusions as scientific truths (Johnson, 2010). Hence the growth of post-processualist archaeology, which emphasized, among a number of other things, subjectivity in archaeological analysis (Johnson, 2010; Julian & Tilley, 1992; Shanks, 1992). Post-processual thought usually held that while societies provide structure, culture is actually a recursive mediation

between normative paradigms - which themselves are often self-contradictory and amorphous - and the volition of individuals (Dobres, 2000; Hegmon, 2003). Because of this, material culture always means different things to different people and, like a text, will be interpreted differently depending on the cultural background of the "reader" (who can be both the ancient producer/user of the artifact or the modern scholar; Hegmon, 2003; Johnson, 2010). According to many thinkers in this school, the problem with assuming that archaeological evidence has a single archaeological meaning is that, due to the perceived structures of control and dominance built into western rationalism, archaeology risks reinforcing both ancient and modern apparatuses of power (Johnson, 2010). Most post-processualist theory still acknowledges that archaeological ideas can be judged at least quasi-objectively depending on their essential usefulness in explaining specific sets of evidence (Hodder 1991; Julian & Tilley, 1992). However, I suspect that post-processualism's inherent distrust of positivism, which could easily be construed as an inherent distrust of observation and science, is a possible root of the New Materialism's desire to "return" to objective, unmediated things. As a result, the New Materialism (as applied by, for example, Olsen [2010]) implies that a practice rooted in a type of "pure" observation is preferable to an interpretational science.

The New Materialism can also be connected to the broader spatial turn in humanities, which has roots in mid-20th century structuralism. During this time, cultural theory saw an increased emphasis on what can be termed the "social production of space" (Lefebvre, 1992). Thinkers like Lefebvre, de Certeau (1984), Foucault (1977), Hillier & Hanson (1984) and Massey (1994) were particularly influential within this turn, raising questions of the symbolic meaning of landscapes, panoptic

surveillance, and the relationship between identity and daily patterns of movement. The spatial turn was a natural complement to structuralist thinking, which held a view of knowledge and observation as provisionally affected by cultural, conceptual and linguistic structures. The importance of space to structuralist thinking is attested by influential studies such as Pierre Bourdieu's of Berber domestic space, in which the division and organization of Berber households reflects linguistic and religious structures in that society (Bourdieu, 1970). Socially produced space, then, became a way of objectifying society's conceptual structures into physical environments and daily patterns of habitation (Lefebvre, 1992). Or, as Massey (1994) put it, "the spatial is constituted by the interlocking of 'stretched-out' social relations" (p. 22). For thinkers like Lefebvre, the process of "spatialization" is often seen as political, reinforcing the power structures of dominant groups. In archaeology, the importance of spatial relationships had been recognized since the late 19th century, but the spatial turn did coincide with increased interest in phenomenological aspects of environments and, accordingly, a growing emphasis on spatial documentation such as the kind achieved with a GIS (Wheatley & Gillings, 2002). This created a timely intersection between theory and technology, and reinvigorated a critical interest in how we document and interpret spatial information (Bodenhamer et al., 2010).

The history of these intellectual movements is important because post-processualism, which gave rise to reflexive archaeology, owed a great deal to the emphasis of structuralism (and, later on, post-structuralism) on the provisional nature of knowledge. Part of reflexive archaeology, then, means challenging empiricist epistemologies of objects, which are categorically opposed to structuralist approaches

to knowledge (Fiske, 2011). The issue is that the New Materialism seems to embrace at least a quasi-empirical view of knowledge (Witmore 2010), with its assertion that things, "contrary to the linguistic sign," contain a reality which is "experienced directly, through themselves" (Olsen, 2010, p. 156). Witmore (2010) qualifies the "symmetrical" approach to empiricism as "Empiricism 2.0" (p. 20), but still remains skeptical of Hodder's emphasis on the subjectivity of human interpretation. If we wish to unite a reflexive approach with a New Materialist conception of archaeological things, it is important to reconcile the epistemological differences between the two.

The New Materialism certainly shows that trusting in objects does not necessarily mean reproducing narratives of power. Particularly, interest in the mundane over the monumental is a way of acknowledging non-elite, diverse voices in the archaeological record (Olsen, 2012a). My suggestion is by no means that the New Materialism is reducible to the political (or even epistemological) shortcomings of processualism, but that its application is severely compromised if we ignore that the process of unraveling the entanglements which define human-thing interaction is one of *interpretation* and *subjectivity.* A return to things is promising, as is the ability of non-print interfaces to facilitate it (Witmore, 2007). It is best realized, though, by encompassing a reflexive approach. Interpretation is inescapable, both in archaeological practice and representation. The most effective way of overcoming our individual biases, preconceptions, and tendencies to oversimplify what is actually an infinitely complex past is to subject our ideas constantly to scrutiny and criticism from as many angles as possible (Chadwick, 1997; Hodder, 1997). The way that "all things gather achievements" (Witmore, 2007, p. 557) should not be viewed as an absolute truth, but

should be treated as a subjective construction of knowledge, open to criticism and revision. Witmore (2007), in his “manifesto” of symmetrical archaeology, points out that understanding “the impact of things” depends on archaeologists closely considering how they “engage with the material world” (p. 559). In other words, a symmetrical approach places less faith in the “objectivity” of things, and more on the entangled - and provisional - relationship between people and materials. These observations on the intersection of reflexive archaeology and the New Materialism set the foundations for a theoretical understanding of what a thing-centered interface must address. At this point, we will begin sketching specific user functions which might accommodate diverse types of data and arguments.

At a fundamental level, field archaeology is still largely (but not wholly!) a practice of description. Despite anxieties that the subjective epistemologies of post-processualism would emphasize meaning, symbolism, and multivocality at the expense of logic, fact and scientific rigor (Yoffee & Sherratt, 1993), and even if anecdotal examples to the contrary abound, archaeological data are increasingly collected and managed in categorical, standardized ways (Carver, 2006; Spence, 1990). At Gabii, descriptive data and preliminary interpretations are serially logged into an online database. The goal of this interface is to convert field data into an accessible form. As field operations operating under even reflexive methodologies have demonstrated, completely eschewing the conventional ways of organizing evidence is not helpful. Documentation produced at Çatalhöyük, for example, which offers perhaps the definitive example of a post-processual excavation methodology, includes Harris Matrices and traditional methods for illustrating artifacts, sections, and contexts

(Leibhammer, 2000). This is true even as illustrators explored alternative methods for documentation and depiction and strived for a uniquely critical view of how archaeological images both situate and are situated by our interpretations of the past (Leibhammer, 2000; Swogger, 2000).

From an interface design point of view, the same is true; many critics note that the best advances in interface complement, rather than replace, existing paradigms (Landsdale & Ormerod, 1994). Thus, access to statistical, qualitative, or otherwise "scientific" pro-forma data expressed in terms familiar to the field - and heavily influenced by the assumptions of processual archaeology - is a major priority. Basic information about an SU's composition, bulk finds, and stratigraphic sequence are all important parts of understanding a *possible* way of interpreting the evidence in the Area B House, especially given the preponderance of the single-context method of documentation in Italy and, more broadly, regions and schools influenced by the English tradition (Carver, 2006). Because this type of information is generally concise and of a serial nature, it lends itself to a template format. We can imagine, for example, "pop-up" windows which, depending on their corresponding features or stratigraphic units, fill pre-defined forms with descriptive information.

While standardized pop-up windows are an effective way of displaying categorical descriptions, New Materialist approaches rightfully warn against the pitfalls of attempting to "sanitize" the past into clean, orderly representations (Olsen, 2012a). Standardized object typologies and descriptions run the risk of implying that the unstable, messy outcomes of human-thing entanglement at a site can be distilled into a straightforward representation. Because of this, pop-up type entries for different

features should also require a space for individualized comments on phasing, use, or social interpretations. On the other hand, trying to present extended descriptions and arguments in a single window could make for a jumbled, unnecessarily text-heavy interface.

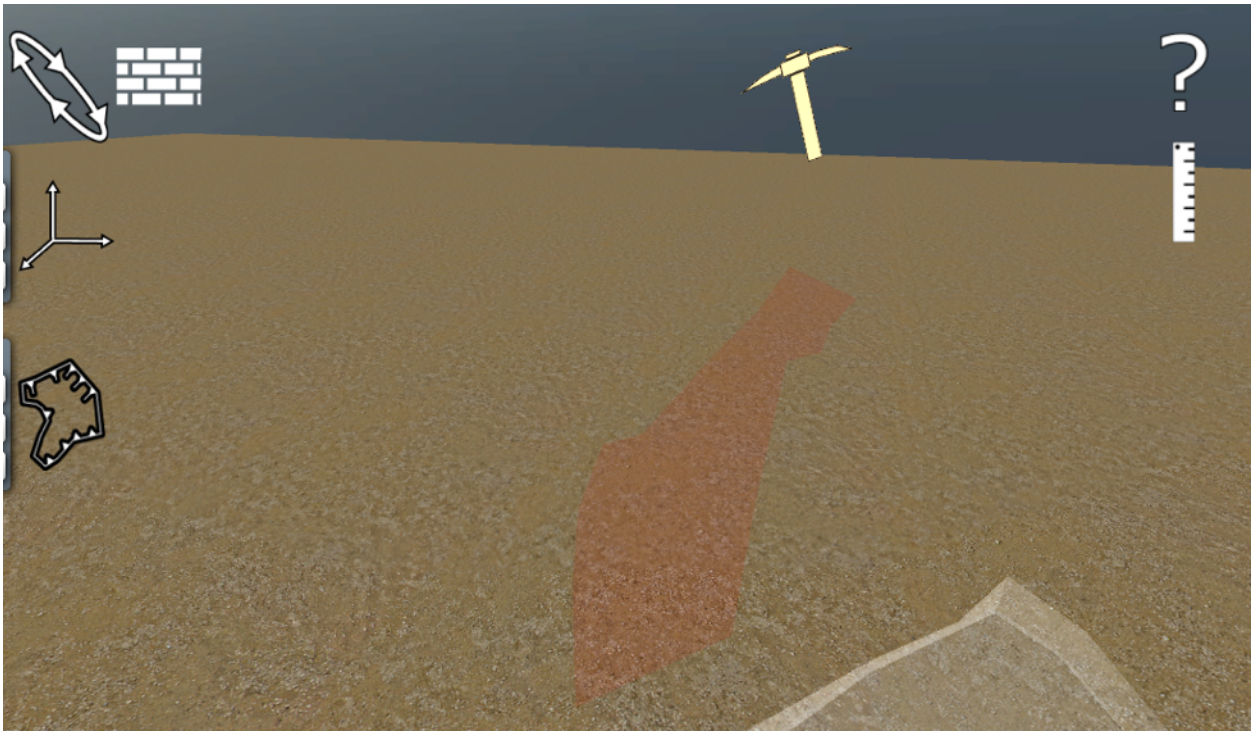

Figure 6: *Preliminary concept of the stratigraphic unit icon system. The pickaxe represents the red context. Normally, the outlines of the context are not visible. When the user hovers over the icon (shown in this illustration), the icon becomes yellow and its corresponding context becomes red.*

Coherent and linear interpretational narratives are a major expectation of the archaeologically community, even as we can cite numerous experiments which use hypertext to avoid or check linearity (Denning, 2004). This means that we should not shy away from integrating standalone text into our interface. A narrative displayed alongside our visualization could, for instance, contain hyperlinks which, when clicked, move the user's camera to whatever feature the text is describing and open its

corresponding information pop-up. The implications of this feature would be that our interface facilitates two primary modes of exploration: free movement throughout the visualization and linear reading of a narrative with directed movement in the scene. As discussed in the previous chapter, nonlinear exploration can allow for unpredictable, emergent systems, while linear movement provides coherence, clarity, and an opportunity opportunity to challenge the authorial voice.

Our interface should provide reasonable access to the variety of features contained in the Area B House, so as not to constrain the user to this or the other aspect of the scene unnecessarily. A system which expects users to click directly on models of interest is not feasible. First, due to the vertical nature of archaeology, the most recent (topmost) features would hide those beneath them. Also, variation in the size of stratigraphic units in this house means that certain large contexts would tend to overshadow smaller ones. Since the stratigraphic position or size of a context is not a useful way of determining its value, our interface will abstract each stratigraphic unit into a GUI icon which “floats” near the context. Clicking these should open the corresponding information pop-up, as well as give the user a sense of the limits of the stratigraphic unit.

The value of this system is that features which are inconspicuous, but potentially information-rich, are represented in the same way as ones that are highly visually apparent. This is a similar approach as the one taken by the Harris Matrix, which represents all contexts, no matter their qualities, as a simple box of text. In both instances, the usefulness of the visual abstraction trumps its correspondence with any specific physical form. Elsewhere in archaeology, Witmore (2013) argues that the

"workability" (usability) of maps is often more pressing than a one-for-one representation of a landscape (p. 132-133). On the other hand, visually linking these icons with their corresponding stratigraphic units (by, for example, programming the limits of the stratigraphic unit to become highlighted when the user hovers over its icon) means that we are not completely divorcing the icon from its referent (Figure 6).

To envision how a user might take advantage of these different interface features, it is now helpful to sketch out a "use case," or a specific series of steps a user would need to take in order to accomplish a certain goal. Let us imagine, for example, a scenario wherein a user wishes to understand one of the several cuts in the bedrock located in the courtyard of the Area B House. This process could be initiated in at least two ways: by clicking on a link in the textual narrative which refers to the feature or by clicking a specific cut's "floating" GUI icon. At this point, the user has opened the cut's information pop-up and discovered that it seems to be an inhumation which, according to our interpretations, was performed during the post-occupation phases of the house. Part of understanding why the cut is interpreted as a grave requires checking the basic descriptions contained in the pop-up, as well as the features of related contexts: what was found in its fill, what are its stratigraphic associations, etc. Since the pop-up is a brief distillation of the feature, the user should also be able to access the cut's more comprehensive Ark database entry. This can be accomplished by a GUI button placed within the pop-up window, which prompts Unity to open an external webpage containing the Ark entry.

Extended interpretations of features are not well suited to small pop-up windows. If we wish to communicate, for instance, how the burial in question links to larger

changes in the funerary practices of Latium, or reflects the processes of urbanization and abandonment in Gabii, it is most effective to share these arguments in the textual narrative. This is actually a rather unorthodox approach to interface design. Because the text would appear separate from the main window of activity, it would seem to disrupt the need for simple, readable structures which the human eye can rapidly scan and process (Landsdale & Ormerod, 1994). However, the inclusion of hyperlinks in the narrative which directly interact with the Unity scene (by moving the user's camera and manipulating pop-up windows) helps to maintain an abstract connection between what the user reads and the task at hand in the Unity frame. At any rate, the archaeological value of this system points to an expansion of the criteria for effective interface design in response to the needs of specific disciplines. The narrative provides coherence and linearity, while the Unity scene provides contextualization and free movement. A balance of these two approaches to communicating ideas is crucial for a field that is heavily concerned both with pro-forma, categorical data and "high-level" interpretations of that data (Carver, 2006).

Since reflexive archaeology encourages multivocality, it is also important that users have an opportunity to respond to the information and interpretations they see. An obvious starting point for such a feature is the pop-up window itself, which might contain some kind of form for submitting responses, criticisms, or comments to designers. Depending on use and submission rates, a separate system might be required to organize and host these responses, but for now our goal is a prototype of this function. Building in the ability to critique the arguments presented in the interface is a valuable

reminder to the user that our interpretations are not always absolute facts, but are subject to reconsideration.

Aside from pop-up windows, this project will provide other functions that communicate our interpretations more subtly. One example of this is the delineation of a structure's phases into discrete parts. While we might acknowledge that splitting a site into a finite number of phases ignores the fluidity with which buildings evolve over time, we can confidently take advantage of these familiar ways of organizing archaeological evidence as long as we do not treat them as *a priori* truths (by, for example, allowing users to assign alternate phases to contexts). Specifically, providing the user with the ability to toggle entire phases of models on and off not only helps isolate certain features (a practical necessity given the vertical nature of stratigraphy), but also allows users to consider the relationships and changes between phases. Phase groupings, then, can be a strong way of showing (and inviting criticism of) our understanding of the site's general chronology. As always, the more we tie these interpretations to specific pieces of evidence, the more useful they will be as points of discussion and debate.

This summary of the specification phase of our project has not aimed to provide a comprehensive description of features, but rather to establish a strong theoretical basis from which to design specific functions, as well as to specify several types of functionality we wish to include. Users should have access to a variety of other features as well, including camera control and navigation. In the next section, I will take a more extensive view of our features, as I explain the specific interface design choices made for this project.

Chapter 4

Design

Having established some of the specific features our interface should provide, the next step of is to address how these features will be implemented into the project's GUI. I will begin with a consideration of how design choices can have a bearing on our content's reception, identifying fun as an important aspect of the interface's intended effect. Next, I will define the concept of *reflective design,* showing why it is an appropriate guiding principle for a reflexive archaeological interface. We will then move on to a discussion about the major design choices of this project, beginning with how users will navigate throughout its content. Navigation raises the question of physical movement, and I will argue that embodied gameplay is archaeologically meaningful. The nature of embodied interaction with virtual materials also raises a further critique of New Materialist conception of unmediated contact with archaeological objects. I will then evaluate the actual appearance of our GUI, embracing a dynamic approach to how users make meaning of graphical icons. The way users might interpret not only the graphical symbols, but also the archaeological arguments themselves made by our interface will be considered in light of the HTML page's accompanying narrative text mentioned in previous chapters. To close this chapter, I will consider the overall desired effect of our GUI, revisiting the idea of fun and pleasure as an important element for archaeological and reflective design approaches.

While approaches to interface design are as varied as they are predictable, and while the concept of "good design" resists standardization and objective definition, it is important to consider carefully the implications of specific design choices. Our interface

must meet the practical demands of the features described in the previous chapter, but should also be intellectually and emotionally rewarding to use and explore. GUIs can respond to the pointed criticism raised by post-processual thinkers of the disconnect between what is “human and attractive” about the past and the “difficult, esoteric and sometimes narrow terms of academic debate” (Shanks, 1992, p. 2). A good interface should help provide a post-excavation experience which is “stirring and evocative” (Shanks, 1992, p. 2), acknowledging that the *fun* and emotional appeal of thinking about the material past is an important part of archaeology and presumably a reason why young scholars and those outside of the academy continue to take a marked interest in it (Ramos & Duganne, 2000, p. 19-25). In previous chapters, I explained the relevance of game criticism to this project, and toward the end of this chapter, I will compare our design choices to the way games construct and engage fun and pleasure as a design element.

In the field of design studies, one approach which underscores the significance of fun and pleasure is reflective design (Quanjer, 2013; Scollan, 2007; Sengers et al., 2004). At its core, this approach encourages critical self-awareness of “unconscious values embedded in computing and the practices that it supports” (Sengers et al., 2004, p. 1). Reflective design emphasizes emotionally rewarding and/or challenging scenarios for users, and is less interested with a task-oriented, efficiency-driven approach to design than most traditional models (Quanjer, 2013). In fact, it is partially a deliberate response to the centrality of the concept of “work” to interface studies, and sees task-oriented approaches as running the risk of “making all of life like work” (Sengers et al., 2004, p. 1). In attempting to challenge efficiency-driven design, reflective designers will

often focus on slower, less deliberate ways of carrying out tasks which provide ample opportunity to users for self-examination.

Reflective design shares a deep theoretical affinity with reflexive archaeology. Reflective aspects of user experience support "users in reflecting on their lives," as well as "skepticism," "diaologic engagement," and "interpretive flexibility" (Sengers et al., 2005, p. 6-7), all of which resonate with the most central demands of reflexive archaeology (Hodder, 1997). Both emphasize a multivocal, fluid approach to meaning-making, as well as a recursive relationship between producers and users of knowledge and interfaces. Furthermore, Quanjer (2013), Quanjer & Lamers (2014), and Sengers (2006) are interested in how the design of things relates to the design of interfaces, showing how the physical objects that we experience every day can lead to unpredicted uses and meaning. In this way, reflective design is also in accord with certain aspects of the New Materialism, which emphasizes the capability of things themselves to affect entanglements (Webmoor & Witmore 2008). On the other hand, like symmetrical archaeology, reflective design could encourage us to scrutinize how the discursive relationship between objects and people of the past might have contributed to specific design choices for ancient objects. In other words, to the extent that the New Materialism might idealize an unmediated form of interaction with objects, it must downplay the engagement of ancient object-makers with design issues, but a combination of reflective design with a symmetrical approach things would, in fact, give ancient designers, along with things, a greater voice. The way reflective design might contribute to our understanding of ancient objects is a promising area for future

research, and clearly, as a principle for interface design, it is an appropriate source of ideas for this project.

The term “reflective,” however, can take a variety of meanings in the context of interface, and deserves some consideration. One meaning pertains to the user experience - “what the user sees and interacts with” - and stands in opposition to the elements of an interface which are “transparent,” or provided to the user with minimal graphical representation (Bolter & Gromola, 2006, p. 369). According to this application of the word, reflective design entails inviting users to be more self-aware. On the other hand, reflective design encourages designers to check their assumptions about the tasks they face, to “experience…oneself in a fundamentally different way” and to focus on alternative or unfamiliar ways of approaching design challenges (Quanjer & Lamers, 2014; Sengers et al., 2005, p. 6-7). In other words, the design process itself must be reflective in order to provide a user experience that brings “unconscious aspects of experience to conscious awareness, thereby making them available for conscious choice” (Sengers et al., 2005). Specific strategies for reflexive design include involving users in the process of making meaning, encouraging users to participate and providing them with feedback, appealing to the emotions of users, and presenting familiar ideas in new or strange ways (Sengers et al., 2005).

A good starting point for the design process is to determine how users will navigate content. Navigation is a significant element of the overall interface and user experience, and has a meaningful impact on how the user views and interacts with GUI elements. Virtual movement inevitably requires some sort of input from a user, whether it be selecting predetermined waypoints (e.g., Google Maps “Street View”) or freely

navigating in real time using a keyboard or controller. A dynamic input-feedback loop thus arises between the physical actions of the user (clicking, pressing, etc) and the responses that occur onscreen. This raises a theme which recurs often in both game criticism and archaeology (and to which I have nodded frequently in the previous chapters of this paper): embodiment. Like some archaeologists, and like proponents of reflective design, game critics are interested in the embodied, haptic, kinesthetic, and emotional aspects of interacting with virtual environments (Favro, 2013; Hamilakis et al., 2002; McGowan, 2006; Olsen, 2010; Tarlow, 2000; Tilley, 1994). Before deciding what forms of movement and navigation our interface will offer, we must carefully consider how the phenomenon of virtually embodied action contributes to the overall interface experience.

A reflexive user experience must not place undue limits on the way users experience archaeological content, and the notion that gameplay is embodied challenges the idea that virtual environments are too ocularcentric, and thus "amputate" the majority of the sensory range (Chrysanthi et al., 2012; Jay, 1994). The very vocabulary of games and *visual*izations often suggests that we are concerned with primarily visual media. However, Shinkle (2003) argues that virtuality is chiefly an embodied experience. Overemphasis on the visual aspect of games is sometimes explicitly rooted in Renaissance notions of perspective and, influenced by the pervasiveness of the Cartesian ideal in western thought, suggests a self which is distanced from the body. This is an especially likely reaction to "first-person" games, whose use of linear perspective is "a direct, and privileged, descendent of Renaissance perspectival space" (Shinkle, 2003, p. 3). By Shinkle's account, linear perspective in

virtual reality is “designed for a technologically colonized subject, one that knows ‘instinctively’ how and where to find itself in the view” (p.3). Shinkle (p.4) advances the idea of an “anamorphic subject” to resolve the conflict in virtual reality between the disembodied Cartesian subject and Merleu-Ponty’s form of embodied proprioception (i.e., sensory self-awareness). What her argument implies, and what Keogh (2014) makes a point to argue explicitly, is that players are not physically distinct from, but a component of the video game as text. One need only observe a particularly engaged gamer at play to witness this point. Fingers and eyes are not all that move. The “real” body tenses, relaxes, leans, sways, winces, and shouts as the game body is equally jostled. Swink (2008) argues that gamers do not simply respond to visual feedback, but are “caught up in a circuit of organic, technological, and representational actors and materialities” (p. 226; quoted in Keogh, 2014), and their corporeality is thus “redistributed across the circuit” which starts with their physical bodies, moves through the controller, to the game console, and finally to the onscreen interface. What results is a unique form of embodiment, partially rooted in but also distinct from the player’s physical body. This is not only a lesson in how games physically engage players, but a statement about what archaeological interfaces should be (i.e., more than “eye candy” or visual fetishism).

According to Shinkle (2012) and Bigras (2011), gameplay does not mean inhabiting one visual or corporeal realm at the expense of another, but entails existence in two worlds - the virtual and the real - simultaneously. Sometimes, the virtual world can spill over into the real world, creating jarring and interesting results (e.g., the character Psycho Mantis of the 1998 game Metal Gear Solid, who speaks to the player directly

about the contents of her/his memory card and even “telekinetically” moves the controller via its rumble motors; Keogh, 2014; Shinkle, 2012). What this unstable but always present link between the player and video game as text (albeit, a highly unusual one) implies is a form of mediation, which for Shank & Webmoor (2013) is an essential function of archaeological representation, but for some versions of the New Materialism (e.g., Olsen, 2010) is simply a distraction from the actual materiality of objects. Far from subverting the “thingness” of things which we experience, however, mediation is an unavoidable component of human-thing interaction, designed into ancient materials from the start by the designers, builders, and craftspersons who contributed to the ancient record. The best approach acknowledges this, and seeks to parse out how a game system is a unique mediator between people and archaeological materials. The most salient benefit of games as mediators, in my estimation, resides in their capability to produce “performative” interaction, “movement” and “engagement,” fulfilling the role of archaeological mediation as described by Shanks & Webmoor (2013, p. 105).

Clearly, the multi-sensory, kinesthetic aspects of game environments can elicit a unique form of proprioception among users, and this seems essential to a reflexive, engaged experience with ancient materials (Keogh, 2014; Swink, 2008). Archaeologically, we might pay particular attention to the role of physical movement (in both the real and virtual worlds) and navigation in interpreting environments and narratives (Flynn, 2003). In order to do so, it is necessary to clarify the relationship between the “game-body” we use during our virtual experience of an archaeological site and the “archaeological-body” we use during excavation and on-site reflection. The familiar physical components of excavation (squatting, scraping, swinging, sweating)

are obviously different than those of gameplay (clicking, touching, shaking, teeth-clenching). This does not mean, however, that we should automatically place more value on interpretation “at the trowel’s edge” (i.e., during the physical act of excavation) than (re)interpretation at the controller’s edge. Instead, the specific ways that physically excavating a feature overlaps with experiencing it in a virtual space should be considered carefully.

Put simply, interaction between game-bodies and 3D models (through sight, collision, or GUI elements) is archaeological meaningful, even if different than interaction between archaeological-bodies and “actual” things. As explained above, it might not be helpful simply to “conceptualize the physical self as material and the virtual self as immaterial” (Bigras, 2011, p. 3). Rather, when we play games, we are operating as a single - albeit redistributed - self who “translates” physical movements “between physical and virtual spaces” (Bigras, 2011, p. 3). Bigras himself emphasizes the role of the game controller, ever more responsive to nuanced bodily movement, in this translation of action. This project’s choice to design for movement controlled with the mouse and keyboard is largely a function of convenience (i.e., users are more likely to have a mouse and keyboard than a game controller), but in the near future it is likely that archaeologists will be compelled to design for multiple interfaces, including virtual reality headsets like the Oculus Rift.

Bigras continues to argue that equally important to the physical elements of game interfaces (like controllers or keyboards) are the “rules that govern the game space,” or the way “actions and movements [are] dictated by the digital environment” (Bigras, 2011, p. 8-11). One thing to emphasize in this project’s navigation

system, then, is *collision detection* (the detection of intersecting 3D objects, e.g., the player and a wall). Because collision detection can constrain the movement of users by not allowing them to proceed "through" walls or other things that shape where human bodies can go in a space, it conveys some of the kinesthetic properties of a site which are impossible to capture via non-interactive media like photographs or plans. This is also a testament to the way that things both determine and are determined by cultural conceptions of space. People make buildings which reify - or, alternatively, defy - cultural rules, while buildings themselves enact a system of rules for movement and navigation upon people. One implication of this is that game engines can help us understand how the shifting constraints placed on movement by archaeological materials at a site affect our interpretations of it. The paths archaeologists take around sites, which are so crucial to how they unconsciously conceptualize them, vary constantly based on what is being excavated and where. I see this as a promising avenue for future research, but for now wish to emphasize that constraining movement to areas accessible by human bodies is a powerful way facilitating a corporeal understanding of archaeological sites.

I have already stated that an "immersive" reconstruction of the Area B House is outside of the scope of this paper. Nevertheless, in the Area B House, walls are mostly only preserved at the foundational level. For users who are not familiar with the site, supplementing SFM models with schematic representations of walls, doorways, and roofs can be a way of using "environmental" interface elements to intuitively represent our understanding of the overall architectural effect of the structure. Since evidence in Area B House's for doorway placement, wall height, and the arrangement of roofs is

mostly indirect (e.g., the arrangement of drainage systems might suggest how a particular section of roof might have been constructed in order to shed water properly), reconstructions in this project will take the form of semi-transparent walls and roofs, communicating the hypothetical nature of our understanding of the house's architecture (Figure 7). Reconstructed walls will also contain colliders which, unlike the stubby remains of walls as they were excavated from the Area B House, will constrain user movement to open spaces and doorways.

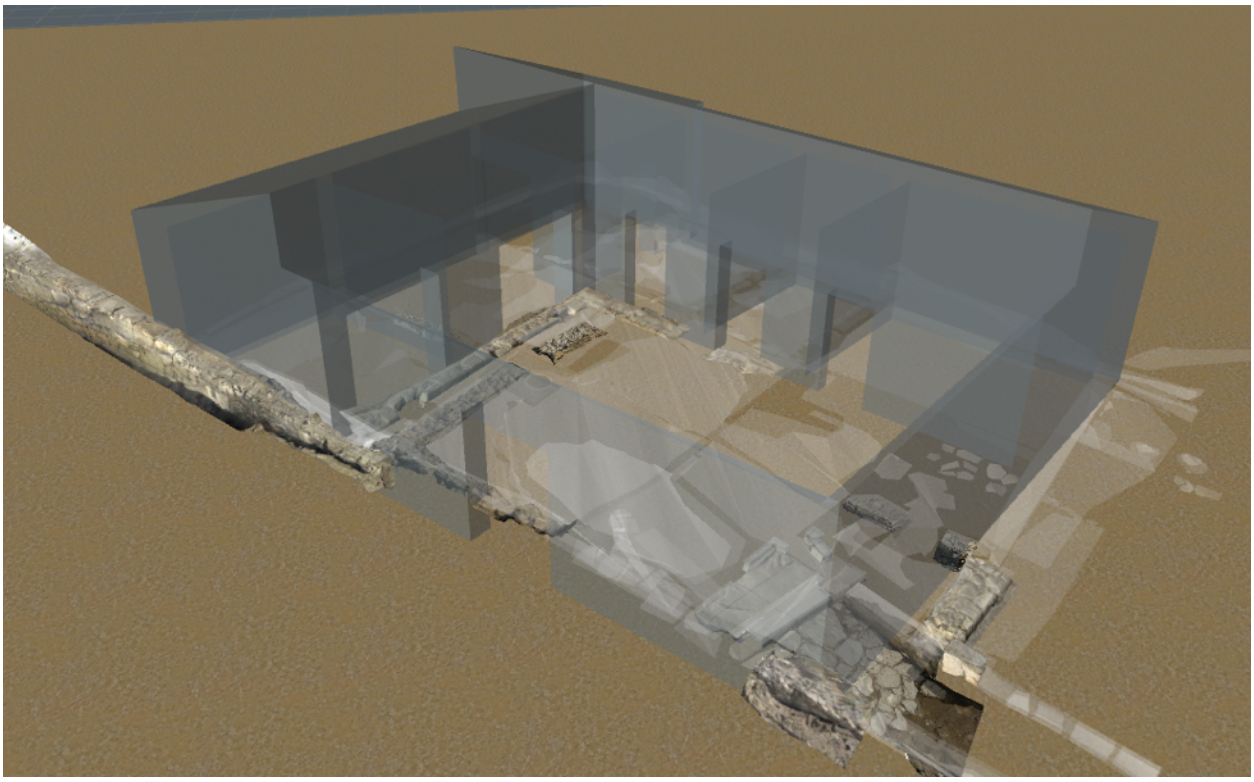

Figure 7: *Schematic, semi-transparent reconstructions of the Area B House. The juxtaposition of the reconstruction with the SFM models provides an intuitive sense of the evidence for the reconstruction.*

As users navigate these reconstructions, they hopefully gain a more visceral understanding of the structure's spatial layout, as well as have the opportunity to compare our interpretations to the evidence as communicated by 3D models and GUI

dialogues. As suggested above, what makes this system promising is the combination of navigation, schematic representation of architecture, and collision with those representations which results in constrained movement. Such a system also invites an interesting response to the New Materialist conception of things. First, although the English word “thing” might connote self-contained, personal objects, an approach which truly emphasizes materiality should also regard walls, floors, roofs, and indeed entire architectural arrangements as things of interest. Comments from New Materialists such as that things include “stones, cars, mountains, prisons, refugee places, and so on” would seem to verify this assumption (Olsen, 2010, p. 133).

However, the way we interact with architecture is different than the way we interact with objects such as pens, bottles, clothes, or hammers. While the latter are easily (if unjustifiably) conceived of as completely subject to human use and manipulation, it is more obvious how the former places constraints and exerts a type of agency on human action. One cannot walk through a wall, and changing a building’s spatial layout is much less easily achieved than removing the cap from a pen or moving a hammer from one toolbox to the next. The relative malleability and agency of different objects is an interesting area for further consideration. For the time being, I will posit that being physically constrained by reconstructed walls in a virtual space is a unique way of understanding what a structure communicates in terms of movement, control, and organization. Another way of putting it is that “being in the world can never be purely cognitive or contemplative,” but is a result of “active involvement with things” (Olsen, 2010, p. 132) and, by extension, the way they were resulted either from

the conscious design choices of ancient object-makers or the unique properties of specific types of materials.

Interaction with reconstructions, then, is surely a more active form of illustrating things than static, 2D plans or photographs. Like interaction with real objects, interaction with virtual things is corporeal and mediated. If humans and things interact in an “inter-subjective” way, as argued by Olsen (2010, p. 133), then our experience of things depends on innumerable variables, only two of which are the relative positions of our bodies and the objects that come into contact with them (Merleau-Ponty, 1962; Olsen, 2010). As has been explained above, human-thing interaction is also context-dependent. Engagement with structures in the form of navigation necessarily implies taking part in a system of space. In gameplay, this can be an emergent system, and the 2007 platform game *Portal* provides a good example of game design that allows for highly variable ways of approaching challenges and proceeding through a narrative. For archaeological visualizations, we should consider how “individual” things (or, more accurately, discreet features as divided up by single-context recording) contribute to a larger system that is more than sum of its parts. A room is more than four walls, and a doorway is more than material absence. It is an unlikely outcome that, in a contextual, physically interactive scene like the one we have constructed, an interface could ever facilitate an unmediated representation of a single wall, for instance, without reference to the other walls and features which contribute to a site’s larger system of materiality and movement. Becoming an actor in a system which is more than the sum of the things that constitute it is necessarily a form of mediated contact, and contrary to hard-line New Materialism, this does not imply a distorted view of things. Rather, as a user

experience that is strongly connected with the context offered by interface elements, it is an opportunity to be reflexively self-aware about the systemic constraints and opportunities for interpretation and sense-making.

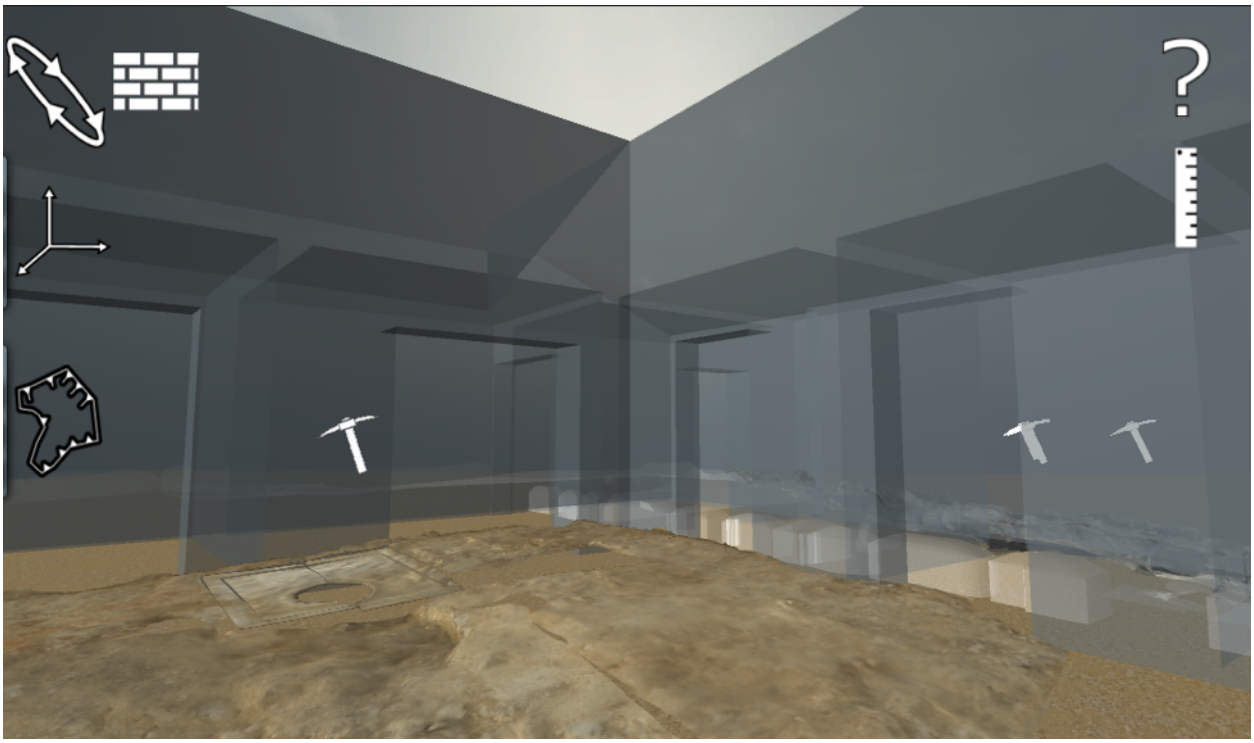

Figure 8: *View of the reconstructions and SFM models from inside the house in first person "explore on foot" mode.*

For our purposes, a navigation system need not be specially designed to facilitate meaningful archaeological interaction with things. Unity's stock "first-person controller" (FPC) is a perfectly suitable choice for providing an experience that is embodied and conducive to a contextual interface display. As described above, the FPC provides a linear perspective which, although visually disembodied, responds to player input in a way that suggests embodied movement. The most common way that games allow players to move their FPCs throughout a scene is the use of controller inputs, which, for this project, entail the so-called W-A-S-D commands native to first-person PC

games (i.e., the “W” keyboard key moves the FPC forward, the “A” key backward, the “S” key left, the “D” key right). These function as the player’s virtual feet. Meanwhile, mouse movement controls the direction the camera is facing, serving as a sort of virtual head. This combination of moving and looking suggests an embodied player, and since these features are controlled with the keyboard and mouse, they do not require any graphical representation onscreen. Navigation might thus be conceptually assigned to the “transparent,” or implicit/not immediately obvious part of our interface (Bolter & Gromala, 2006).

Our navigation system should also address some of the strategies of reflective design. One thing an FPC does is invite players to experience the Area B House in a “slower” way, a design principle advocated by Segers et al. (2004) and Quanjer (2013). This is because unlike reading an archaeological plan - where the eye moves rapidly between areas of a site that are actually separated by some distance - an FPC requires users to “walk” (at a speed determined by the designer, but plausibly reflecting the average walk speed of human beings) from one point to another, creating the opportunity to observe and take note of features lying along their path of movement which might otherwise have gone unnoticed.[2] From a perspective of reflexive archaeology, this is important because it invites a more complete view of the site’s evidence and increases opportunities for archaeologists to second guess their assumptions and interpretations. This concept has also been described as “slow archaeology” by Caraher (2014), who argues that excavators and researchers should

[2] It is worth pointing out that first-person games tend to include very “fast” controls, and this speaks to the demands of games as an entertainment platform. Our own interfaces designs for much slower movement, raising a key distinction between our needs as archaeological interface designers and the needs of entertainment-based game designers.

take the time to “appreciate the complexity of the entire archaeological record” (para. 2). While some have pointed out that this sort of claim might verge on the absurd for the majority archaeologists whose access to sites is severely limited by money and time (Carver, 2006), slow archaeology is more feasible when applied to interfaces which will primarily be used in a post-excavation context.

FPCs also serve to “make the familiar strange.” Even though first-person embodiment is somewhat suggestive of real-life archaeological experiences, plans, photographs, matrixes, or other abstract, static - and thus disembodied - representations are the most common way of interacting with a site during post-excavation. FPCs, then, offer an alternative way of experiencing sites. Meanwhile, Sengers et al. (2004) also advise designers to create “bridges” between the familiar and unfamiliar, arguing that experiences which are overly jarring can “alienate, confuse, or simply not interest people” (p. 8). Our interface’s response to this advice involves providing users with an alternative, perhaps more familiar way of looking at the Area B House: a so-called “orbit camera.” This mode of viewing, which allows users to orbit their camera, at varying levels of zoom, around arbitrary points in the structure, is less powerful as a tool for embodiment. Since orbit movement bears no resemblance to human movement, it makes little sense to program the orbit camera to collide with surfaces in an embodied way. What this mode of view does accomplish is a more holistic, overhead view of the structure which archaeologists are accustomed to from site plans. Alternation between these two modes of viewing and moving is facilitated by a GUI button (more on the design of buttons themselves later), and also provides users with a greater degree of control over how they experience and analyze features. In this

way, multiple forms of navigation offer users a “license to participate” (Sengers et al., 2004). In the next chapter, we will consider how user feedback concerning the “feel” of the navigation system (e.g., its sensitivity, smoothness, speed, etc) will allow us to tweak this system in order to make it more natural and pleasurable to use.

Figure 9: *View of the scene from “orbit mode.” The slider at the top right allows the user to control the zoom of the camera.*

Having established what tools users will have for navigation, I would now like to consider those features which users will manipulate more directly using GUI elements. Continuing the discussion about “real” and “virtual” archaeological materiality, I acknowledge the unique nature of 3D models which, like conventional archaeological illustrations, are distinct (if less abstract) representations of actual objects. As Rabinowitz (2015) argues, no amount of realism, detail, or artifice can wholly reproduce the unique materiality of an object; from a New Materialist perspective, this would seem to be a weakness of the 3D approach.

However, as I have already shown, even “live” encounters with objects are culturally/intellectually provisional interactions. In other words, there is no “perfect” form of interaction that 3D representations will inevitably fail to replicate. Moreover, by combining multiple 3D models into a single game space, and by representing our descriptions of them with GUI, we provide more than a simple representation of or substitute for a physical reality. In fact, in one sense we create an extension of *spatial* and *experiential* reality, an opportunity to see and experience things in a way that is impossible onsite (Flynn, 2003; Zona, 2015). I have already shown that combinations of things creates an emergent system of organization and context that is more than the sum of its parts, as well as the implications of this line of thinking for the New Materialist approach. Emphasizing spatial context is also a way to make the familiar strange; archaeologists are used to thinking about context, but less used to participating in it, with a virtual body, during post-excavation.

A successful GUI will adequately convey our interpretations and descriptions, will encourage reflection about that information, and will be rewarding and pleasurable to use. Reflexive GUI elements should call attention to themselves, and more often than not should attempt to create a sense of fun and exploration by distorting and defying expectations (Bolter & Gromala, 2004; Quanjer, 2013; Scollan, 2007). Yet contemporary design often assumes that “transparency,” or the idea that interfaces should “serve as a transparent window, presenting an information workspace to the user without interference or distortion,” is an ideal quality of interfaces (Bolter & Gromala, 2004, p. 2). Like Shinkle’s criticism of the disembodied virtual reality subject, Bolter & Gromala trace the roots of transparency-as-ideal to the Renaissance conception of knowledge as

symbolized by linear perspective (p. 4). They do not entirely reject transparency as a design choice, however, instead arguing that designers should always balance transparent elements with reflective ones. Rouse (2005) provides a good example of the negative outcomes when designers focus too exclusively on transparency, criticizing the 2002 game *The Getaway* for its over-reliance on transparent interface elements. *The Getaway* takes place in a procedurally generated representation of London, and a key challenge of its gameplay involves navigating vehicles at high speeds through the dense urban environment. Rather than having access to a map system or other GUI elements to help with navigation, players must watch for their vehicle's blinkers to activate, indicating an upcoming turn. According to Rouse, features like this did not provide enhanced immersion, but instead resulted in frustration and confusion among users. Archaeologically, this validates the argument of Shanks & Webmoor (2013) that no amount of realism can make models self-evident, as no amount of "unmediated" contact with a thing will help us appreciate the way it itself represents the result of design choices made by ancient designers (which are in turn the results of discursive human-thing entanglements). On the whole, the necessity of non-transparent, reflexive design elements challenges interpretations of the New Materialism which would seek to let objects "speak for themselves" in an unmediated fashion.

Despite Bolter & Gromala's (2004) criticism of "windows" as a somewhat futile device for effecting transparency, I think that their familiarity as design elements makes them a strong choice for displaying the type of information needed for a reflexive interface. By my estimation, pop-up windows actually serve to draw attention to themselves. Representing the bulk finds of a single context in a pop-up, for instance, is

a more direct way of communicating that information than, for example, arbitrary symbols placed in the actual game space. Pop-up windows can help to make the familiar strange by placing well-established forms of archaeological representation (e.g., pie charts for finds, Harris Matrices, etc.) in an unfamiliar setting. They are also capable of "magnify[ing] details that otherwise would be overlooked," inducing "dubiety about meaning and entrenched viewpoints" by framing descriptions as interpretations, suggesting "different options" for interpretation, and allowing for user feedback, all of which Quanjer (2013, p. 10-11) identifies as important to reflexive design. Lastly, by intentionally avoiding a rigid dedication to archaeological illustration conventions, by perhaps taking a lead from the appearance of GUI elements in media which are typically associated with leisure and enjoyment, and by implicating users directly in the process of making meaning, pop-up windows of this sort could appeal to the emotions of archaeologists as users. Barring extensive feedback from users, it is unclear how the pleasure of experiencing archaeological data in a novel, participatory fashion might relate to the phenomenon of fun as experienced by many gamers (Hunicke et al., 2004; Schell, 2008; Tekinbas & Zimmerman, 2003). For the purposes of the design phase, however, I contend that a reflective/reflexive pop-up window is a good starting point for communicating information and encouraging feedback in an appealing way.

Similarly, the type of information to be displayed in pop-up windows should be sensitive to the needs and priorities of our user base. In the interest of reflexivity, it is useful to establish a starting point for what the pop-ups will communicate, explain why we find those choices to be important, and then to consider the reaction of users to this arrangement at later stages, tweaking the format if necessary. I think it is fairly

indisputable that a reflexive interface will communicate our broad interpretations of each context. Placing this information at the top of the window, with more quantitative descriptions of the data below it, invites users to make a direct connection between our interpretations and the evidence upon which they are based.

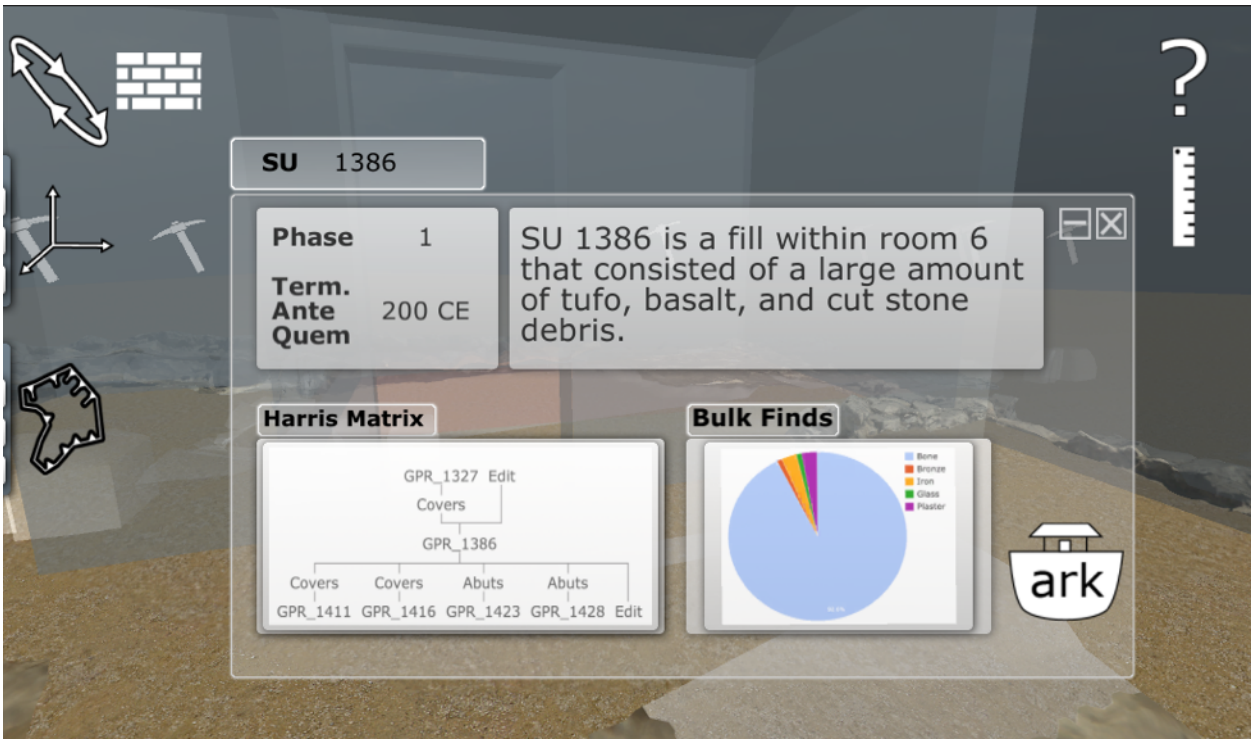

Figure 10: *The information pop-up for SU 1386 in the Area B House. The pop-up is opened by clicking the context's pickaxe icon (seen in the background). Note that the outline of the context - seen beyond the transparent window - remains highlighted in red as long as the window is opened.*

Keeping in mind that one way of accessing these pop-up windows might be via hyperlinks in the accompanying narrative text, it should be clear that our interface always attempts to qualify descriptions as contingent upon specific interpretations of the evidence. In terms of which types of quantitative descriptions to include in the pop-ups, we will begin with displaying bulk finds (represented with a pie-chart), stratigraphic sequence (represented with a Harris Matrix), phase assignments, and, when available,

estimations of absolute dates. Further information which relates to the standard context sheet of single-context recording techniques may be accessed by a link from the pop-up window to the Gabii Project's Ark database.

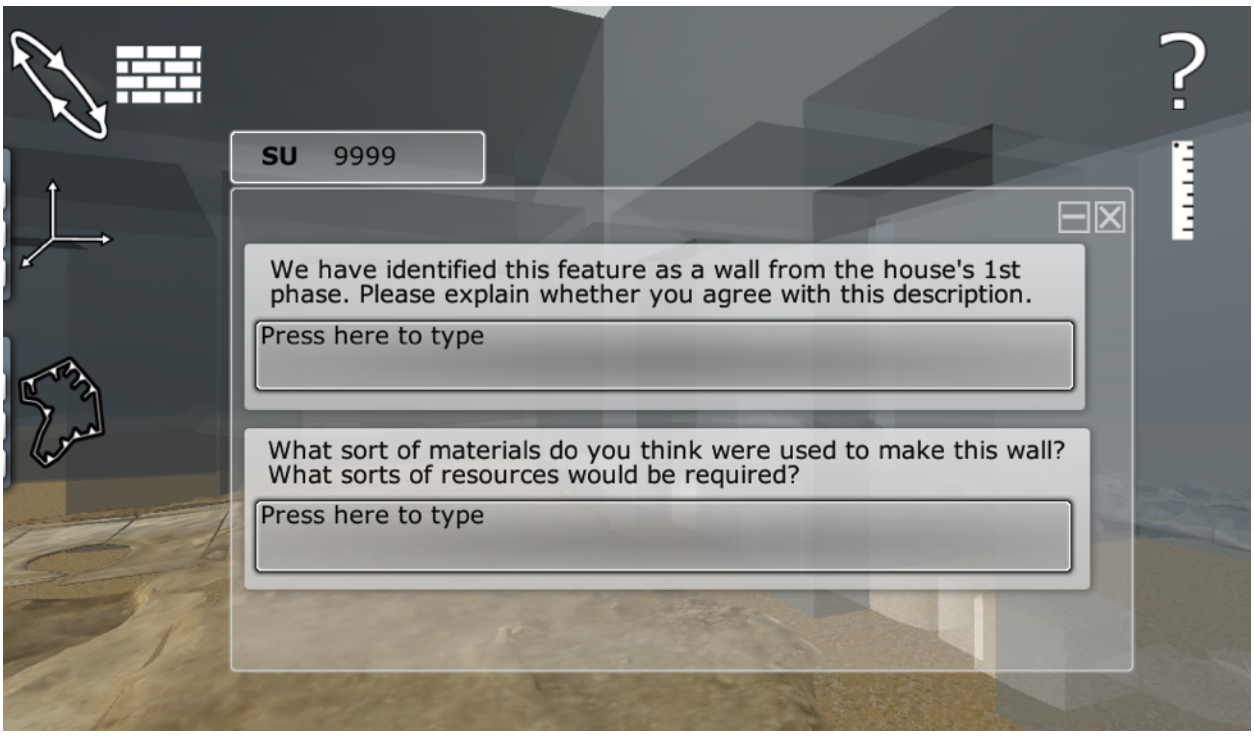

Figure 11: *Prototype version of an option which allows users to provide direct feedback about the content of the scene.*

Perhaps most importantly, users should be able to comment upon or dispute our interpretations. Accordingly, each pop-up window features a dialogue box, accessed by clicking on a designated GUI icon, into which users can enter responses and criticisms. The technical challenge of handling this sort of system will be addressed in the next chapter, but another obstacle standing in the way of user responses is the fear of contradicting the dominant experience or interpretation of a site. In other words, simply providing "a new channel for…expression is not enough to encourage or provide license for participation" (Sengers et al., 2004, p. 5). In addition to a space for free response,

then, our interface could pose more open-ended questions either directly or via relatively more implicit means. These might ask them to hypothesize about, for instance, what kind of person might have made an object in question, why they might have made it like they did, and how they might have done it (Figure 11). Framing these questions as risk-free activities - by, for instance, ensuring responses will be collected anonymously - encourages creative thinking about archaeological materials, and can perhaps expose weaknesses or unseen opportunities for elaboration in the evidence for a particular interpretation. Furthermore, since these kinds of questions are radically different than the sort of information archaeologists must document on context-sheets or other standardized information forms, they are less suggestive of “work” and task-oriented approaches to archaeology. This is a way of designing a sense of fun and pleasure into the user experience, especially if questions are posed in an incidental, implicit fashion.

Another design challenge requires us to decide how users will control what is visible on the screen at any given point. Put simply, there is no shortage of different types of physical assets in this scene: SFM models, stratigraphic unit limits (i.e., polygons created with survey data that show the shape, size, and location of each SU), reconstructions, and schematic models of features which were not recorded with SFM. Displaying all data at once would result in a largely unintelligible 3D environment; overlapping and stacked models would flood the screen and make it impossible to discern the physical details of the Area B House (Figure 12). Yet as soon as we must make a choice about how to organize interaction with content, we are engaging in an interpretive decision that should be considered carefully. As always, it should be a priority to allow the users to participate in the process of interpretation and making

meaning. One way of dividing up assets that is obvious from an archaeological point of view is by phase (Figure 11). Since grouping contexts in phases is necessarily interpretational, users should have the option of responding to the phase assignment we provide to features. This could take a similar form as the user response feature in the pop-up windows. Posing the question directly (e.g., “Does this feature seem to belong to phase 2?”) is perhaps a way of overcoming users’ uneasiness with contesting the dominant narrative of the site (Figure 11). Otherwise, in general, justifications for phase assignments should be contained in the accompanying narrative text.

The overall organization and appearance of onscreen icons can have a marked effect on how users read and interpret our GUI (Landsdale & Ormerod, 1994; Oswald, 2013), but also require us to consider, once again, the embodied component of interaction with our scene. Initial interface attempts for the Gabii Project placed a number of icons and buttons at the bottom of the screen, but this interfered with the way archaeologist users translated their archaeology bodies into game bodies. Simply put, excavation is a practice that is concerned with what is in/on the ground, and excavators tend to look *down* during their work on sites. Future research would track the movements of individuals in the Unity scene, determining preferred camera angles and patterns of navigation. Initial reception among members within the Gabii Project team, however, suggested that the bottom of the screen space should be clear of icons, so as not to block the view of the downward looking archaeological head (Figure 8). Another common movement of archaeological bodies involves squatting to closely inspect the soil or ground level features. I thus include a simple zoom feature for the FPC, activated by the middle mouse button, which temporarily magnifies objects in the center of the

player's field of view, roughly imitating the archaeological squat. Lastly, the scale of features is something that is intuitively understood onsite, while conventional archaeological illustration includes mechanisms for conveying the size of objects. While our interface does not offer a tool for taking direct measurements, it does provide the option of toggling a simple one meter-by-one meter grid, overlaid above the ground surface (Figure 13). This communicates at least a basic understanding of the size of the site, the size of objects and features, as well as where things might be in relation to the player's virtual body.

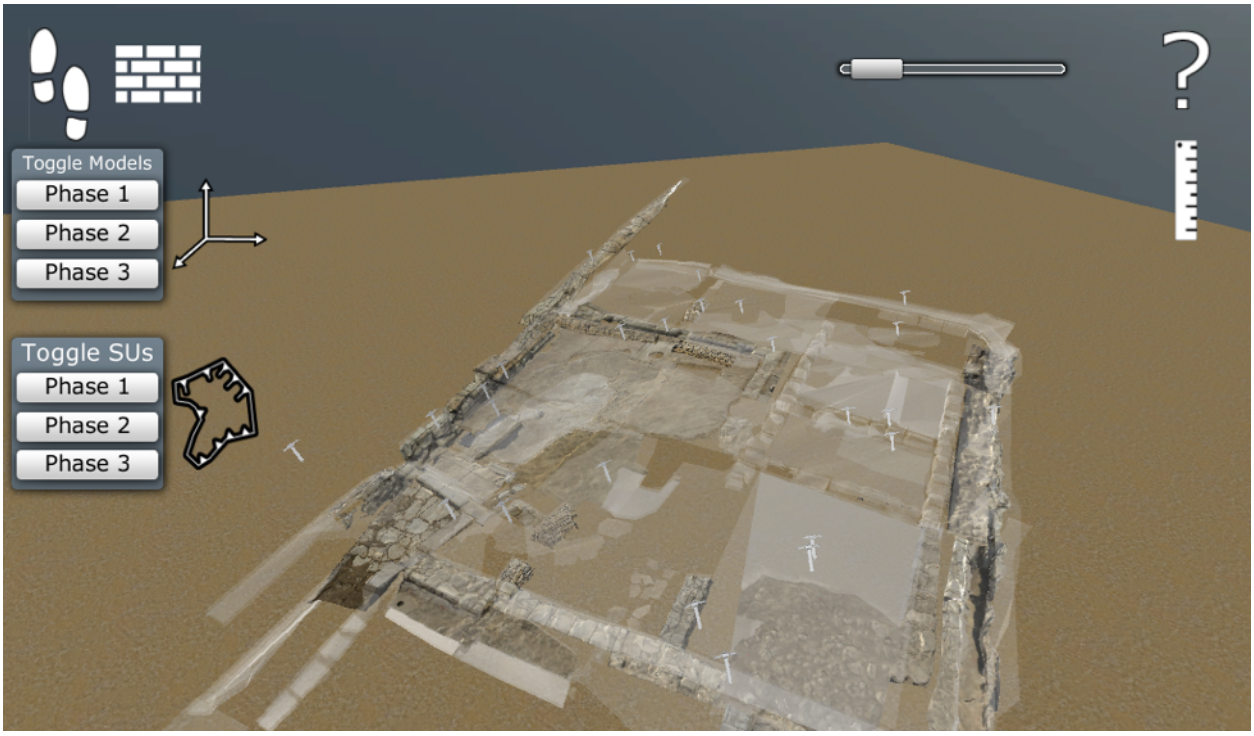

Figure 12: *The Area B House scene with all content, besides reconstructions, toggled on. The panels on the left side of the screen allow us to toggle phases of both SFM models and survey polygons. So as not to crowd the screen, the icons to the right of each panel (a 3D axis and an abstracted context outline) hide or show the phase panels when clicked.*

By definition, GUIs represent complex programming functions occurring “behind the scenes” with simple graphical icons (Bolter & Gromala, 2006). The question of how to represent specific actions graphically is an important final step of designing a GUI system. What sort of graphic, for instance, best signifies the action of toggling a phase or exiting a pop-up window? Oswald (2013) provides an overview of the way that researchers haves applied semiotic theory to the design of GUIs, for instance by relating different types of graphical representations to different typologies of signs (e.g., symbols, indices, and icons). Ultimately, Oswald argues that attempts to outline a comprehensive system which would describe how graphics communicate meaning to users severely oversimplifies the “dynamic character of sense-making in use processes” (Oswald, 2013, p. 8). Such a system would also be a result of specific cultural preferences, even as it would present itself as universal. No GUI can ever represent itself “perfectly” in the sense that the meaning of images will always vary from user to user. Oswald recommends that designers respond to the expectations of their intended user base, treating the meaning of graphics as a “dynamic” (i.e., subjective) and largely arbitrary property.

In archaeology, print illustration conventions are clearly well-established, but no visual system exists for most of the actions we are performing in our visualization of the Area B House. On the other hand, some actions in our scene, such as exiting or minimizing windows, clearly have a precedent in the larger visual language of computing. Acknowledging Oswald’s contribution that “predominant patterns of interpretation change over time” (p. 8), I nevertheless attempt to respond to these precedents, using an X, for example, as the icon which users click to close the

stratigraphic unit information pop-ups. On the other hand, we can borrow from the familiar images of excavation and archaeological documentation in an attempt to present an intuitive user experience to archaeologists. Pickaxes, for instance, can serve as the representations of individual stratigraphic units which, when clicked, display that context's information pop-up (Figure 10). Or, a stylized representation of an archaeological context as it appears in conventional plans might represent the options for toggling the phases of stratigraphic unit survey polygons (Figure 11). Certainly, this can have the effect of "making the strange familiar," and can reinforce the notion among users that even if we are not in a familiar archaeological setting, operating with an archaeological body, we are still participating in an archaeological experience. These kinds of icons can also suggest a wry irony, as they import symbols of archaeological labor - pickaxes, illustration conventions, etc. - into a medium which is generally associated with fun and leisure. It is my intention that this ironic effect might be a pleasurable outcome of the interface, and would further distance the process of archaeological interpretation from the sensation of task-oriented "work."

Other actions - such as toggling reconstructions on and off, or switching between the "orbit" and "walk" navigation systems - have no clear precedent in design or archaeological imagery.[3] For these, I have attempted to create icons which, in my estimation, symbolize the action in a meaningful way. A simple brick wall, then, represents reconstructions; a set of footprints represents "explore on foot" mode. In terms of the actual style of these graphics, I have opted for a simplistic approach. Our

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[3] Future research might explore the potential precedents of "uniquely" archaeological actions in commercial games. Games often allow players to switch between various types of "map modes" and embodied movement using GUI elements, for example.

toggle-reconstructions button, for instance, is not a photographic representation of a brick wall, but an abstract, monochromatic image. Like all aspects of our GUI, the viability of these icons largely depends on their reception among our users. Feedback and, if necessary, revision are important steps of providing graphical representations of user actions, and will be discussed in the next chapter.

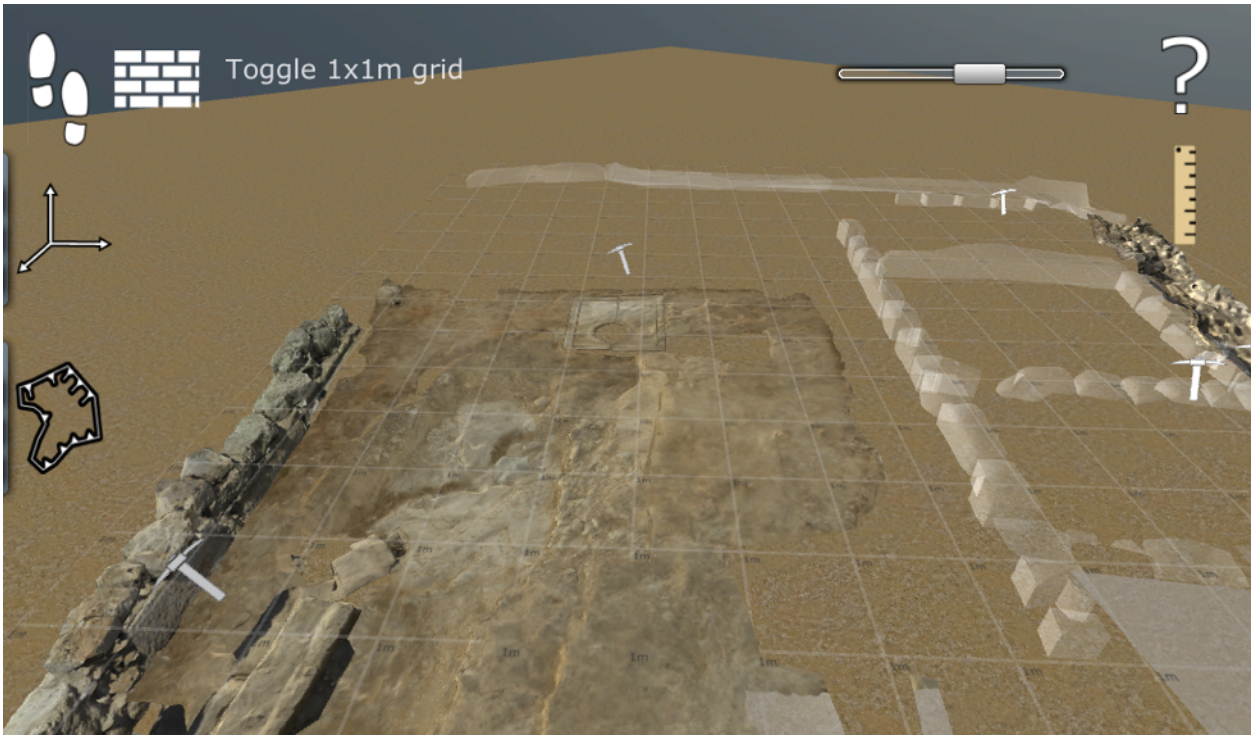

Figure 13: *1x1 meter grid, activated by the ruler icon in the top right.*

To conclude this chapter, I will attempt to characterize the overall effect of our project's GUI. As mentioned previously, the use of Unity, a game engine, as our platform demands that we pay attention to the design elements of fun and pleasure, which are often essential components of gameplay. Hunicke et al. (2004) provide a taxonomy of fun which deconstructs pleasure in gaming into seven types: sensation, fantasy, narrative, challenge, fellowship, discovery, expression, and submission. On the whole, the authors assign fun and "desirable emotional responses" to the "aesthetic" qualities

of a game, as opposed to “mechanical” (how the system works) or “dynamic” (how the system and player interact) qualities (Hunicke et al., 2004, p. 2). A linear relationship exists between these three components of games, they argue, with mechanics producing dynamics, which themselves lay the foundations for aesthetics. Hunicke et al. refer to this as the “MDA framework” (standing for mechanics, dynamics, and aesthetics; p. 1). It is safe to say that the majority of this chapter has outlined our project’s mechanical and dynamic properties, inasmuch as I have described how users will interact with the game system. What remains is to determine how our project’s mechanics and dynamics produce specific types of aesthetic results. Hunicke et al. point out that games are not formulaic. The way that specific gameplay mechanics combine to result in certain types of appeal is largely elusive (or dynamic, to borrow from Olsen, 2003), and the MDA framework is a way of describing, not predicting, how different games engage different combinations of fun (Hunicke et al., 2004, p. 2-3). Hunicke et al. claim, for instance, that because the first-person-shooter game *Quake* emphasizes competition against computer opponents, it primarily engages the sort of fun associated with challenge (p. 2). I conclude that our own interface actually engages several types of fun, especially sensation, narrative, discovery, and expression.

I have discussed extensively how the Area B House interface provides an embodied user experience. Creative integration of responsive game-controller technology - such as the Leap Motion, which tracks hand motions, or the Omni treadmill, which responds to a variety of bodily inputs - could augment the pleasurable sensory experience of our interface, but the very practice of “feeling” and becoming familiar with archaeological materials that arises out of player collision with walls and

surfaces has the potential to be viscerally rewarding. This, I think, is related to the archaeological pleasure that is a product of “direct encounters with the very material past we study,” as described by Olsen (2012a, p. 26). Gillings & Goodrick (1996) even posit that archaeological interfaces have the potential to be “sensual” (2.2.3) if movement is facilitated in an intuitive way.

Several dynamic properties of our interface also allow for narrative fun. At a basic level, the linear textual narrative which occurs alongside our scene provides narrative structure. While this might seem to disrupt the relatively free mode of exploration our interface provides, a sense of discovery (another type of fun) might accompany users as they read about and come to understand the Area B House while at once moving around a representation of its state as excavated. On the other hand, users have the opportunity to create their own narrative as they freely explore our environment, at once discovering more about what the archaeologists involved with our project think about the structure, as well as their own independent interpretations of its meaning. Our interface also connects narrative fun to opportunities for expression, allowing users to challenge or respond to the scene’s content. At a sub-narrative level, the directed questions which our interface poses - “What resources would be required to build this wall?” - also encourage users to express themselves. On the whole, expression, narrative flexibility, and sensory awareness are related to our drive to be reflexive/ reflective. Constructing and vetting interpretations should be both a challenging and, hopefully, a rewarding endeavor for designers and users of this interface alike.

The design phase of this project has covered a lot of ground, and has raised some of the deepest theoretical issues which this paper addresses. If, as I have

previously argued, interfaces are a vital element of archaeological visualizations, the process of designing those interfaces is an opportunity to be theoretically reflexive about what we wish to communicate to users. Because of this, I have included an extensive treatment of the major theoretical ideas which have contributed to our interface, namely reflexive archaeology, the New Materialism, and the roots of those approaches in the intellectual history of the 20th century. Two main points arose out of this consideration. First, the possibility of unmediated contact with archaeological things is unrealistic. This is especially true from within a game environment, which produces an emergent system of interaction between users and the environment. Second, because mediation is always a component of archaeological experiences, both users and designers should strive to be reflexively aware of the outcomes of the specific system with which they are engaging. We have seen that navigation is one very important element of our game as a system, but also that the way that our interface communicates information, receives feedback from users, and allows users to manipulate the environment have important repercussions for a thing-centered, reflexive approach. To conclude, this chapter has attempted to parse how our interface might effect a pleasurable user experience. This has raised the question of our project's reception among users, which is the focus of the last stages of the waterfall model.

Chapter 5

Evaluation and Maintenance

This chapter outlines a preliminary approach to evaluation and maintenance. While a version of the Area B House interface was disseminated among and tested by members of the Gabii Project and a small group of individuals interested in gaming, archaeology, or some combination of both, a thorough treatment of evaluation and maintenance is an area for future elaboration. This thesis largely represents a contribution to the broader Gabii Digital Project, and has attempted to utilize prototyping and design-experimentation to explore some high-level questions in archaeological theory. In other words, this paper does not contain an extensive treatment of evaluation and maintenance, because the project remains in a “beta” stage. Rather, it has been a practical exercise in archaeological interface design which might lay the groundwork for future considerations. Accordingly, this chapter will establish some possible directions for research into how game-based archaeological visualizations should be evaluated, published, and maintained over time. I will begin by pointing out some key differences between the way that games are tested and evaluated and the traditional process of academic review. Then, I will report some of the most common themes that occur in the necessarily limited dataset of feedback which the Area B House interface has received so far. I will consider some possible ways of addressing the concerns reported in this feedback, as well as underscore the design choices that *do* seem to have their intended effect, at least among the small group which has tested our content so far.

Design is a process that is fraught with unpredictability, and while developers might strive to follow frameworks (e.g., reflective design, MDA) and engage strategies

that are intended to shape the user experience in a certain manner, the way users will respond to content always remains uncertain until the evaluation phase. Software evaluation represents its own professional field, and approaches to testing and evaluating digital content are as varied as design strategies themselves (Patton, 2005). Certainly, the game industry has developed a fairly standardized and certainly rigorous - if flexible - approach to the testing and evaluation of games both as technical products (e.g., exposing and resolving bugs) and as forms of entertainment (e.g., determining how much fun players have and what type[s] of fun they might be experiencing; Hoberg, 2014). I refer to this process as play testing. Usually, game studios take advantage of play testing by either conducting “in-house” testing (i.e., allowing the design team or professional game testers to formally critique the product) or by publishing a “beta” release of the game (the first publicly available version) and collecting feedback via some type of questionnaire (Collins, 1997). Once the game is released, designers will typically monitor for further technical or gameplay problems and will continue the process of revision and patching, often well into the product’s cycle of use (McAnlis, 2012). Additionally, the process of product reviews, informal online discussions, and formal “postmortems” contribute to the rigor of game evaluation. From both a design and archaeological standpoint, we can relate this process to the idea of reflexivity, in that designers must be open to criticisms of their approach, but must also strive to encourage testers (users) to involve themselves in the process of assigning meaning and value to the content in question. In other words, what is good according to designers might not be good (fun, usable, useful, rewarding) to players. Seen this way,

play testing, like reflexive archaeology and reflective design, is a process that acknowledges the value of interpretive flexibility and user feedback.

In chapter 2, I introduced the idea that that academic digital content, especially interactive archaeological visualizations, could benefit from the way that professional games are tested. However, in an academic setting, the existing model for peer review of textual publications does not allow for the iterative, fairly transparent process of play testing found in the game industry. Chapter 2 explained my reservations about the call for developing rigid standards or "best practices" that would dictate the way archaeological or heritage visualizations are produced. Now, I would like to provide a brief discussion of the institutional challenges in the way of a dynamic, iterative review process in an academic setting. Mechanisms for reviewing academic game content or visualizations should, in my opinion, constitute an area of research in their own right, and it is my hope that further work will help us develop creative solutions to these obstacles.

To begin, play testing is necessarily an iterative process, while academic peer-review, if not a completely one-off endeavor, is generally limited to only a handful of revisions. After publication, designers can expect that their user base will expand rapidly beyond the review/play testing team, and this increases the chance that bugs or other problems will be exposed. While the same might be said of, for example, formatting errors in a peer reviewed publication, the likelihood that technical or design failures will impede usability and enjoyability is substantially greater for digital content than for textual publications. In other words, for digital content, the limited process of review that is typical to most journals does not offer the rigor of play testing. This problem also

extends to archiving. When a journal article is published, it is “done,” but games are usually subject to versioning and revision throughout their use lifetime. At what point digital content should be archived, or indeed whether or not it should ever be considered completely finished, is an unanswered question that deserves further consideration, particularly in light of data which might only exist in digital form.

Besides iteration, the relative lack of transparency in academic peer review is another challenge. Journals do not typically make their standards for review available, for instance, and this means that it is difficult to understand the variability of expectations between publisher to publisher. Game design, being a subjective and interpretive practice, requires that designers consider their user base, and the same applies to archaeological visualization. Greater transparency about how we are evaluating content could also ensure that processes for review reflect both the way designers envision their product being used as well as the needs and priorities of the product’s user base at large. For archaeology, this user base should arguably include both professionals and non-professionals.

Related to transparency is the issue of anonymity in peer review. While the relative benefits and drawbacks of an anonymous peer review system for print publications have been discussed (“Pros and Cons,” 1999), there are several reasons why it might be important for developers to collect at least rudimentary data about who their reviewers are. Collins (1997), for example, notes that a play tester’s gaming background (or lack thereof) can have an important bearing on the type of feedback she will provide developers. We can imagine that the archaeological background of the tester would have a similar effect. Research interests, field experience, specializations,

and exposure to archaeological representation in general will all undoubtedly shape the player's responses. In other words, if a play tester characterizes the navigation system as extremely difficult to use, it will be helpful to know if she has no background playing games. On the other hand, if we receive negative feedback about the way our pop-up windows represent stratigraphic sequences, for instance, that play tester's archaeological specialization would be a relevant piece of information.

In addition to basic background information, designers should also be interested in "tracking" the actions of play testers as they evaluate their content. This kind of diagnostic information can help shed light on the potential difference between what testers describe and what they actually do in the game space. But player diagnostics are not as much about vetting a player's experience (e.g., did she really try to execute the function which she reported not to work) as understanding the component of the player's experience that can be captured as data connected to physical actions (e.g., buttons pressed, area traversed, or FPC camera behavior). If, for example, a tester reports that the navigation system was understandable and fun to use, we would be interested in knowing the relative amount of time she spent in either orbit or walk mode. This differs from traditional academic peer review in that reviewers usually have a fair degree of control over what type of information and response they submit to editors and authors. The implication here is that efficient play testing requires that designers have at least some control over what sorts of questions are posed and what kind of information is collected about testers. This is not to say that publishers must sacrifice all authority over the review cycle, but that for certain types of information, the process of collecting

and responding to user feedback must be somewhat democratized to accommodate the unique nature of game/interface design.

How can we apply these considerations to the Area B House interface? A good start is simply to disseminate the content among a small group of interested users (members of the Gabii Project or individual who otherwise have an interest in historical visualization and gaming) and provide a simple questionnaire about their opinions on the content. The questions posed to play testers attempt to integrate some of the considerations mentioned above, namely that we should consider the background of each play tester as well as both the technical features and emotive qualities of our interface. In the future it may also be possible to track user behavior in the Unity scene itself, and evaluate questionnaire responses against logs of user behavior. For now, however, we can identify a few major trends in the way our interface has been received among play testers as well as suggest some ways that we might adjust our interface in response to their concerns.

Out of the nine play testers participating in this project, five identified as archaeologists, and all identified as either active gamers or persons who have had experience playing games in the past. Almost all felt that the interface controls were clearly presented and easy to understand, although some suggested that instructions be presented in a more concise way. One way of addressing this might be to include an introductory or tutorial scene, which guides users through specific actions, such as opening a context's pop-up window or toggling the phase groups of SFM models, in order to familiarize them with the interface. Play testers also tended to feel comfortable navigating the scene. Interestingly, however, while most felt that the "slowness" of the

speed at which the orbit and first-person cameras move was appealing, some expressed desire for faster controls. While I have already explained how slow movement throughout the Area B House might help to facilitate a reflexive experience, allowing users to adjust a camera speed setting is also a way of providing a greater opportunity to users to shape their own experience. In the future, then, we might explore some general options for camera and movement settings. This is also a testament to the general way that embodied interaction is impactful, since the play testers indirectly indicated that the way they moved around the scene had an effect on their overall experience.

The schematic reconstructions included in our scene were generally praised by all nine play testers because of the way they provided an intuitive sense of what kind of structure the Area B House might have been. However, one play tester pointed out some possible practical and theoretical problems with its current configuration. First, when the player moves the FPC too close to a wall, the camera seems to pass "through" its surface, resulting in a potentially obstructed view of the structure. This can be easily fixed on the front end using the "near-clip" feature of Unity's camera parameters, but the play tester also raises the issue of the reconstruction's transparency in general, pointing out that a fully opaque wall surface would provide a better understanding of how the structure controls vision and movement. My initial wariness with this suggestion is that we breach too far the question of the "lived-in" experience of the house, rather than sticking with a representation of the modern archaeological experience with its remains. In my earlier estimation, reconstructions were more a way to represent what kind of overall structure we think the remains

suggest than to understand its effect on the perception and movement of its ancient inhabitants. However, given that our scene *does* contain colliders on the reconstructed walls, we should accept that it is at least partially concerned with the question of movement and perception. In the interest of responding to feedback in a reflexive way, later iterations of this project should explore more explicitly the question of what our reconstructions are intended to communicate, and what the best way to represent them might be.

Reception of the interface's overall appearance was more mixed. None of the play testers had major complaints about the usability of onscreen icons, although least one found them somewhat "distracting." While some said that the GUI's appearance was "smart" or "cool," others admitted that they did not find it "attractive." In my estimation, attractive graphics are somewhat of a prerequisite for a pleasurable interface. Although the question of what is and is not attractive is obviously highly subjective, future rounds of play testing should encourage users to provide more pointed responses about what they liked and did not like about the way the interface looked and felt.

Play testers were also asked to describe whether or not the visualization was fun to use, and this produced perhaps the most interesting results. Five claimed the interface was fun with no qualification. One avoided calling the experience fun, but did say it was "definitely better than reading a monologue or trawling through raw data." Finally, two play testers stated that they simply did *not* have fun, even as both indicated that the experience was in some way pleasurable (e.g., "it's looking good" or "it was interesting"). Like the attractiveness of the GUI, the amount of fun it elicits is also highly

subjective. Nevertheless, these responses seem to indicate that “fun” and “pleasure” in interfaces should not be considered synonymous terms, and these two play testers, for instance, seemed to find the interface pleasurable, if not fun. Future research would attempt to parse the distinction between fun and pleasure in greater detail, as well as provide a stronger framework for what, precisely, might constitute different types of archaeological fun. We might envision, for instance, a sort of MDA framework tailored around archaeological interfaces in particular.

Project maintenance entails maintaining a strong rapport with the content’s user base, and responding to concerns, technical glitches, and bugs in a responsive manner. One last issue I will discuss in this chapter is the challenge of striking a balance between diligently addressing user concerns and making discerning choices about the viability of certain features. In other words, although reflective design, like reflexive archaeology, is generally “user centered” in that it attempts to place users at the center of the meaning-making process, I do not think this means designers should be afraid to make a final judgement about whether or not a desired feature is feasible. Among informal responses to our interface, for example, several users have requested the ability to access information about features by clicking directly on them, as opposed to abstracted representational icons. This was indeed the type of system our project attempted to implement in its nascent stages, but in chapter 3 I explained why, due to the vertical nature of archaeological stratigraphy and the unequal size of contexts in the Area B House, expecting users to click directly on features would mean that only a handful of contexts would likely be accessible: the interface would almost certainly become much busier and more confusing. In addition to this, we can add the technical

concern of placing colliders (a requirement for an object that will respond to mouse clicks) on each high-resolution SFM model. In other words, although users might intuitively want certain features, technical or aesthetic concerns might make them, in the designers' estimation, poor choices. On the other hand, in the interest of reinforcing the feeling among users that their contributions and opinions are valuable, we should provide some mechanism for providing a justification of our interface and explaining our reasoning for *avoiding* certain design choices.

Processes for evaluating, publishing, and revising the interfaces of archaeological visualizations represent a promising area for further research. This chapter has attempted to establish the importance of a transparent, iterative review process for academic visualization. Because of this, the model which has arisen out of the professional game industry for testing and reviewing games might be a more promising approach to evaluation than traditional academic peer review. Nevertheless, these two models contain certain conflicts (such as the problem of anonymity) which we should attempt to resolve, even as we maintain sensitivity to the institutional requirements of academic research and publication. I have also reported the preliminary findings of the first round of play testing for the Area B House interface, establishing some important trends in those responses which should be addressed by further research. Lastly, since games move through many iterative phases before arriving at the state of a "finished" product, we should consider how we might respond to play testing in a way that acknowledges both the design prerogatives of the development team and the need to encourage active, engaged feedback from users.

Chapter 6

Conclusion

This thesis has taken a multifaceted approach to understanding the role of GUIs in archaeology, and has made the case for theoretical self-awareness and reflexivity about the implications specific design choices. My own theoretical approach has shown that interfaces and interface design can facilitate archaeological reflexivity, as well as respectfully respond to some of the shortcomings of an "asymmetrical" New Materialist approach. On the other hand, the incorporation of highly realistic SFM models into a game-engine based context, along with contextual interface elements that help users engage with those models, represents a major step towards a symmetrical treatment of archaeological materials.

I have extended the idea of interfaces as illustration, arguing that like illustration conventions, interfaces are a way of elevating "superficial views" of objects to skilled, intellectually fertile and even emotionally engaging representations. The notion that 3D models, game-based archaeological content, and embodied virtual interaction can be both emotionally *and* intellectually rewarding is perhaps contrary to much recent thinking in digital archaeology, which expresses a wariness over the seductiveness of rich visual content. Nevertheless, I maintain that game media need not be conceived of as ocularcentric, and that the embodied, visceral components of gameplay actually defy this characterization. Moreover, since games represent a multi-sensory experience, they are necessarily subjective. Sensory reactions always vary from person to person, but have a major bearing on our intellectual conception of the things with which we interact. Because of this, the New Materialist hope of unmediated contact with ancient things is

unfeasible, and this is true for in-person experiences as much as it is for virtual ones. What does unfold in a virtual context, however, is an emergent system of interaction with 3D models, largely connected to the way that collision with virtual surfaces can direct user movement and navigation. Since this project has chosen Unity as its platform, instances when concepts like emergent systems, borrowed from the study of games, pertain to our interface have been especially emphasized.

Due to the way archaeological interfaces for interactive 3D media challenge a hard-line interpretation of the New Materialism, it has also been necessary to provide an extensive critique of the intellectual roots of that theoretical school. While I am somewhat sympathetic to the concerns which the New Materialism has raised about post-processual archaeology (namely, that it unfairly emphasizes the agency of humans over the agency of things), I maintain that unless the New Materialism takes a symmetrical approach to human-thing interaction, it risks rehashing some of the weakest arguments of processualism. Olsen's (2010) emphasis on unmediated contact with things - which is not embraced by all voices in the New Materialism (Shanks & Webmoor, 2013) - can be seen as a reversion to the positivist epistemological approach taken by many in the field of processual archaeology. Ironically, in my estimation, this actually undermines the idea that humans and things are entangled in a recursive relationship because it implies a strict Cartesian separation between subject and object. In a virtual setting, recursive relationships between users and things often arise as an emergent system, and can be underscored by thoughtful approach to navigation and interaction in interface design. At any rate, embodied archaeological gameplay makes a

strong case for a symmetrical approach to humans (as both users and ancient people) and things.

The Area B House interface as it currently exists makes contributions to the study of interfaces in archaeology, reflexive archaeology in the post-excavation context, and the New Materialism. However, it is very much an aspect of an ongoing project, and must undergo several more rounds of evaluation and iteration before it might be considered a finished product. I have attempted to outline some of the challenges which will accompany this process, especially as they relate to peer review and publication. Ultimately, however, this project has represented a practical exercise, attempting to integrate several high-level theoretical ideas into a usable, functional and (hopefully) rewarding interface experience. If we are to move away from the idea of visualization as a problem and begin to understand how, in concrete terms, it can be useful as an inclusive research tool, the design process itself represents a necessary step toward confronting and resolving the theoretical and practical issues raised by interactive archaeological representations. This challenge is not wholly new, as archaeological illustrators have spent decades developing a deeper theoretical understanding of what their practice contributes to the field. This thesis has attempted to extend that sort of understanding to digital representation, and has shown that GUIs are an essential element of meaningful visualization.

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