Creating an Interactive Past: Digital Technologies for Public Representation of Archaeological Sites and Artifacts

By

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Creating an Interactive Past: Digital Technologies for Public Representation of Archaeological Sites and Artifacts

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Abstract

Archaeological sites are met with a wide array of constraints ranging from limiting budgets to a lack of standing structures that pose unique challenges when creating representations of the sites and artifacts for the public. This thesis notes that archaeologists have not widely embraced digital technologies for the representation of archaeological sites and artifacts, posits that digital technologies enable archaeologists to excel within financial and material constraints, and argues for an expanded use of digital technologies in archaeological representations. Specifically, this thesis focuses on how three digital technologies – augmented reality, video mapping and online repositories – can enable the public to develop compelling, lasting, and meaningful connections to archaeological sites and artifacts. A chapter is dedicated to each technology and includes an explanation of the technology, examples of how it is currently being used for archaeological representation, and an original case study developed to test and demonstrate its significance for archaeology.

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Chapter 1: Archaeology's Adoption of Technology

Traditionally, archaeologists have readily adopted technology for analysis of archaeological sites and artifacts. In 1949, J. R. Arnold and W. F. Libby developed radiocarbon dating at the University of Chicago. Radiocarbon dating has enabled archaeologists to date artifacts without relying solely on stratigraphic sequences and seriation. Since then, radiocarbon dating and an array of other dating methods have become essential tools for archaeologists (Renfrew, et. Al. 2008: 143). While technology can be broadly defined to encompass everything from trowels to laboratory methods used for artifact analysis, technology will be considered "computing" or digital technology – the use of computer hardware and software – for the purpose of this thesis.

There is a disjuncture in the adoption of digital technology by archaeologists. It has been fully embraced for analysis and record keeping (Schreibman, et. al 2004: Part 1, Section 2; Aldenderfer and Machner 1996; Wheatley et. al 2002), but not for the representation and interpretation of archaeological sites and artifacts. To be sure, there has been a great increase in the use of digital technologies for public representation (Kerruish 2010; Proctor 2011; QRator: About the Project), but they are far from being widely used. This thesis encourages expanded use of digital technologies for the representation of archaeological sites and artifacts.

According to Susan Schreibman, Ray Siemens and John Unsworth (2004: 21), archaeologists in the mid-1970s began to use database software because the need for efficient record keeping increased with the increasing quantity of excavated artifacts: “For instance, studies of plant and animal remains in the archaeological record (to understand food sources and the surrounding ecosystem) required sifting through large quantities of earth to find seeds and bones that could only be interpreted with statistical analyses; such work cried out for sophisticated data-handling techniques. Similarly, more careful and conscientious attention to small finds and fragmentary evidence could only become common with the advent of better recording techniques. It goes without saying that the recording of all these data would have been of little use had the programs not also made the retrieval of information – in an incredibly wide variety of forms – more efficient and flexible.”

The increased interest in computer use in archaeology sparked the creation of the Computer Applications and Quantitative Methods in Archaeology (CAA). Since its inception with a small conference at the University of Birmingham in 1973, the CAA has become an international organization with annual conferences bringing archaeologists, mathematicians, and computer scientists together for collaboration. As the CAA describes on its 2010 conference website, its “aims are to encourage communication between these disciplines, to provide a survey of present work in the field and to stimulate discussion and future progress” (About CAA 2011). Because of its English roots, many publications on the role of computing in archaeology have been published by British archaeologists (Cooper and Richards 1985; Henderson, et. al 1991).

Mapping and spatial thinking have long been an integral part of archaeology and have led to one of the most popular uses of technology in archaeological analysis: geographic information systems. “With the emergence of the ‘New Archaeology’ in the 1960s and its emphasis on explanation, quantitative thinking, and a scientific perspective on the past, archaeologists increasingly turned to other fields, notably geography, for tools and ideas for spatial analysis. Geographical information systems (GIS), as they become practical tools for spatial analysis in the early 1980s, were quickly seized upon by archaeologists, who immediately recognized their potential” (Aldenderfer and Maschner 1996: 8).

The New Archaeology’s focus on quantitative analysis even fostered an interest in the use of computers to create simulations and for typological, chronological and statistical analysis (Deetz 1965; Dyke 1981, Hodder and Orton 1979, Howell and Lehotay 1978, Thomas 1973, Wobst 1974). “Using computers to simulate development in relatively simple societies was considered a very promising technique as early as the 1960s, but, as the popularity of the ‘new archaeology’ waned, so did the enthusiasm for simulation” (Schreibman, et. al 2004: 26).

However, the use of computers to organize and present data continued to expand. As computer assisted design (CAD) programs became available for personal computers in the mid-1980s, archaeologists began to use them for drafting. Surveying equipment such as the total field station were developed to record detailed 3D data. The resulting survey data and increasingly complex CAD programs could be used to create 3D models. Despite this development, 3D models were more often viewed as another form of record keeping than for public representation. “In general, archaeologists have been more likely to use CAD as a record-keeping technology, since their approach to data gathering emphasizes such recording. Archaeologists and architectural historians dealing with older and less complete structures have often used CAD for precise records as well" (Schreibman, et. al 2004: 25).

Computer databases, CAD software, Geographic Information Systems, LIDAR (Light Detection And Ranging), satellite imagery, ground penetrating radar and even CAT scan machines are part of the long list of technologies that have been used for archaeological analysis. As early as 1972, archaeologists used the satellite LANDSAT 1 to conduct remote spectral analysis (Aldenderfer and Maschner 1996: 8). In short, digital technologies have long been key tools used for archaeological analysis and record keeping.

Digital technologies offer archaeologists the opportunity to create experiences that allow the public to engage with archaeological sites and artifacts, helping cultivate deeper levels of appreciation and understanding. Despite the benefits digital tools can provide for public representation, they have not had equally widespread adoption. Recent efforts to study the use of technology towards the representation of archaeological sites and artifacts are disjointed. Technology's application towards cultural heritage preservation has been studied under several monikers and in several fields: Digital Archaeology, Digital Humanities, Digital Preservation, Cultural Heritage Informatics, Computational Archaeology, Archaeological Computing, Cultural Heritage Preservation, Cultural Heritage Management, Museum Studies and Information Science to name a few.

Arguably the most productive of these has been the Digital Humanities, a growing field of study that examines the interplay between technology and humanity in addition to how technology can be applied to scholarly interests for both academics and the public. However, some “Digital Humanists” aren’t even sure if their research interest constitutes a field, according to Presner (2008: 2): “Digital Humanities is not a unified field but *an array of convergent practices* that explore a universe in which: a) print is no longer the exclusive or the normative medium in which knowledge is produced and/or disseminated; instead, print finds itself absorbed into new, multimedia configurations; and b) digital tools, techniques, and media have altered the production and dissemination of knowledge in the arts, human and social sciences” [original emphasis].

Traditionally, the Digital Humanities consisted of a large number of academics from English, Classics and other Humanities departments, many of which have shown an interest in cultural heritage. According to associate director of the Maryland Institute for Technology in the Humanities Matthew Kirschenbaum, the field of Digital Humanities is growing so quickly that it should be seen as a “Big Tent” which can accommodate all interested parties and related areas of research. However, archaeologists are, for the most part, conspicuously missing from the Digital Humanities (DH). Ethan Watrall, Associate Director of Michigan State University’s MATRIX, The Center for the Arts, Letters and Social Sciences Online and founder of MSU’s Cultural Heritage Informatics Initiative, recently wondered why this was the case at a digital humanities conference in a topic proposal entitled, “Archaeology & DH: Two Great Tastes That Should Taste Great Together (so why the hell don’t they)?”

> Everyone in DH is talking about “the big tent” as a metaphor for constructing the boundaries of DH (who is in, who is out – who is a digital humanist, and who is not). In the meantime (and to continue the metaphor), archaeologists (specifically anthropological archaeologists) are so far away from the “tent” that they don’t even know it exists. Why is this? You would think that archaeology and DH would be natural (and very happy) bedfellows. Many of the disciplines that self identify as being part of DH (history, classics, etc.) articulate very nicely with archaeology (and have done so for many years). On top of that, archaeology has long been invested in a wide variety of digital practices (since as early as 1954). So, what is the problem? (Watrall 2011a)

Watrall traces the roots of this disassociation to the focus processualism placed on the adoption of a scientific approach rather than a humanistic one. Because of this, Watrall argues, archaeologists do not readily align themselves with the digital *humanities* since they categorize the field as a social *science*.

> A recent example (and perhaps manifestation) of this was when the executive board of the American Anthropological Association (AAA), at 2010 annual in New Orleans, adopted a long-range planning document that removes the word "science" at several points from the description of the association's mission (Lende). The change, which, by all accounts was fairly routine,resulted in what only can be described as a firestorm of criticism (Lende). Many archaeologist and physical anthropologists were infuriated, incredibly frustrated, and alienated. (Watrall 2012: 13)

Since analysis and record keeping can be considered part of the scientific process, it may explain why archaeologists were so quick to adopt digital tools for such purposes. This being so, it follows that the adoption of digital technology for the representation of archaeological sites and artifacts for the public has comparatively lagged behind because it is considered a humanistic endeavor.

Despite the disjuncture between archaeology and DH, there seems to be less of an identity crisis in Western Europe with respect to where the marriage of technology and archaeology stands in academic research. Many European universities have undertaken this research within the broader category of cultural heritage studies, including traditional preservation techniques along with the study and application of new media technologies towards preservation and public presentation. University College London (UCL) is a prime example of an institution that has established cultural heritage studies programs that combine archaeology, preservation, and the digital humanities. UCL has made technology an important research focus in a myriad of degree programs: MA in Public Archaeology, MA in Cultural Heritage Studies, MA in Museum Studies, MA/MSc in Digital Humanities, MA in Managing Archaeological Sites, MSc in Conservation for Archaeology and Museums and an MSc in Digital Anthropology (UCL Archaeology Degrees; MA/MSc in Digital Humanities).

The University of Southampton houses the Archaeological Computing Research Group and offers two degrees that explicitly focus on the application of technology towards archaeology: an MSc Archaeological Computing (previously known as Virtual Pasts) and an MSC Archaeological Computing: Spatial Technology. The Department of Archaeology at the University of York offers an MSc in Archaeological Information Systems. In Italy, the University of Naples Federico II offers a one-year Master's Degree program in Multimedia Environments for Cultural Heritage and Sienna University offers a masters program in Archaeoinformatics.

Efforts in the United States have not been as organized or widespread as in Western Europe and are largely found within the Digital Humanities rather than archaeology. While there are many degree-granting programs in Western

Europe, North American efforts have largely been research groups typically affiliated with Humanities departments. One of the only groups that is firmly in the field of archaeology is the University of California Berkley's Center for Digital Archaeology (CoDA), which offers hands-on trainings and workshops for preservation professionals in everything from 3D modeling for cultural heritage to field and laboratory photography for archaeology. CoDA currently offers a handful of summer courses, but only offers one semester-long course on Digital Documentation and Representation of Cultural Heritage. Another CoDA effort is the CoDiFi iPad app that aims to offer a digital and interactive version of the archaeological monograph that they term the "multigraph" (CoDiFi, Center for Digital Archaeology).

Some research organizations in the U.S., however, have kept the cultural heritage title that is popular in Europe and added "informatics" to represent the digital aspect. In the private sector, California-based non-profit Cultural Heritage Imaging (CHI) provides training and preservation services focused on the use of imaging techniques. CHI has partnered with the National Science Foundation, the Institute of Museum and Library Services, the National Center for Preservation Technology and Training and the Kress Foundation on several projects (Cultural Heritage Imaging, Projects).

Michigan State University's recently formed Cultural Heritage Informatics Initiative (CHI) has also uses heritage as a category. Located within MSU's Digital Humanities Center called MATRIX, CHI has created fellowships for graduate students and a fieldschool to research the application of technology towards cultural heritage. I participated in its 2011 fieldschool and produced an iPhone application that showcased archaeological sites on MSU's campus excavated by the Campus Archaeology Program. Each archaeological site is represented by a pin on a map-based interface. Users of the application can tap on each pin to reveal more information about the site, historic pictures and even video of the excavations. The 2011 fieldschool's application was used as a prototype for a professionally produced application to be released in 2012.

The common thread is that research regarding the use of digital technologies for the representation of archaeological sites and artifacts is fragmented. In addition, little research on the topic is being done within the field of archaeology itself, at least in the United States. However, that could be a symptom of a larger problem in archaeology: a greater need for public engagement, which is outside the scope of this thesis (Crews 2012; Little 2002; Shackel and Chambers 2004; Stone 1997).

In this thesis, I endeavor to show how three digital technologies that can enable the public to develop compelling, lasting and meaningful connections to archaeological sites and artifacts: augmented reality, video mapping and online repositories. A chapter will be dedicated to each technology and will include an explanation of the technology, examples of how it is currently being used and an original case study developed to demonstrate its significance for the field of archaeology.

The next chapter provides an overview of augmented reality from a technical standpoint, reviews some of the current projects using the technology and presents a case study developed for this thesis.

Chapter 2: Augmented Reality

Looking into the distance, an archaeologists spots a rise in the landscape and an oak hammock not too far from it. A few test pits confirm the archaeologist's suspicions. The area was occupied by Native Americans several hundred years ago and was a site of European contact as evidenced by the foundations of an early fort. The archaeologist sees a window to the past by reading the landscape, but the public sees very little and can likely imagine only a little more. With augmented reality (AR), archaeologists can help the public look through the same window and visualize the past.

AR applications layer digital information relevant to particular locations onto the physical world in an effort to enhance, supplement or "augment" reality. Because information that can be layered can include text, maps, video, images, audio and even 3D models, AR applications can vary greatly in their features and functionality. Nancy Proctor, Head of Mobile Strategy & Initiatives at the Smithsonian Institution, notes that what can be considered the earliest form of augmented reality, audio tours, have been in use since at least 1952. "Arguably, they are also the oldest source of 'augmented reality' (AR), enabling us to 'overlay' the observed environment with interpretation and other content we hear" (Proctor 2011: 7)

AR applications have the ability to create an unmatched level of immersion and understanding for archaeological sites by contextualizing both places and information. Such applications consist of two basic components: a camera and a screen. The camera is used to display live video of the landscape on the aforementioned screen and the AR program displays digital information layered on the live video. Because of these simple technical prerequisites, many personal computers, mobile phones and even mobile media players can make use of AR applications.

Countless archaeological sites no longer have standing structures, leaving the public – equipped only with their imagination – to visualize how the past might have looked with the traditional tools of signage, historical photographs or an artist's rendering. Such sites pose a challenge to archaeologists and cultural heritage professionals in the creation of compelling, meaningful and lasting connections between the public and a site.

Augmented reality (AR) applications offer a new level of context for the public to visualize the past, particularly at sites that have had little to no support for reconstruction or representations. With the use of AR, visitors can see 3D models of structures, monuments and the like layered onto the environment through their smartphone's screen and camera.

Archaeologists can use AR to virtually situate structures which are now only part of the archaeological record in their original context. 3D models of no longer extant structures layered above live video would appear as if they are situated in the physical world rather than isolated to a screen. With an AR program, one could point a smartphone at an area where a historic landmark once stood and see it layered onto the environment through the smartphone's screen and camera. Users would even be able to walk around 3D models to view them from different angles.

In addition to providing greater context and immersion, AR applications can also make archaeological sites more accessible. For example, a monument or building at an archaeological site that is hundreds or even thousands of miles away can be virtually experienced with the use of an AR program. Artifacts can also be virtually manipulated through an AR program. For example, users could print and hold a playing card-sized marker in front of a computer's or smartphone's camera and see a 3D model of an artifact or a miniature structure appear. Instead of a static image of an artifact, a user can manipulate its orientation and interact with it in an immersive fashion that still protects the actual artifact.

AR not only has the potential to benefit sites that no longer have standing structures for the public to see, but also those that lack the funding for physical exhibits or museums. As AR applications require very minimal or no physical objects located at archaeological sites in order to function, they are cost effective and require little to no maintenance. Changes and updates to the application can be completed with a change to the application's code, which may require a specialist. Even with that in mind, the cost is likely less than creating or changing a physical exhibit or moving a historic house to a new location for preservation.

Examples of AR

Streetmuseum

The Museum of London partnered with the creative agency Brothers and Sisters to create an AR application called Museum of London: Streetmuseum for iOS devices (iPhone, iPod touch, and iPad) and Android OS devices. Essentially a combined marketing and public relations, Brothers and Sisters develops campaigns with creative means such as videos or software and website development for clients. Released in May of 2010, Brothers and Sisters developed Streetmuseum (Figure 2.1) that allowed users to find over 200 historic places on a map-based interface complete with historic photographs and information regarding points of interest. The app's AR feature, called "3D View," overlays historic photographs onto the landscape, fitting the photograph onto the present like a puzzle piece, to give users an idea of how the city used to look.

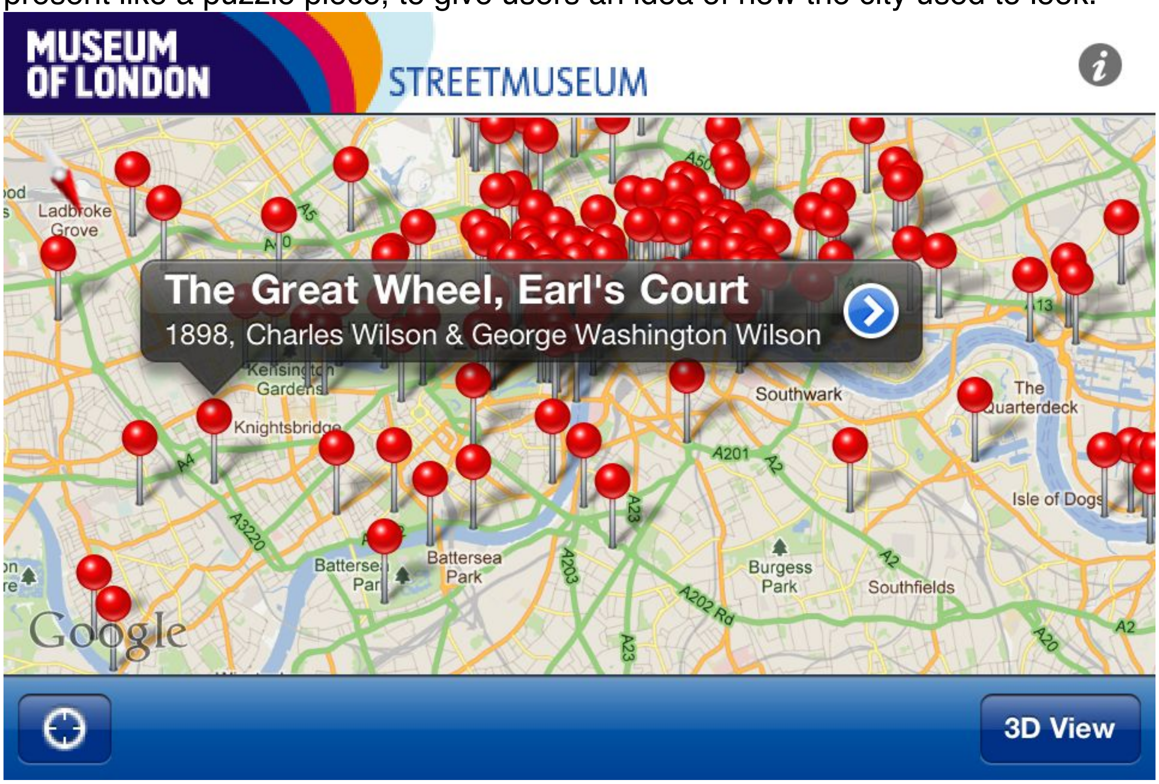

Figure 2.1: Streetmuseum's main interface centers around a map which users can use to select points of interests scattered across London. (Screenshot courtesy of author.)

Although the museum's initial goal was to have the application downloaded 5,000 times, it has received more than 300,000 downloads in the 18 months since it was released. Brothers and Sisters estimates that it generated £1 million worth of publicity for the museum with news coverage the application received. After the application's release, visitors to the Museum of London tripled in number (Kerruish 2010).

Londinium

With the success of Streetmuseum, the Museum of London partnered with the History Channel in addition to Brothers and Sisters to create a second application, *Museum of London: Streetmuseum Londinium* (Figure 2.2). While similar to the original *Streetmuseum*, *Londinium* highlights London when it was a Roman settlement on the Thames River in AD 125 with a more aggressive AR component. Video reenactments of fighting gladiators, pottery making and a market scene are layered onto the landscape through AR. Users can walk to a location where an artifact was found and play a mini-game to unearth the artifact by stroking the screen to wipe away dirt and virtually excavate it.

Figure 2.2: Streetmuseum's successor can display videos layered on the landscape. (Image courtesy of Mobile Museum http://mobilemuseum.org.uk/ 2011/11/streetmuseum-londinium/)

Case Study: Recreating Rye

Many small archaeological sites which dot the U.S. lack the funds to have reconstructions, visitor centers or even the most basic of signage or historical markers. In order to demonstrate AR's usefulness, I have applied it to one such small archaeological site in Manatee County, Florida. The site contains the remains of a late 19th and early 20th century village called Rye that illustrates how quickly places can be forgotten and become part of the archaeological record. Rye is an ideal candidate to showcase how augmented reality can be used to digitally reconstruct similar sites. An abridged history of Rye (see Santos 2011 for the full history) and a condensed survey of the area today based on my research follows.

Rye's History

Confederate Army soldier Erasmus Rye was freed during a prisoner exchange between the Union and Confederate armies in New Orleans in April of 1865. After being released, Erasmus returned to his wife Mary and homestead located on a deep creek off the Manatee River in Manatee County, Florida. Although the area was inhabited only by his wife and in-laws when he joined the Confederate Army in 1863, the area began to grow after his return. "By 1875, the attraction of living at the head of navigation on Manatee River had brought other families into the section. The site had promise of becoming a large community and had been named Rye, in honor of Erasmus Rye" (Warner and Warner 1986: 144). In 1879, the community had grown substantially and a bridge across the Manatee River was proposed to the county commissioners. Several months and $150 later, Rye Bridge was completed and became the first bridge on the Manatee River (Warner and Warner 1986: 144). With the bridge, Rye was the first section of the Manatee River easily crossed to reach areas further north such as Tampa, Florida. Rye Bridge would remain the only bridge on the Manatee River until 1920.

Rye was even politically connected at the county and state levels. “On election day the voters came to Rye to cast their votes, that being the most important place in the county at the time. . . .The active minded men would put on horse races or some sort of sport as a celebration of the event” (Haines 1936: 1). In addition, Rye was home to a representative of the Florida State Legislature, James Layne. The Governor of Florida from 1893-1897, Henry L. Mitchell, was the brother of Rye resident and general store owner Samuell Mitchell (Warner and Warner 1986: 146). Simply put, Rye was not isolated.

Families continued to move to Rye as it held promise for being a crossroads at the head of the Manatee River. In 1882, Samuel Mitchell, a merchant who moved to Rye from Tampa, built a general store and a dock for boats to load and unload goods. Mitchell also founded a second cemetery and platted a subdivision with 90 lots and five streets, for purportedly 25 families (Warner and Warner 1986: 144).

By 1890, a second general store was opened by T.S. Browning. Rye even drew the attention of the River and Harbor Committee of Congress, which had a six-foot channel dredged in the portion of the Manatee River that led to it in 1909 (Warner and Warner 1986: 146). A celebration was held on January 5, 1910 with hundreds of Manatee County community members, even including the Manatee County Superintendent of Schools Leslie L. Hine, to commemorate the dredging.

“A crowd of 500 to 600 people were expected. Every available launch and the gasoline steamer, ‘Vandalia,’ brought passengers from Manatee and Bradentown. A long train of automobiles and carriages slowly made their way to

Rye over dirt and shell roads" (Warner and Warner: 146). The dredging made Rye more accessible to steamboats, furthering bolstering its growth.

As more families arrived at Rye, the community grew to add a post office, saw mill, grist mill, school, church and even plans for a subdivision and 72 families in 1910 (Warner and Warner 1986: 146). One inhabitant of Rye was quoted in the *Manatee River Journal* saying that the people of Rye were "jubilant over the prospect of a railroad" (July 16, 1891). Such a railroad would have further increased Rye's size and importance in the region.

Despite Rye's initial growth and success, a confluence of the Great Depression and the end of the steamboat era brought Rye's demise. "Sadly, this was the end of the steamboat era, and within a few years the town became isolated once again. By 1929 even the post office closed, and the remaining settlers eventually all moved away" (Around the Bend Nature Tours 2009). Other options of traveling north across the river became available and Rye was bypassed. In fact, a mill located at Rye provided the lumber for a bridge which would help make the bridge at Rye obsolete.

Though the use of railroads and the fall of the steamboat era were significant factors for Rye's demise, the Great Depression played an equally important role. Manatee County Land Revenue Records show that during the midst of the Great Depression in 1932, and just three years after the Rye Post Office closed, most of the land in Manatee County was sold to the county government for failure to pay taxes. Through an analysis of Manatee County records, it is clear that approximately two-thirds of Manatee County's residents had lost their land. Rye residents, including descendants of the village's namesake, sold their property to the county for back taxes.

In 1936, just four years after the county reclaimed much of the land at Rye, a news article headline proclaimed that "time erases pioneer town of Rye, but memory of it is fresh in the minds of many" (Haines 1936). The article continues, "though the town has vanished forever, and most of the early inhabitants have passed to their reward, the days when Rye was a flourishing village live still in the memory of Elijah Rye and his brother Will" (Haines 1936).

Although the 1936 *Bradenton Herald* article claimed that Rye was still "fresh in the minds of many," that quickly changed. Rye became a re-appropriated space, devoid of the meaning it once held for its settlers as early as a decade after its abandonment. The shift in memory can be seen by the trash that is scattered throughout Rye today. The space where the town of Rye once stood continued to be re-appropriated for use well into the 1980s by "vagrants," according to local newspapers. "Although no one has been living in the house for (years), Johnson said he saw several mattresses on the floors recently. 'It looked like the hippies were there,' he speculated. 'It was probably a marijuana smoking den for a while'" (Greenwald 1988: 1).

On May 11, 1988, the last standing structure at Rye (Figure 2.3) was set ablaze by the reported vandals who frequented it. Braden River Fire Chief Henry Sheffield, ". . . said the fire was probably deliberately set. He said that he found beer cans and other evidence that people had been using the house and surrounding property, which is owned by the county, as a place to have parties" (White 1988: 1).

Since 1988, 160 acres on the east side of Rye Road have been owned by Manatee County and made into the Rye Preserve. The Rye family cemetery has been restored through a cleanup effort by the Manatee County Historical Commission and local volunteers. Rye has gone through many changes since it was first settled in the early 1860s but today, not much is visible. The Rye family cemetery and a smaller satellite cemetery with one gravemarker are all that are left of Rye.

What remains of Rye largely consists of artifact scatter: fragments of metal, whiteware, porcelain, glass, bricks and ceramics (Santos 2011: 26). The most noticeable historic scatter in the area are those associated with the Rye Family Homestead, located approximately thirty feet south of the cemetery. The most prominent feature of the Rye Homestead site are the remains of the tin roof. Charred planks of wood and bricks from a chimney are obscured by overgrowth (Figures 2.6 and 2.7). Many other artifacts that were once in the homestead are also scattered throughout the area (Figures 2.4 and 2.5).

Figure 2.3: A photograph of the Rye Homestead that appeared in a newspaper article before it burned down. A mattress can be seen in the second floor. (White 1986)

Figure 2.4: Likely the same mattress frame as seen in the previous photograph, at the Rye Preserve in 2011. (Photo courtesy of the author.)

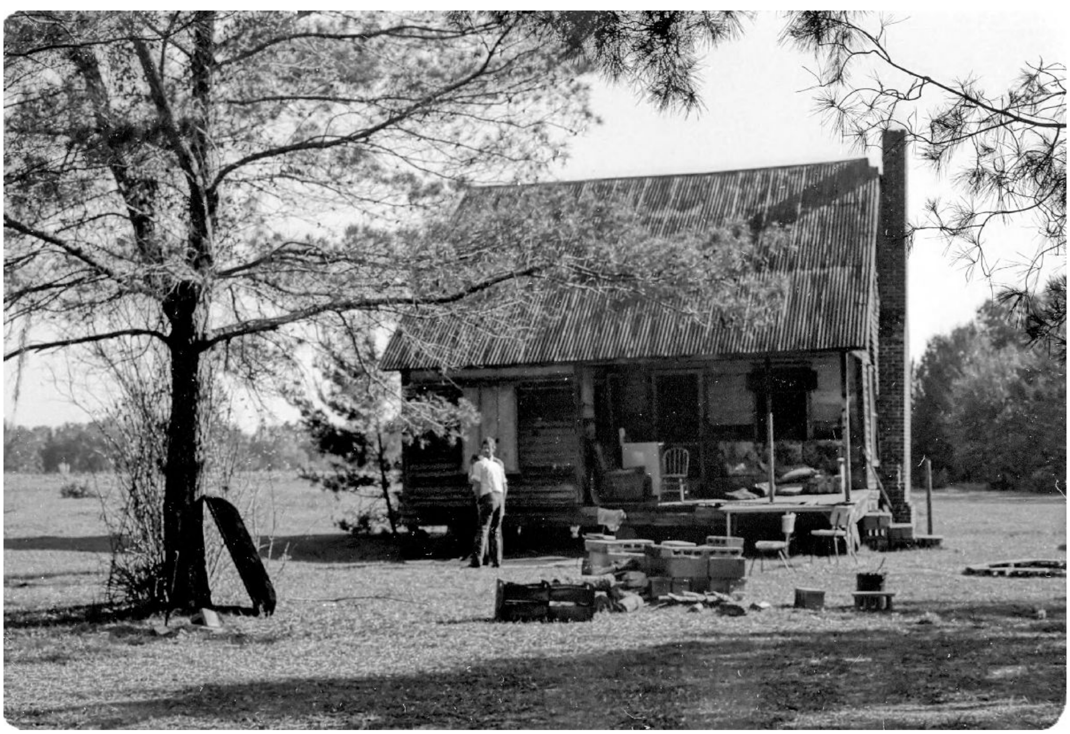

Figure 2.5: Much of what is seen in this photograph remains only as artifact

scatter. (Photo courtesy of the Manatee County Public Library Historic Photograph Collection http://digital.lib.usf.edu:8080/ usfldcFedoraCommonsViewers/USFLDCfcIMAGEviewer?pid=usfldc:M01-07301-A)

Figure 2.6: Charred wood from the homestead fire is still visible in the underbrush. (Photo courtesy of the author.)

Figure 2.7: Bricks from the Rye Homestead chimney are clustered among metal. (Photo courtesy of the author.)

Despite so much of Rye lying just beneath the surface, scattered above ground or hidden by underbrush, there is practically nothing left of the village for visitors to the county park to visualize how the village might have been. Because there are no standing structures left from Rye – a community that had a post office, saw mill, grist mill, school, church and a subdivision – and the county does not have the resources for a reconstruction, it is a perfect site for AR to demonstrate how it may have looked in the early 20th century.

Augmenting Rye

There are two approaches augmented reality programs use to anchor 3D models to a point in the physical world: GPS and image markers. With the GPS approach, 3D models are anchored to predetermined latitude and longitude coordinates. The result is a 3D model that appears when a user is both near the coordinates and aiming the camera-enabled device in the coordinates' direction. Because of the limited accuracy of GPS on commercial devices, the 3D model often seems to shake erratically, does not appear in the correct spot and can only be viewed from one perspective.

AR applications that use markers generally display 3D models with more stability and allow them to be viewed from different perspectives. The markers can be photographs, images or arbitrary symbols that an AR application is programmed to recognize with the device's camera. Once a marker is recognized, the application will display the appropriate 3D model anchored to the model.

For Rye, I chose to use the marker-based Qualcomm Augmented Reality platform (QCAR) – recently rebranded as Vuforia – developed by telecommunications corporation Qualcomm. The platform is free to use for non-commercial purposes, so long as the resulting programs are not distributed. QCAR integrates with the Unity game development engine to configure 3D models and the markers used in AR applications. I used an extended trial license of Unity Pro for iOS, courtesy of Unity. To create the 3D model, I used a historic photograph of the homestead as a guide and a demonstration version of Google

Sketchup Pro (Figure 2.8 and 2.9). However, the open source 3D modeling program Blender could have been used as well. Finally, I used the free Xcode software development kit to build the application and deploy it on an iPhone.

Figure 2.8: As the only photographed structure that was at Rye, the Rye Homestead was the obvious choice for use with an AR application. (Photo courtesy of the Manatee County Public Library Historic Photograph Collection http://digital.lib.usf.edu:8080/usfldcFedoraCommonsViewers/ USFLDCfcIMAGEviewer?pid=usfldc:M01-07299-A)

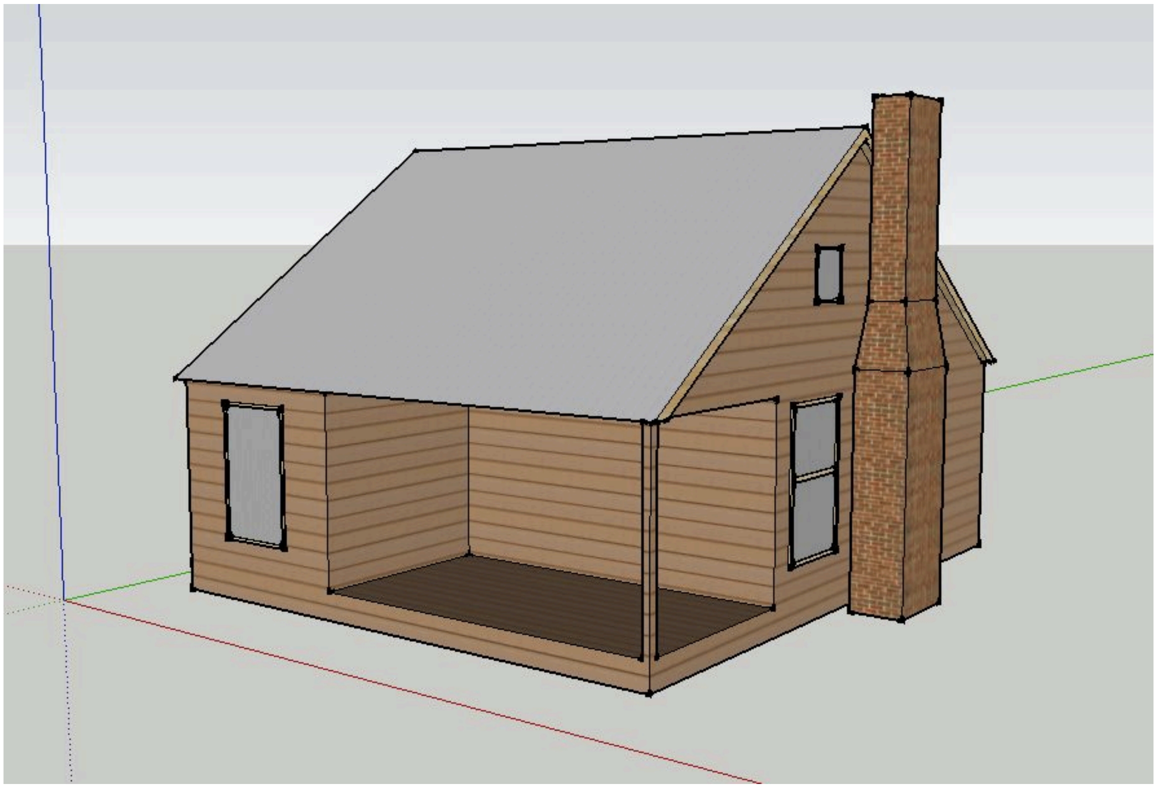

Figure 2.9: The 3D model of the Rye Homestead the author created with Google Sketchup using preliminary textures for the wood paneling, roof and chimney. (Image courtesy of the author.)

I created a faux historical sign in Photoshop with some historic information about the Rye Homestead and the AR application (Figure 2.10). Though I would have liked to include more detailed historic information, I had to use a large font for the application to easily recognize the marker. After finalizing the marker, I printed it in two pieces using a 3.5 foot wide printer in the New College Public Archaeology Lab. Each piece was 3.5 feet by 7.5 feet in length. Once printed, I taped them together using duck tape.

I then constructed an eight foot tall frame from PVC pipes to hold the marker.

I taped two ends of the marker to the vertical parts of the frame and used them to transport the marker. Next, I brought the marker out to the site of the Rye Homestead and placed it beside the homestead's artifact scatter (Figures 2.11, 2.12, 2.13 and 2.14) and tested the application.

Figure 2.10: Though not actually available on the iTunes AppStore, I included the AppStore badge in an effort to simulate what a sign could look like. (Image courtesy of the author.)

Figure 2.11: Metal scraps, likely from the roof and other parts of the Rye Homestead, are strewn over the floor where the house once stood. (Photo courtesy of the author.)

Figure 2.12: The marker was placed beside the metal and a bare information

stand. (Photo courtesy of the author.)

Figure 2.13: This screenshot is taken from an iPhone using the Rye AR application. (Photo courtesy of the author.)

Figure 2.14: Users of the application can view the model from different

angles or get closer to the marker to view it up close, in detail. (Photo courtesy of the author.)

The AR application successfully layered a large scale model of the Rye Homestead where it once stood. Using the application, I was able to walk around and view the model from different angles and at varying distances. Though the faux historical sign was recognized well by the application, a sturdier permanent marker would be needed if the application were released to the public. For a site that no longer has standing structures, augmented reality can provide an unmatched level of immersion, visualization, understanding and context that can only be surpassed by a reconstruction.

Not only is AR a more engaging alternative than a static historical marker and more cost-effective than a full blown reconstruction, but it can also be created within a matter of days. If research on a site were already complete, a similar AR application could be easily developed within two days. The use of AR can be extended to other sites like Rye that either have no standing structures or have largely been erased from common knowledge and the landscape.

The next chapter concentrates on video mapping. Like AR, video mapping can help the public visualize the past as it might have been, but provides an extra level of physicality that AR cannot.

Chapter 3: Video Mapping: Bridging the Gap from Digital to Physical

Video mapping is the process of projecting or "mapping" images and videos onto a physical object that, in most cases, is not a projector screen. Without being constrained to a screen, videos and images can be projected on everything from buildings to monuments. For example, a historic building that has lost plaster, paint or structural features can be cost effectively digitally restored with video mapping techniques instead of having to physically alter it or create a costly replica. While 3D models can virtually recreate artifacts, monuments and buildings, video mapping can virtually restore something *in situ*, providing unparalleled context. Video mapping can also be used with artifacts inside museums or even to create traveling exhibits. Video mapping can provide a dazzling experience to entertain visitors that presents an opportunity to interest and inform them of the people and cultures related to the artifacts, monuments or sites.

The basic equipment needed for a video mapping application is simple: a computer and a projector. The complexity of the setup and hardware required can increase depending on the scale and elaborateness of the project. For example, multiple high resolution projectors may be needed if the area to be projected upon is especially large. Image editing software, video editing suites and 3D modeling programs are typically employed to create the visuals which are projected upon objects.

Examples of Video Mapping

The Macula project is the product of a small group based in the Czech

Republic that has been experimenting with video mapping throughout Europe since 2009. The Macula developed a custom video mapping application to celebrate the 600th anniversary of the city of Prague's astrological clock tower (Figure 3.1). The result was a ten-minute video mapping project that featured everything from the mechanical workings of the clock tower to important events in its history and even a simulation of its construction (Figures 3.2, 3.3 and 3.4). The Macula teamed with a local production team to create the animations:

> Computer animation introduces clock construction from architectural plans through the stone work of Peter Parler, to a calendar board by Josef Manes. Visitors to Old Town Square will be able to see into the bowels of the clock through the optical illusion. Screenings will also mark the dramatic events - the Hussite wars, the execution of Lords after the Prague Astronomical Clock damaged during the liberation of Prague in 1945. (Tomato Productions 2011)

Figure 3.1: Prague's astrological clock tower in daylight. (Photo courtesy of Dan Forys http://www.flickr.com/photos/fozza/5164720567/sizes/l/in/photostream/)

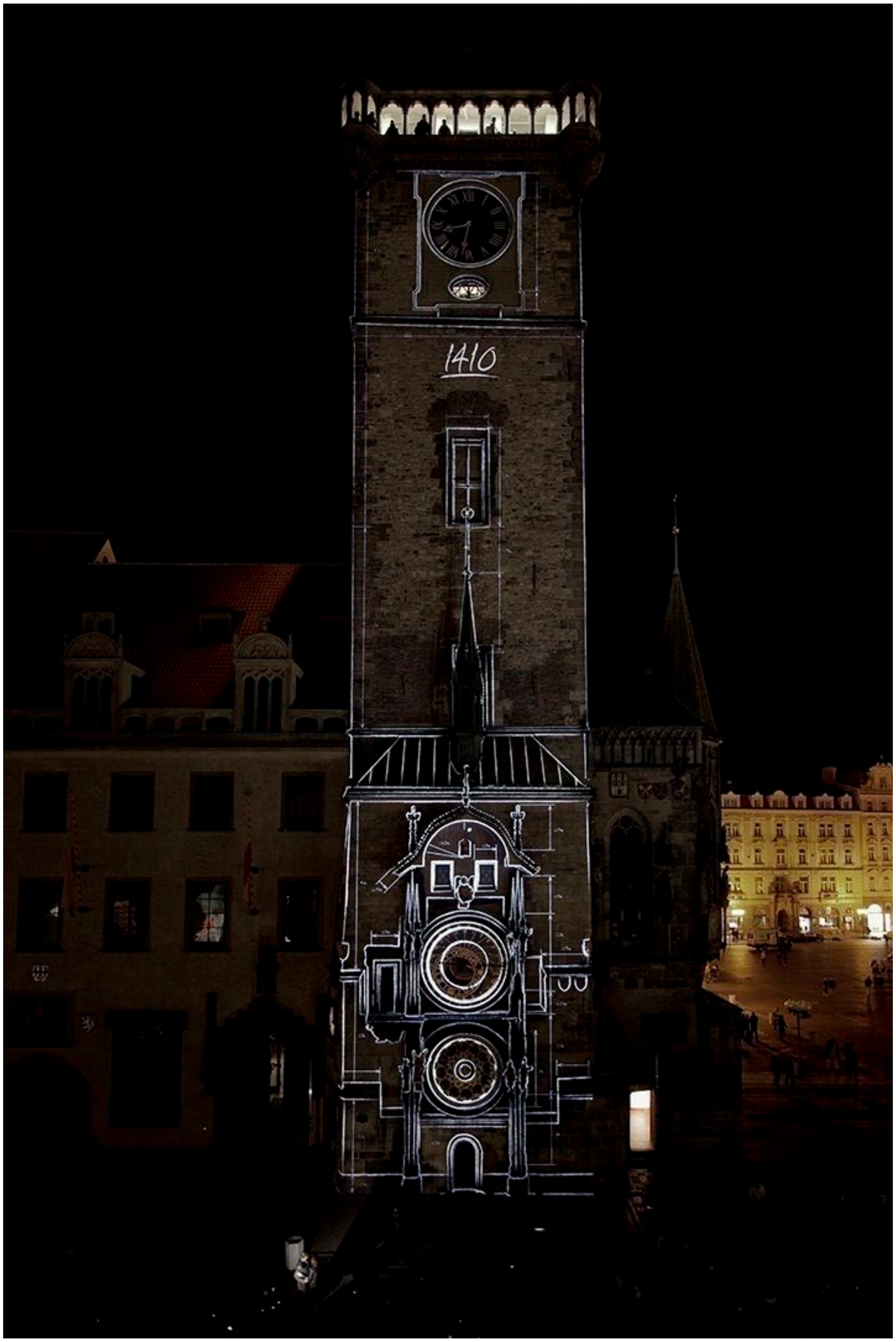

Figure 3.2: The clock tower with blueprints projected onto it at night.

(Screenshot courtesy of the author, original video: *The 600 Years* on Vimeo http://vimeo.com/15749093)

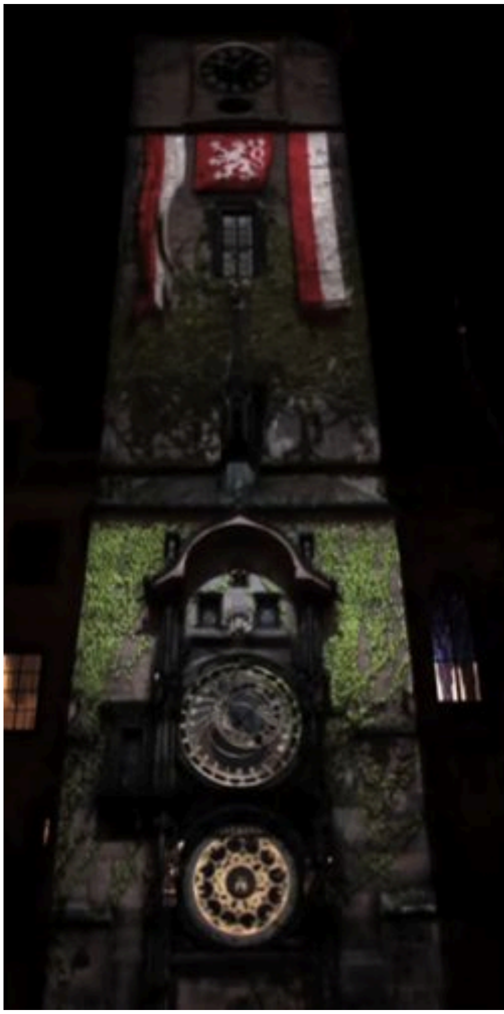

Figure 3.3: The tower is decked in Czech colors to simulate end of war Celebrations. (Screenshot courtesy of the author, original video: *The 600 Years* on Vimeo http://vimeo.com/15749093)

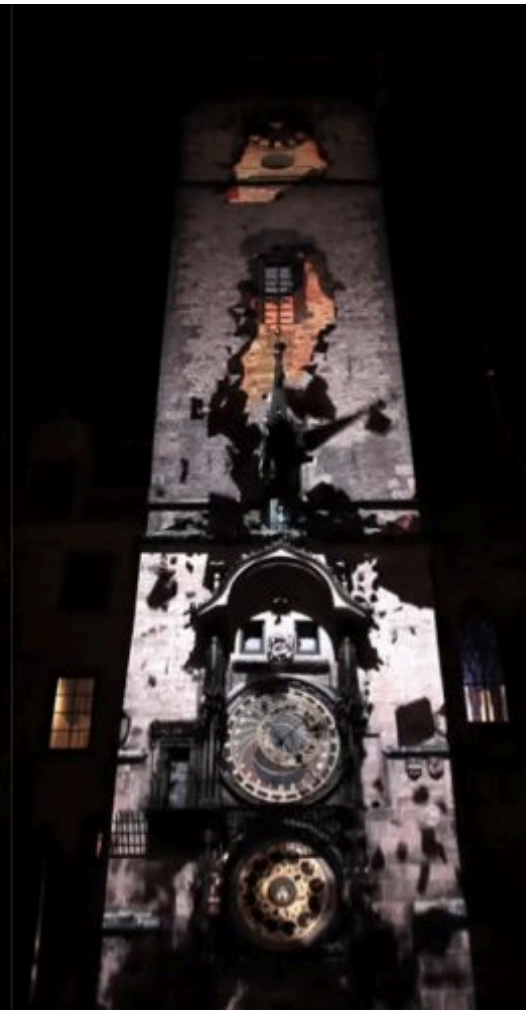

Figure 3.4: After the shadows of WWII era planes fly over the tower, it begins to crumble in order to symbolize the damage it sustained during the war. (Screenshot courtesy of the author, original video: *The 600 Years* on Vimeo http://vimeo.com/15749093)

Video mapping can also be used on artifacts that are no longer intact, as it has been used by the Roman Baths in Bath, England. Using the remnants of the ornamental temple pediment (Figure 3.5) which once hung above its entrance, the video mapping application helps the public visualize how it might have looked. The fragments of the pediment are arranged on a wall as they would have fit together, leaving gaps where pieces are missing (Figure 3.6). A projector cycles through an animation that gradually becomes brighter as it fills in the gaps between the fragments and incorporates the pediment's original colors.

Figure 3.5: The animation first displays an outline of the full pediment. (Photo courtesy of Susanna Hough.)

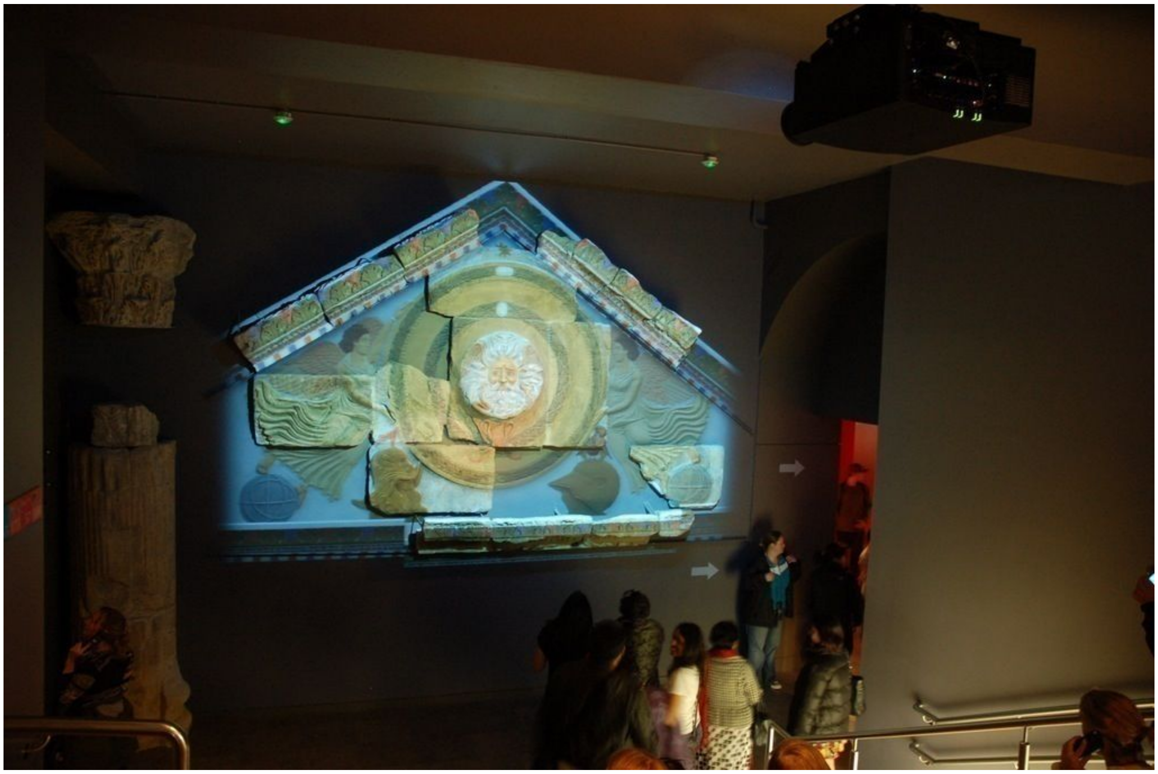

Figure 3.6: The pediment is shown here at the animation's completion. (Photo courtesy of David King http://www.flickr.com/photos/david55king/6165755651/sizes/l/in/photostream/)

While video mapping projects are typically done outdoors, video mapping can also be used within museums so long as there is an object to project upon. Imagine for a moment that a few museum visitors file into a small room with elevated seats available on three sides sides of a sarcophagus. The wall behind the sarcophagus depicts the burial site where it was found in order to provide some context and atmosphere. A projector attached to the ceiling projects down onto the sarcophagus. A short film, similar to that produced by the Macula for the clock tower, can be displayed on the sarcophagus detailing how it was made (materials, decoration, etc.), burial rituals associated with it, how it compares to the burial of the other classes during ancient times, religious beliefs and other pertinent information the museum would like to communicate to visitors. The result is an educational multimedia experience that bridges the gap between the screen and the physical world – arguably more immersive and effective than the standard 14-minute museum video.

Even the Parthenon, or Elgin, Marbles could benefit from video mapping. When viewing some of the Elgin Marbles through an infrared camera while exposed to red light, Physicist Giovanni Verri of London's British Museum was able to detect traces of the ancient pigment, Egyptian Blue. The technique causes the areas with pigment residue to glow, providing hints as to what portions of the marbles were painted. Though they are now highly regarded for their clean aesthetics and pristine white marble exteriors, they may have had a gaudy past. Video mapping could easily be employed to digitally restore some of the paint the Elgin marbles have lost or even project images of the marbles onto the Parthenon (Lorenzi 2009).

Video mapping's uses are not only restricted to large artifacts or monuments, but extend to smaller artifacts as well. Artifacts such as pots and figurines that have lost some of their original decorative coloring or structural features can benefit from video mapping. An artifact can be kept within a display case while a projector or two, from the top or side of the case, project images and video onto them. Equipped with the tool of video mapping, museums and other cultural heritage institutions can more accurately represent artifacts and effectively engage visitors.

Case Study: Painting a More Accurate Picture of the Past with Maya Stelae

Maya pyramids and monuments bore striking hues of red, blue, green and yellow when they were fully painted centuries ago. Though once routinely plastered and painted, they are now largely stripped of their stucco and paint, left with only the underlying stone (Figure 3.7). The typical weathering effects of rain and wind are not the only culprits at work; forest growth pushing up against stucco, water damage, pollution, mold, lichen and stucco-eating insects have also played roles in destroying stucco and the paints that lie atop it (Robertson 1983: 53).

A great amount of care and attention to detail went into the painting process as some structures and monuments were painted at relatively frequent intervals. Andrews (1975: 71) estimates that the structures at Xcaret were painted in intervals of shorter than ten years. “Peculiar to east coast wall painting is the number of coats of painted plaster on the walls of the buildings. At one shrine in Xcaret we counted over 35 such layers. The colors are not always the same, though they are frequently repeated.” In some instances, monuments were painted with a fresh coat of white stucco before they were painted with different colors or a new coat of the same color (Robertson 1983: 51).

Figure 3.7: A structure in the Maya city of Tulum devoid of plaster and paint. (Photo courtesy of Brian Chia http://www.flickr.com/photos/21592468@N03/4267821883/sizes/z/in/photostream/)

Entire Maya cityscapes would have been accented with a variety of colors. At Xcaret, on the east coast of Yucatán, surviving stucco gave clues as to how many prehistoric structures were painted and what colors were used as Andrews and Andrews (1975: 71) state:

> The remnants of color on the stucco walls of many east coast structures indicate that most of the prehistoric buildings were painted. The most common wall-surface colors are deep red, blue, and turquoise green; gray is also occasionally found. Yellow and orange appear to be less common and are part of more detailed designs or small surface areas, such as inset panels. Black is the standard fine-line paint used in borders,

wall and doorway edges, inset panel frames, and detailed drawings. Thick borderlines of any of these colors frequently surround doorways.

Though certain colors may have varied slightly in how heavily they were used from site to site, Robertson (1983: 52) found that colors were used generally uniformly and had symbolic meaning: “After documenting thousands of examples of color at Palenque, it became apparent to me that, at least by Late Classic times, color had a definite iconographic meaning (Robertson 1977, 1979, in press). As I proceeded with this investigation, I found that certain motifs, backgrounds, elements of dress and paraphernalia were always painted the same color.”

An especially striking hue of red (Figure 3.8) was typically used to coat the bulk of large structures and pyramids as the color was seemingly assigned to the “living world of man and kings” (Robertson 1983: 52). Robertson also found clear links between blue as the heavens and things of a divine nature; yellow had clear ties to the Underworld.

Color held ideological values for the Maya in art and texts, often linked to the cardinal directions, their belief system and cosmology. “The colour itself, for example, has a highly important symbolism; in the codices many objects are distinguished only by the colour in which they are painted. This tells us whether a jewel is jade or gold, what a vessel contains, or from what bird the feathers of a headress came” (Bernal 1963: 8). In pottery, color was also used “to differentiate components of the imagery and also function symbolically, for example to identify precious materials such as jadeite and quetzal feathers, which were important visual markers of status" (Budet 1994: 11).

Because colors used to paint structures and monuments held such significance for the Maya, it follows that the colors that once adorned their surroundings should be conveyed to the public. Even archaeologists exclaim, "What a sight of splendor the city must have presented when it was ablaze in color" (Robertson 1983: 52). Video mapping holds the potential to digitally restore Maya structures, sculpture, monuments and art without having to physically alter the originals, remove them from their original context or incur the costs of reconstruction.

Figure 3.8: Reconstruction of the Rosalila Structure at the Copan Sculpture Museum. The actual structure was buried beneath a larger structure that took its

place. Ironically, the reconstruction has begun to suffer plaster and paint loss from weathering as well. (Photo courtesy of Adalberto H. Vega http://www.flickr.com/photos/ahvega/3666416711/sizes/o/in/photostream/)

In an effort to demonstrate the usefulness of video mapping, I created a proof of concept centered around Maya stelae; stone slabs erected to depict and commemorate important events such as wars, marriages or even religious events in an effort to legitimize a ruler's claim to govern their subjects. Many stelae are thought to have been plastered and painted, but have since lost their paint. Fortunately, some stelae still have some flecks of paint which we can use to extrapolate what colors they bore when fully painted.

Since I did not have access to an actual stele, I improvised with digital photographs of stele from the image sharing website Flickr.com. Using the image editing software Photoshop and a digital pen tablet, I created an image of how a stele might look if it were video mapped to digitally restore its color. Ideally, one would use a projector to display the Photoshop workspace onto the stele and paint digitally onto it instead of a photograph.

Using a photograph of Stele H from Copán that has noticeable flecks of paint left, I filled in some areas with an approximately matching shade of red (Figure 3.9). Much of the stele photograph is left unaltered to emphasize the difference between the restored and unrestored areas. In some cases, it may be beneficial to digitally restore only part of a stele in order for visitors to better compare its current state and the reconstruction, much like some pottery is only partially reconstructed.

Figure 3.9: This comparison image features the top half of Stele H at Copán. (Original photo of stele courtesy of Christine and John Fournier http://www.flickr.com/photos/christine4nier/847383799/.)

The most compelling use of video mapping would be to project directly onto a stele, but without access to stelae, I focused on how video mapping can be used to reduce the cost of access–such as travel–that visitors face when going to see exhibits by making simulations of artifacts or monuments like stelae portable. With this in mind, the second method I used to demonstrate the usefulness of video mapping was to simulate a life-size stele with a custom projector screen. Using a screen approximately six feet tall and one foot, ten inches wide fashioned from wood and muslin, I was able to project an image of a stele at approximately 1/2 scale and demonstrate what it might look like near life-size. The muslin and wood to construct the frame cost approximately $30. The tools (hammer, staple gun, staples and saw) were approximately another $30.

Figure 3.10: A front view of the custom-made screen. (Photo courtesy of the author.)

Figure 3.11: The custom-made screen viewed from the back. (Photo courtesy of the author.)

The result is a projection of a stele that seems not bound to a screen, but situated mere feet away from a viewer (Figures 3.12, 3.13 and 3.14). With little ambient light, the canvas is difficult to see, helping create the illusion that a stele is physically located in that space. Consequently, the screen is difficult to see in the following photographs.

Figure 3.12: An image of Stele D from Copán is projected onto the screen at night. (Stele image courtesy of Flickr.com user frischi http://www.flickr.com/photos/frischi/5103061901/. Photo courtesy of the author.)

Figure 3.13: Lights from within the New College Public Archaeology lab illuminate the porch where the screen stands. (Photo courtesy of the author.)

Figure 3.14: In this photograph, parts of the headdress and legs are digitally

restored to visualize how the stele might have looked. (Photo courtesy of the author.)

Ideally, a screen would be the size of an actual stele (approximately 14 feet high and 2 1/2 feet wide) to show how large it truly is. In addition, a very high resolution photograph of a stele and a high definition projector would provide for the optimal video mapping scenario. Though this model is only six feet, I believe this proof-of-concept demonstrates that the techniques can be effectively scaled to a larger size and made into a multimedia experience.

Imagine for a moment a touring exhibit filled with full scale stelae-sized screens lit up with their digital likenesses at night. For greater detail, blank stucco or papier-mâché-like replicas of the stelae could also be used for greater depth and detail. An audio-visual presentation could demonstrate the process of construction, painting, its history and the importance tied to it in terms of cosmology, beliefs and other systems of significance. It is important to note that such a presentation would be most effective at night or in a dark room. However, museums and other institutions could use that to their advantage and make the exhibit a special nighttime event. Maya sculptures, murals and sarcophagi were often painted as well and can also benefit from video mapping techniques.

Video mapping not only helps the public visualize the scale of artifacts and monuments, but *experience* the scale as well. I suggest that the physicality of video mapped artifacts fosters stronger connections to them, through which an appreciation for them, the culture, and the people who created them can develop.

Equipped with these new tools, archaeologists, museums and other cultural heritage institutions can create compelling and informative experiences for the public. Video mapping can more accurately represent artifacts, create an immersive experience to better engage visitors and virtually give them access to artifacts.

The following chapter shifts focus from on-site representations to the web, with the use of online repositories to store data from archaeological sites and excavations for scholarly and public access.

Chapter 4: Open Access and Online Repositories

Archaeologists collect massive amounts of data in the field, ranging from hand drawn sketches to ground-penetrating radar data. This chapter examines the use of online repositories in archaeology to manage that data beginning with a consideration of the amount of archaeological data created, its accessibility in terms of public or “open” access and current efforts to realize the potential online repositories offer.

Cultural resource management (CRM) projects result in tremendous amounts of archaeological data. Often called “grey literature,” CRM data and reports typically sit unused – and in all likelihood, forgotten – residing inside filing cabinets and computers within private CRM firms and government departments (Uzi Baram April 2012, personal communications). In the United States, it is estimated that between $650 million and $1 billion is spent annually on approximately 50,000 CRM projects (Chapman, et. al 2011: 33).

> On both sides of the Atlantic, therefore, this activity generates vast num- bers of reports that together constitute the unpublished “gray literature” whose inaccessibility has long been an issue of major concern. With so much work being performed and so much data being generated, it is not surprising that archaeologists working in the same region—let alone those working in different continents—do not know of one another’s work. Decisions about whether to preserve particular sites, how many sites of specific types to excavate, and how much more work needs to be done are being made in an informational vacuum. Furthermore, new data are not fed into the research cycle, and academic researchers may be dealing with information that is at least ten years out-of-date. (Chapman, et. al 2011: 32)

As the status quo of archaeological publishing, the journal subscription model also contributes to the vast amount of data that remain unpublished since it focuses on analysis rather than raw data. Whether as a result of publishing models or CRM projects, a vast amount of archaeological data is inaccessible or otherwise difficult to access and the potential benefits it offers lies untapped. If such data were made easily accessible, academics and students would be able to collaborate and work with an immense body of data and research. For the public, increased access to *some* archaeological data could provide greater insight into the field of archaeology and the peoples and cultures being studied. Online repositories offer a solution to make archaeological data easily accessible for both academics and the public.

The Internet as we know it today has its roots in academia and has vastly increased scholarly communication since its creation. Though the foundations of the Internet stretch as far back as 1968 with the US Department of Defense's Advanced Research Projects Agency Network (ARPANET), its current incarnation stems from Tim Berners-Lee's work at the European Organization for Nuclear Research (CERN). In 1990, Berners-Lee developed the standards and protocols used by Internet browsers today to aid CERN physicists, and eventually other academics, to share information across computer networks. Before the Internet saw commercial success with in-home use, its initial growth can be attributed to use at universities. The wide availability of information and ease of communication e-mail has provided have proved to be a boon for academics.

At the same time, Open Source software – software that is freely available, modifiable and redistributable – was blossoming at universities in the U.S. thanks to very similar sentiments of collaboration in research, which some argue is a reflection of core academic ideals:

> Free Software [interchangeable with Open Source] was largely started in U.S. research universities and units within them like MIT's Artificial Intelligence Lab and much of the organizational structure of Free Software was inspired by the informal networks of scholarship that are academics' bread and butter. Also, much of the idealism of Free Software was inspired by academic ideals of universal education and freedom of speech and research. So I think we have to understand that when we look at Free Software we are looking into a mirror, and seeing our own values and ideals reflected back at us in a transformed and, I'd say, purified form. (Kelty, et. al 2008: 562)

Open Access and Open Data are the extensions of Open Source to academic research. Open Access promises increased collaboration as a result of freely accessible academic literature and data. The continued refinement of web technologies promises more opportunities when Open Access ideals are applied to academic research and publishing through online repositories. A digital repository of archaeological data that is not open access would be tantamount to digital files sitting locked within a filing cabinet, a digital counterpart of the problem it was created to solve.

In an Open Access effort, the University of York has developed the Archaeology Data Service (ADS) which provides access to reports from the National Monuments Records of England, Scotland, and Wales, in addition to county-level records. ADS currently has over 12,500 grey literature reports available to download free of charge as of April 2012 (Unpublished Fieldwork Reports: Grey Literature Library) and are increasing by 50 to 100 per month (Chapman, et. al 2011: 33). In addition to the large number of available reports, “there is a high level of demand; from May to July 2010, there were 44,483 downloads. Since the library was launched in August 2005, there have been 400,000 downloads” (Chapman, et. al 2011: 33).

Michigan State University’s MATRIX (see page 9) has developed a preliminary proof of concept program called Interactive Archaeological Knowledge Management System (iAKS) that enables archaeologists to enter data as its collected from the field and remotely access, analyze, visualize and share the data (Watrall 2011b: 173). A suite of iAKS programs are planned that would establish a workflow for archaeologists, from collecting data in the field where there may be no Internet access to public access of the data through a website.

> In addition to the iAKS Client and iAKS Manager, the iAKS project will ultimately include a robust online community-based site that will act as a central (and semi-public) repository into which iAKS users can upload the archaeological data from their local iAKS installation. Once uploaded by individual iAKS users, other community members can either search and browse the data online or download and import the data into their own local iAKS installation for standalone analysis or inclusion into an existing iAKS data set. For the purposes of security, iAKS online will have a two-tiered system of access. The first tier will be open and accessible by the general public and will feature data that is filtered by the original contributor. This way, sensitive data, such as site location or exact artifact provenience, can be hidden from the general public. The second tier will feature full and complete data sets and will only be accessible by those professional archaeologists who have registered with the site and whose credentials have been verified. (Watrall 2011b: 173)

Eric Kansa at the University of California Berkley founded OpenContext.org as a way for archaeologists to share data and research. Rather than limiting users to a strict database structure and terminology for datasets, OpenContext aggregates data from archaeologists using a bottom up approach where archaeologists can submit different kinds of data using their own naming and organizational conventions. Thus, a wealth of data from various archaeologists and diverse projects can be located in one place and searched all at once. In addition to being open access, the data can be linked to other data according to relevance and context. For example, an artifact can be linked to the site where it was found, other artifacts in the same assemblage, artifacts from the same time period or related excavations conducted by different archaeologists.

While there are a handful of efforts to establish digital workflows for archaeologists that will bring data from the field to an online repository, none have been widely adopted as standard protocol. Although online repositories have not been widely used by archaeologists for public representation of sites and artifacts either, there is no shortage of software that would enable them to do so. Software tailored for managing large collections of information with online databases in the cultural heritage space has begun to proliferate within recent years.

DSpace, developed by Hewlett Packard and the Massachusetts Institute of Technology, is the most popular online collection management software. The software allows institutions to enter collection items into an online database that the public can access through a website. DSpace has been used at more than 1,000 institutions throughout the world since it was released in November of 2002. (DSpace Registry 2011) Though it is open source and widely used, a handful of organizations have begun to build alternative software to better fit their needs and allow for more flexibility.

Michigan State University's MATRIX has developed KORA, an open-source multimedia repository for cultural heritage information management. With an emphasis on metadata, the collections managed with KORA can be comprehensively queried. Much like DSPace, users enter items within their collection into a KORA database which can then be used to create a public website to access the data. KORA has been used in-house for many MATRIX projects and in partnership with other organizations for custom uses. KORA has been used on projects ranging from a repository of *American Black Journal* episodes that document over thirty years of Detroit history from African American perspectives to ExplorePAHistory.com, a website that encourages visiting historical sites in Pennsylvania and promotes teaching history in classrooms (KORA Multimedia Repository 2012).

The Roy Rosenzweig Center for History and New Media at George Mason University has developed their own online repository solution called Omeka. The open-source online publishing platform can also be used to display library, museum, archives and scholarly collections and exhibits. It has seen significant use by archivists, librarians and museums since it was released in 2008, with at least 136 sites currently using the software (Sites Using Omeka 2012).

While these softwares hold great potential for showcasing archaeological sites and giving the public access to data associated with them, they have only seen extensive use by libraries and some historical organizations. When cultural heritage institutions do use them, they tend to use them for historical rather than archaeological exhibits.

The University of Siena's Stefano Costa finds it surprising that online repositories have not been used by most archaeologists because much of the data that can potentially be shared is "born digital" or already in a digital format. "In 2010, a great deal (albeit not all) of archaeological data is 'born digital' in the field, library, or lab. This means literally thousands of databases, millions of pictures of finds, excavation contexts and all other stuff" (Costa 2010). Though easily published online, an overwhelming amount of data that is "born digital" is not shared.

With so much data that is already in a digital format, the lack of widespread adoption by archaeologists could also be symptomatic of a larger problem within the field. Namely, an aversion to sharing data.

> In theory, this could bring a lot of potential not only to archaeological research per se, but to archaeological knowledge in general. Digital material can be easily reproduced at no cost. But this potential is often not realised, because the vast majority of archaeological information is not shared. Researchers and research groups usually restrict access to their data to a small group of people. In other words, data sharing is not so widespread among archaeologists as one might wish, and dissemination of research is still mostly based on traditional pre-digital means like journal articles, books and the like. (Costa 2010)

The American Anthropological Association (AAA) – one of the organizations responsible for some of the pre-digital means of dissemination Costa notes – has voiced its concerns regarding Open Access of archaeological publications. The White House Office of Science and Technology Policy received comments from both the AAA and the Archaeological Institute of America (AIA) against federally mandated "long-term preservation of, and public access to, the results of federally funded research, including peer-reviewed scholarly publications as required in the America COMPETES Reauthorization Act of 2010" (Public Access to Scholarly Publications: Public Comment 2011).

Both organizations make it clear in their letters that they are committed to the endeavor of adding to public knowledge and that their efforts in doing so are already adequate. "We [AAA] write today to make the case that while we share the mutual objective of enhancing the public understanding of scientific enterprise and support the wide dissemination of materials that can reach those in the public who would benefit from such knowledge (consistent with our associations' mission), broad access to such information currently exists, and no federal government intervention is currently necessary" (Davis 2012: 1).

The AIA echoes the AAA's sentiments in a much shorter letter. "We join the AAA in sharing the objective of enhancing the public understanding of our global archaeological heritage and to this end we support the widest dissemination of information possible. Access to such information currently already exists and no additional federal government intervention is necessary" (Bartman 2011: 1).

The AAA cites the creation of their AnthroSource online archive constructed in 2004 as a testament to their commitment to Open Access. Their letter notes that the association "invested over one million dollars in the establishment of an online archive (AnthroSource) expressly to enhance and increase the availability of our publications" (Davis 2012: 1). Similarly, the AIA points to their *American Journal of Archaeology*'s "modest" subscription rate of $50 per year for digital versions, purchasing options for individual articles–"except that of the last five years"–through JSTOR. The AIA is also quick to mention that "all content prior to

1923 is freely accessible as it is out of copyright.”

The AAA expresses fears that government intervention could ignore differences in publishing cycles, formats and funding between STEM (Science, Technology, Engineering and Mathematics) fields and anthropology, adversely affecting anthropological publishing. Both organizations also make a legal argument positing that the government does not have rights to the published products that are the result of government-funded research.

> We argue that while the government may have a right to the unfinished work product (i.e., the research data of “findings”) of individual researchers to whom they provide financial support, it does not have the right to journal articles that are the cumulative result of the significant time and financial investment of reviewers, editors, copywriters, designers, technology provides, archivists, publishers and distributors of such journal content–none of which is supported by federal research dollars. … Mandating open access to such property without just compensation and lawful procedural limitations constitutes, in our view, an unconstitutional taking of private property–copyrighted material–an expropriation without fair market compensation. In our view, such a practice cannot and will not withstand judicial review. (Davis 2012: 2)

A page on AAA’s website, listing its partners, highlights the funding received from the Andrew W. Mellon Foundation and describes its vision for AnthroSource, making explicit the goal of having resources available to both scholars and the public:

> The American Anthropological Association (AAA), the world's largest organization of anthropologists has received a grant from The Andrew W. Mellon Foundation to embark on a major internet-based communication initiative that will bring 100 years of anthropological material on-line to scholars and the public. All things ‘anthropological’ from ancient ruins to fossils, bones and artifacts, to films of indigenous peoples and stories of how they live will ultimately be accessible on this easy-access portal. (AAA Partners and Alliances 2012)

Despite the enthusiasm for public access and breadth of material to be made available, AnthroSource's current incarnation falls short of its delineated goals. The AAA advertises that it has made all its journal articles available through AnthroSource for paying members of the AAA. Members of the public who are not anthropologists or studying anthropology can purchase an *annual* "Non-Anthropologist Associate Membership" for $120. In parentheses atop the Membership Categories and Dues page of the AAA website lies a potential hidden fee: "Note: All AAA memberships require one AAA Section membership." Though many section memberships are free for non-anthropologist associates, some range between an additional $15-20, bringing the total yearly cost of access to AAA published content as high as $140. In addition to membership fees, non-anthropologist members are subject to annual verification and "are required to send a letter to the AAA national office indicating your title and position using your employer's official letterhead to become eligible for or to continue your AAA memberships at this rate" (Membership Categories and Dues 2012).

A subscription fee as high as $140 and mailing a letter using an employer's official letterhead to the AAA is not open access. By its nature, open access is "open": freely usable and distributable. Keeping research behind pay walls is far from open access, though it may be an improvement from both organizations' previous policies.

Despite the AAA's very clear posture regarding a required subscription, members of the public can create a free account on AnthroSource and have unrestricted access to all its journals. However, this is not outwardly publicized.

Nor does it seemed to have been announced. Whether this is a pilot program or technical glitch is unknown. The contradictory positions and statements do not end there.

Introduced on December 16, 2011 in the United States House of Representatives, the Research Works Act, H.R. 3699, includes provisions that would effectively prohibit government mandated open access for federally funded research. The AAA Executive Board announced they had adopted the following motion on February 3, 2012:

> Acknowledging the Association's commitment to 'a publications program that disseminates the most current anthropological research, expertise, and interpretation to its members, the discipline, and the broader society,' but also the need for a sustainable publication strategy, and building on the Association's support for a variety of publishing models, the AAA opposes any Congressional legislation which, if it were enacted, imposes a blanket prohibition against open access publishing policies by all federal agencies. (American Anthropological Association Position on Dissemination of Research 2012)

On one hand, a letter from AAA Executive Director William Davis expresses sentiments against government mandated open access for federally funded projects. On the other, a statement by the AAA Executive Board *opposes* a bill which would *prohibit* government mandated open access on federally funded projects. Contradictory statements and actions concerning open access by the AAA are puzzling to say the least.

What is telling – and frankly, somewhat disturbing – about both organizations' comments to the White House Office of Science and Technology Policy is that they neglect to mention more practical concerns such as how open access *may* increase looting at unprotected sites, or how open access may change the responsibilities anthropologists have to those they study. Instead, they focus on how such a mandate would disrupt their publishing models. “The elimination of library subscription revenues from the publishing budget of the American Anthropological Association would cripple the society’s ability to continue publishing its 22 scholarly journals” (Davis 2012: 2). Though it could be argued that the concern for revenue is the AAA’s strategy to preserve what access they do create, their model in its current state is not sustainable in light of open access and digital publishing.

The University Press of Florida has created its own open access text-book program called Orange Grove Text Plus (OGT+). Rather than focusing on journals, OGT+ makes textbooks freely available through their website as PDF downloads. Professors are free to modify texts, often so that they improve the quality and depth of information or adapt them to their style of teaching. Since the texts are freely available and modifiable, the University Press of Florida has adapted its role in the publishing process: “This partnership addresses the key concern of faculty in using open resources: Quality. The University Press brings full publisher quality control, editing, indexing and other services as well as fast, cost-effective production of bound versions of open textbooks” (Hood 2012).

Another platform aimed at changing archaeological publishing, the Archaeology of the Americas Digital Monograph Initiative (AADMI), was funded by the Andrew W. Mellon Foundation in February of 2009. A partnership among six university presses including the University of Alabama Press, the University of Arizona Press, the University Press of Colorado, the University Press of Florida, Texas A&M University Press , and the University of Utah Press, the initiative aimed to develop an online system for peer-reviewed monographs (AADMI Grant Proposal to the Mellon Foundation 2009). Their grant proposal showed a clear sense of purpose and a plan for a robust online publishing platform:

> In archaeology, which utilizes large databases and increasingly relies on virtual experiments and demonstrations, publishers have had to turn down many exciting manuscripts or severely reshape them into more limited presentations because of the sheer scope of the descriptive evidence and vast illustrative content available for inclusion. An author trying to support an argument but unable to include all of the requisite data may find the work unpublished, or published in such truncated form that the full import is lost.
>
> We still will produce peer-reviewed monographs, but the data and illustrations included will no longer be limited by the financial or technological considerations of a print book. The monographs—enhanced by large data sets, color illustrations, three-dimensional images, video components, and, perhaps, interactive components such as reader commenting—will present the synthesis derived from those data.
>
> Additionally, we envision that this multi-media platform will take advantage of the electronic interface to not only present more underlying data, but to provide access in new and more interactive ways than the more static mode of print allows, including the possibility of live updating on the part of the author. The cyber components of this initiative will also allow other scholars to use the data not only to evaluate and comment on the arguments presented in the monograph, but also to expand and advance development in the field by conducting their own research and analysis using more complete data set. (AADMI Grant Proposal to the Mellon Foundation 2012)

Despite the ambitious plans, the project has stalled during its planning stages as it was subsequently only partially funded by the Andrew W. Mellon Foundation.

Though the ideal of opening information to the public and the benefits of online collaboration with fellow academics should be enough of an incentive for archaeologists to open their data and make it available online, it has not been enough on its own to achieve that goal so far. While the benefits of Open Data and Open Access are becoming clear and digital distribution is changing the publishing landscape, it may take a change in attitude within anthropology, archaeology and academia in general for such a shift to occur – which is ironic considering the Internet's academic foundations. However, the development of more capable and polished digital publishing platforms and standards for dissemination and collaboration will likely encourage archaeologists to share data among themselves and eventually make the data available to the public.

Examples of Online Repositories

The Chaco Research Archive at chacoarchive.org (Figure 4.1) is possibly the most comprehensive online archaeological database and is a fantastic example of what online repositories can offer the field of archaeology for both research and open access. From user experience design to the wealth of data, the Chaco Research Archive is stellar.

The ease of use and sheer amount of data enables lay users, students and scholars alike to easily conduct research or peruse the archive at their leisure. The repository features survey data (site data, ceramic data, and original site forms) from sites excavated in the Chaco Culture National Historical Park in Chaco Canyon, New Mexico in addition to downloadable spreadsheets, digital monographs, a timeline, a tree-ring database, more than 15,000 historic images and more than 9,000 photographs from the National Parks Service's architectural stabilization work at the site (Figure 4.2).

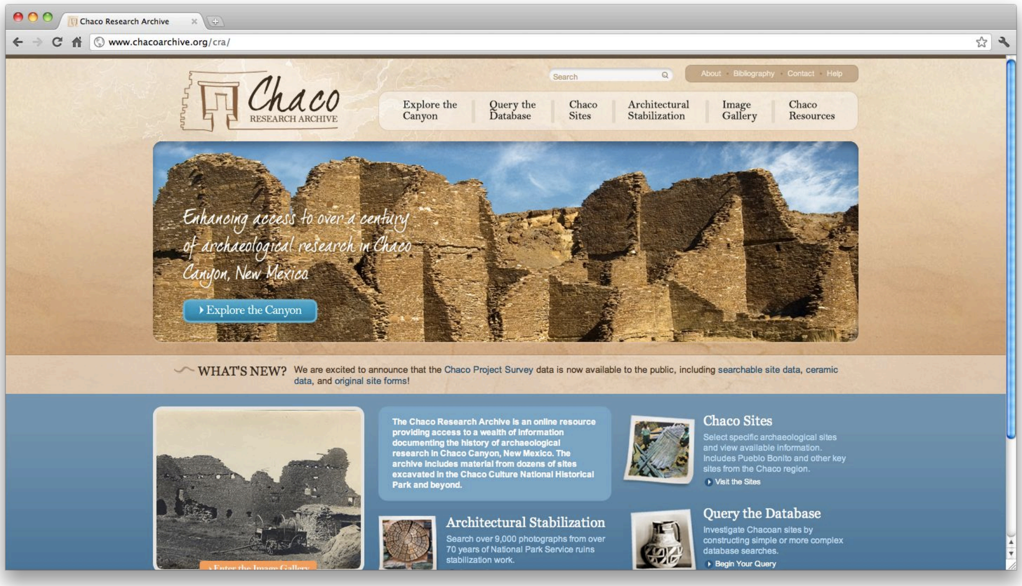

Figure 4.1: Not only does the Chaco Canyon Archive have a wealth of information, but it is beautifully designed. (Screenshot courtesy of the author.)

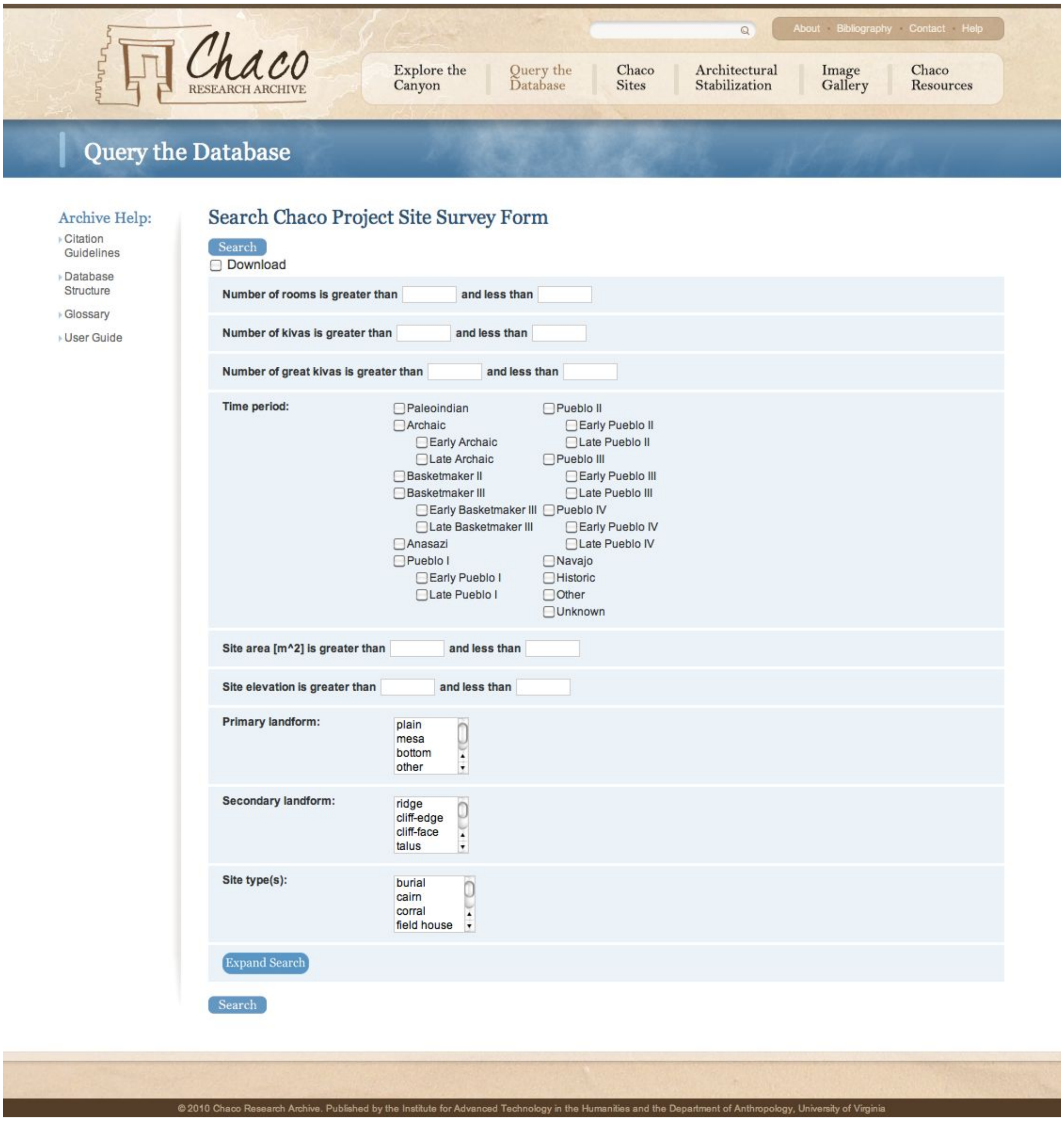

Figure 4.2: The repository is equipped with a “faceted” search feature. Faceted searches allow users to filter information according to different attributes or facets. (Screenshot courtesy of the author.)

The vast amount of data available is meticulously labeled, which allows for a comprehensive search feature. This particular search can be expanded to include site names, lesser used site names, old site numbers, drainage, site exposure, slope, ground cover, soil, description number of rooms, description number of kivas, site description, site condition, specimens, remarks, references, lab notes, time period, phase, dates from and dates to (Figures 4.3 and 4.4).

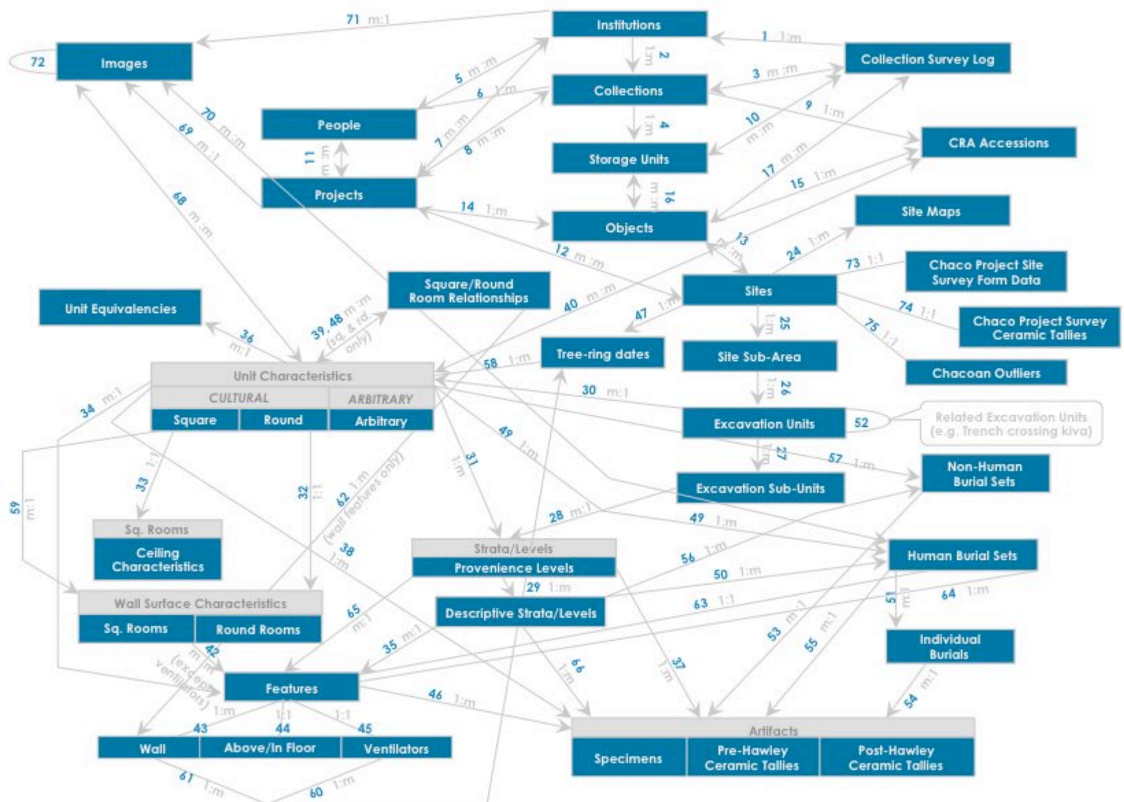

Figure 4.3: The project also makes the database structure of each searchable database visible in a graph for full transparency regarding how the data is recorded, organized and accessed. (Screenshot courtesy of the author.)

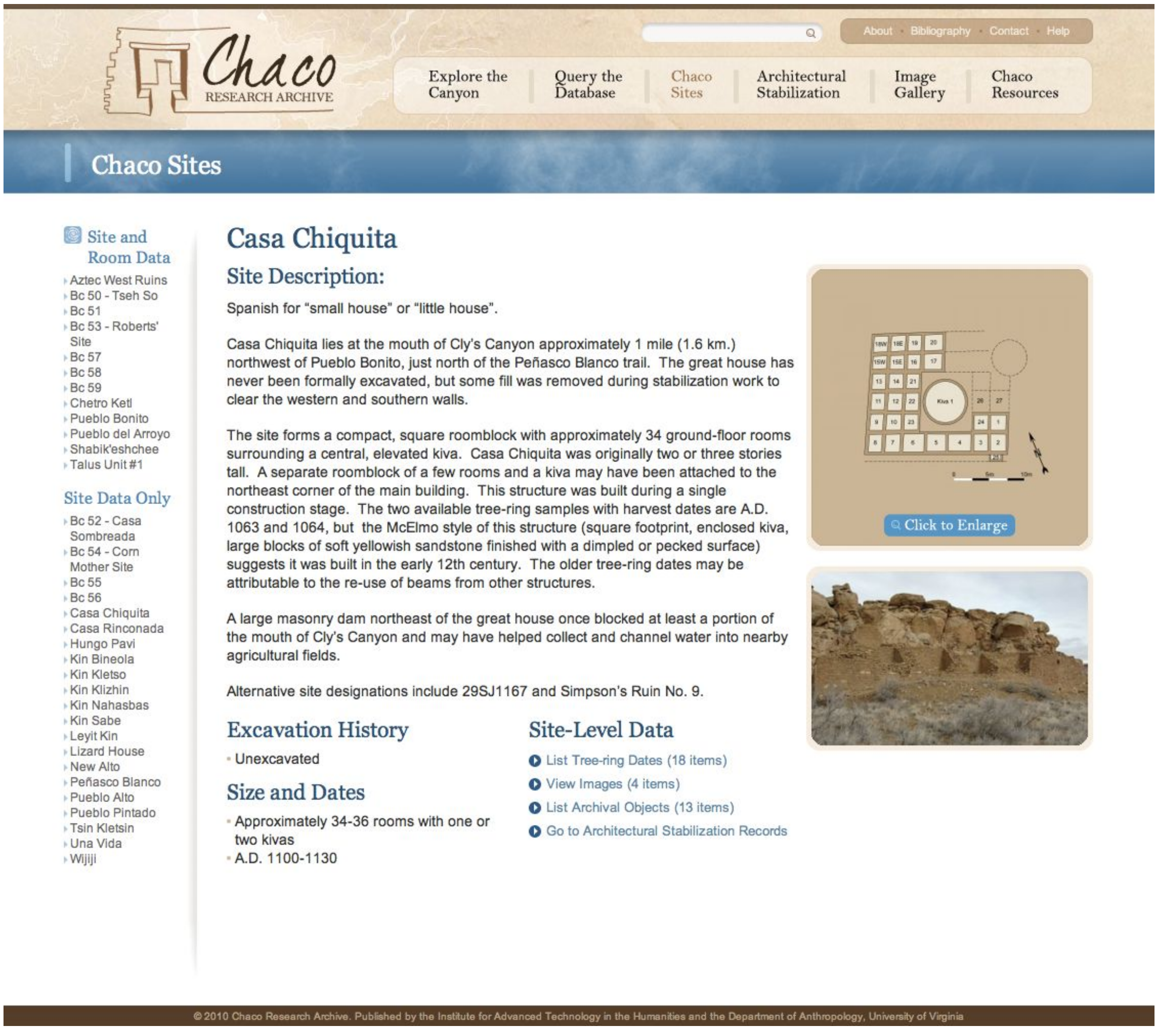

Figure 4.4: Users can navigate through Chaco Canyon via a map-based interface on which pins represent archaeological sites. After clicking on a pin, users will see a page with detailed information about the site, including links to related artifacts, related sites, site excavation history, images and more. (Screenshot courtesy of the author.)

The rich data the Chaco Archive provides does come at the price of significant funding and painstaking data input that has taken seven years to reach its current stage. The Andrew W. Mellon Foundation, the National Science

Foundation, the National Park Service, and the University of Virginia's College of Arts and Sciences sponsor the archive which is published by the University of Virginia's Institute for Advanced Technology in the Humanities and its Department of Anthropology. The Chaco Archive is careful to note the importance of the funding from one of their sources on their "About" page. "Through generous funding from the Andrew Mellon Foundation, the mission of chacoarchive.org is to ensure that the early archaeological research records are preserved for and accessible to future generations" (About Chaco Canyon Research Archive 2012).

The data entry for the archive was – and continues to be – a herculean effort. The 9,000+ ruin stabilization images have been added manually to the archive by University of Virginia undergraduate students and Chaco Research Archive (CRA) staff since 2005. Digital photographs were taken of original images and forms and a database entry with all pertinent information was created for each one (Architectural Stabilization Chaco Canyon Research Archive 2012). The about page describes the data entry process for the entire project:

> Over the last 7 years, the Chaco Digital Initiative team tackled this monumental task in phases. First, we designed an inventory database to track where relevant information sources were located (institutions, collections, boxes, folders, etc.). Next we visited each institution and combed through all the major collections identifying, entering, and acquiring those information sources. Once those materials were digitized, we indexed them for data processing to track which accessions pertained to which rooms at which sites. With the information sources in hand, we needed to design an analytical database that would allow us to enter and extract relevant pieces of data (features, burials, levels, tree-ring dates, etc.). After another year of additional design work, the CDI/IATH team had a database flexible enough to capture information from the diverse excavations that generated those data. With the database created, so

> began the arduous task of processing the data room by room. To date, the Chaco Research Archive team has processed over 15,000 images, created an architectural stabilization database of another 10,000 images, entered over 40,000 specimens, and processed nearly 500 rooms from three different sites. (About Chaco Canyon Research Archive 2012)

Though much of the data wasn't "born digital," the CRA still completed the mammoth amount of digitization required and made the data available online. If the CRA can surmount such an obstacle, other archaeologists and projects should be able to create similar online databases since a large portion of data is already in digital format. We can ease the transition if there does not have to be one. Again, tools that create a digital workflow for archaeologists could ease data collection in addition to providing incentives for – and easing resistance to – digital collaboration and open access through online repositories.

The fact that the CRA is published by the University of Virginia's Institute for Advanced Technology in the Humanities, in conjunction with the Department of Anthropology, demonstrates that much of the digital work in archaeology is situated in the digital humanities (see page 8). Most open access inline repositories that could be construed as archaeological in nature are rooted in history or the humanities. Though it's likely because of the wealth of historical documents and media that are available, the CRA shows that purely archaeological databases are not just possible, but can be executed exceptionally well.

Another example of an archaeological project with a particularly successful public presence online is the Çatalhöyük Research Project in Turkey. Though not nearly as user friendly or well designed as the CRA (See Figure 4.5), it still provides a wealth of information ranging from excavation diaries kept daily by excavators during each season to a database of excavated artifacts. In addition, yearly reports of the excavations since 1993 are available for download. The project also provides pictures and videos in addition to social outreach through Facebook and Twitter.

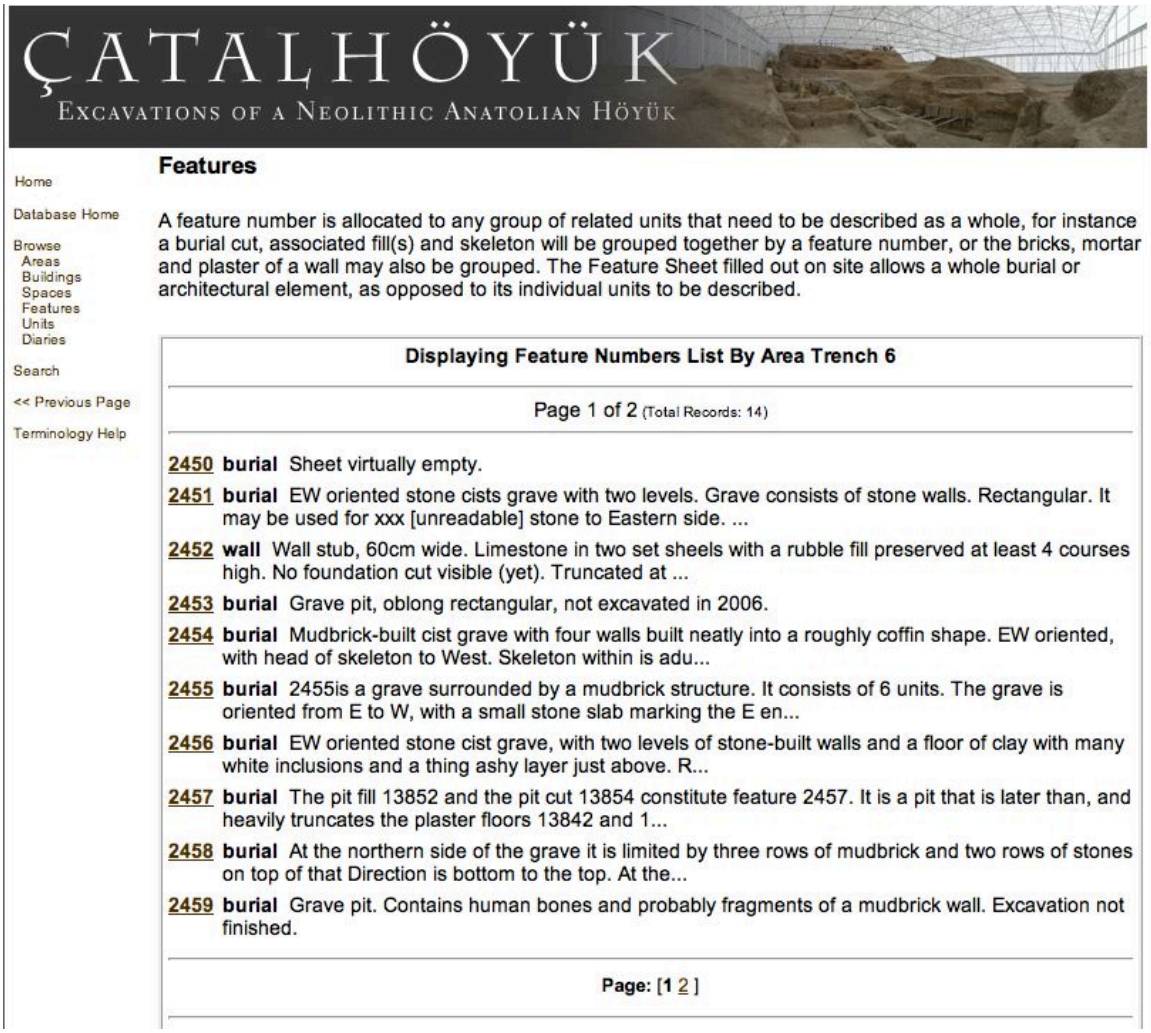

Figure 4.5: Though frequently updated with new data, the Çatalhöyük Research Project’s website could benefit from a greater focus on visual design and usability. (Screenshot courtesy of the author.)

A large majority of cultural heritage scholarly online repositories are not focused on archaeology, but on history. For example, MATRIX has worked with a wide variety of projects aimed at historical interests, from digitizing television episodes of Detroit Public Television's *American Black Journal* to create a resource on African American history beginning with the late 1960s to a partnership with the State of Pennsylvania to create ExplorePAHistory.com which houses "a rich collection of stories from history, lesson plans, historical markers, and related materials about Pennsylvania, past and present" (KORA: Multimedia Repository 2012). Another repository commemorates the struggles of apartheid in South Africa replete with "interviews with South African activists, raw video footage documenting mass resistance and police repression, historical documents, rare photographs, and original narratives tell this remarkable story" (South Africa: Overcoming Apartheid, Building Democracy 2012).

Pleiades is one cultural heritage database that is somewhat related to archaeology and has been particularly well executed. Collaboratively created with the Ancient World Mapping Center, the Stoa Consortium for Electronic Publication in the Humanities and the Institute for the Study of the Ancient World, Pleiades enables "scholars, students, and enthusiasts worldwide the ability to use, create, and share historical geographic information about the Greek and Roman World in digital form" (Pleiades website 2011). Currently, Pleiades contains 34,067 ancient places and 26,518 ancient names with an emphasis on Europe, the Middle East, and North Africa.

Users can interact with information through map-based interfaces or a powerful search feature. Once users select an ancient place, they can identify what type of place it was (fort, tower, settlement, natural feature, etc.), its location on a map with nearby places, associated time periods, where it is referenced and what other places it is connected to.

Though far from comprehensive, the UNESCO World Digital Library contains historic photographs, documents, maps and videos distributed on a map-based interface. Detail pages for each item in the database contain a detailed description, metadata such as pertinent places and time periods in addition to provenience information. On the home page, users can filter through items using a timeline bar.

Case Study: Galilee Cemetery Survey

The Galilee Cemetery has served Sarasota, Florida's African American community from the 1930s until it closed to new burial plots in January of 2010. Decades of neglect and segregation have left the historic cemetery in disarray. Due to overcrowding, areas that were once designated pathways are now filled with extra rows of graves, leaving little space to carefully navigate between them. The county's plat maps were outdated and do not correlate with the reality of the cemetery's state of disorganization, not accounting for hundreds of graves. Some grave vaults are cracked, others are sinking beneath the sandy soil and a majority are suffering from significant amounts of weathering. The cemetery was also overgrown and filled with trash in the early 1970s.

A small group of Sarasota residents formed the Woodlawn-Galilee Cemetery Restoration Task Force and cleaned the cemetery. In February of 2010, New

College Professor of Anthropology Uzi Baram partnered with the Task Force to document the grave markers and the lives of the interred with the goal of beginning a research effort that would add to the history of Sarasota's African American community. Rather than exclusively collecting data for his own research, Professor Baram (personal communications April 2012) aimed to engage the community and make both the process and the results of the survey available to the Task Force, students and anyone interested.

What was envisioned as a semester-long project expanded to approximately two years of documentation. It became apparent that the number of markers was underestimated after the first semester of documentation. Though the cemetery was expected to contain several hundred graves, more than 1,500 were documented.

Making sense of the data collected from more than 1,500 grave markers recorded into a spreadsheet is difficult to say the least. Sifting through an enormous spreadsheet is tedious, time consuming and making connections or finding patterns is a mammoth feat. When not constrained to a spreadsheet, data can be tagged, linked and searched for granular and contextual information.

An online repository offers three clear benefits for the Galilee Cemetery survey data. First is the ability to access a single instance of the dataset from any computer with an Internet connection. Though the "cloud" has become an over-used buzzword, the concept of a singular dataset accessible from any computer is still immensely useful. Backups of the data can even be automated to take place at certain intervals of time or even after updates to the dataset have been made.

In addition to providing easy portability of data, online repositories also allow for improved collaboration. Not only can efficiency be increased through work being done on a single instance of data, an increase in collaboration can be achieved by easily sharing the data–even links to specific data points–with scholars at other institutions or organizations over the Internet. Researchers at other institutions can also access the remote information at their own leisure.

Third, an online repository enables the public to access the information through a custom built website. People searching for information about relatives, or students during research on grave marker motifs can access and search the database of research.

Also, an online repository could have shortened the data collection workflow if it had been used from the beginning of the survey. Rather than collecting data on paper forms, an online repository can be used to input the data in a digital form straight from the field, thus eliminating tedious data entry and allowing for easy back-up of information.

To build a proof of concept online repository for the Galilee Cemetery survey data, I chose the open source web development framework Django, written in the Python programming language (Figures 4.6, 4.7, 4.8, 4.9 and 4.10). Django relies on Python for handling programming logic and HTML and CSS for design. Because Django abstracts database structure from user defined classes, I would be easily able to import data to the database from a CSV (Comma Separated Values file exported from a spreadsheet program) file that contains grave marker information after defining the classes. For the public facing website, I used Twitter's open source CSS and HTML framework called Bootstrap as a base. The final product is a website that can be used to access a list of all grave markers, view detailed information for each marker and search for grave markers by name, motif, dates of birth or death, name of the deceased and other attributes.

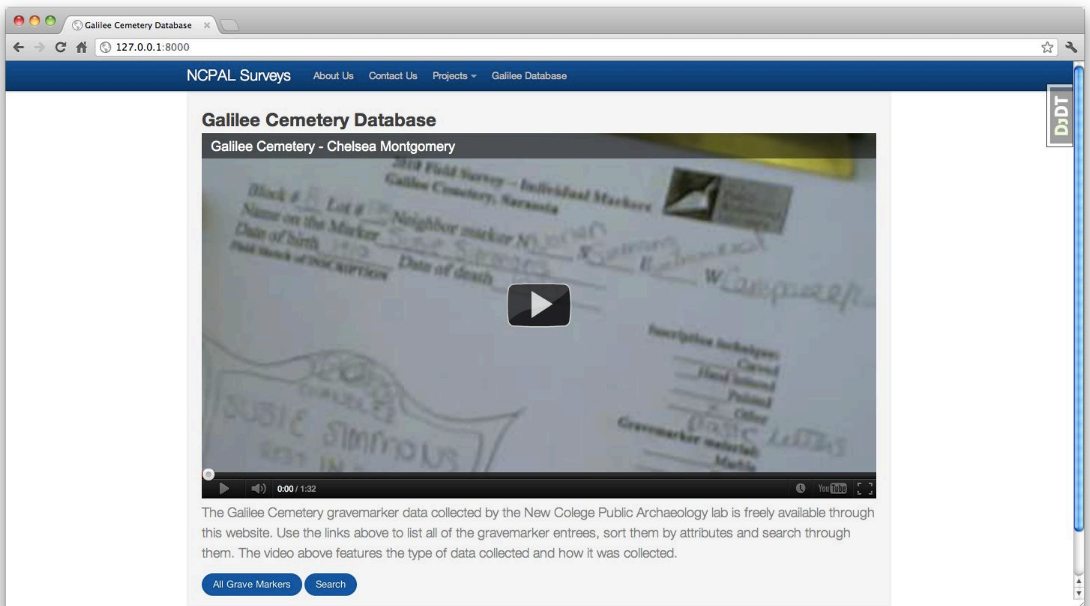

Figure 4.6: Visitors are greeted with a video explaining what kind of data was collected and the process of collection. From the home page, visitors can select how they would like to access the information: through a listing of each grave marker or a search feature. (Screenshot courtesy of the author.)

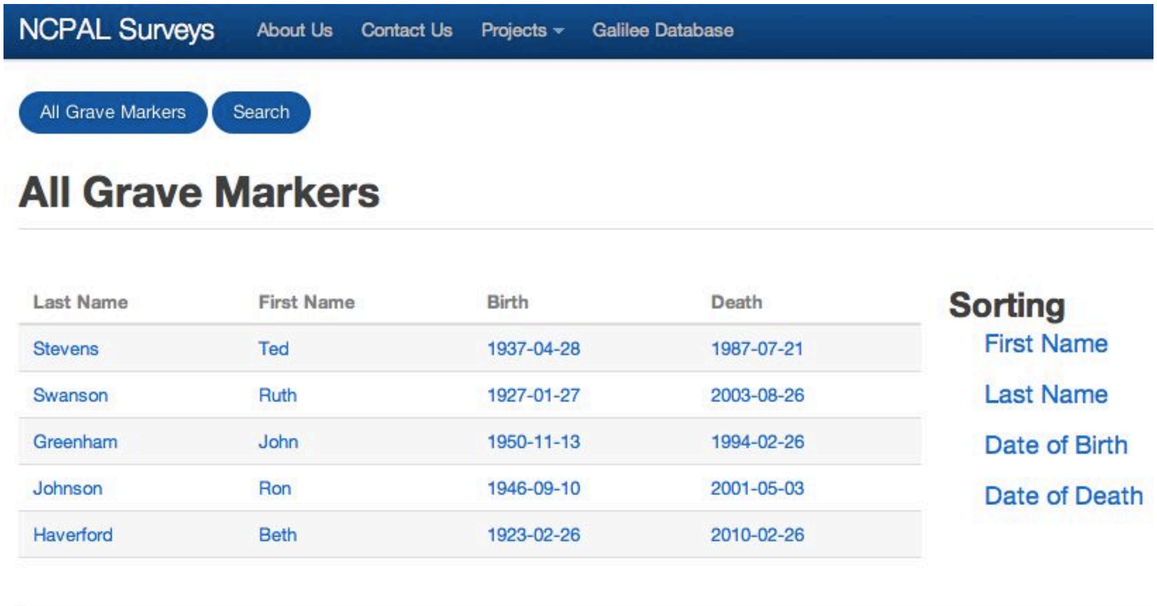

Figure 4.7: On this page, users can see a list of all grave markers, sortable by date of birth, date of death, first and last names. The sortable attributes can be quickly and easily changed with a few lines of code. Users can click on a grave marker entry to see detailed information about it. (Screenshot courtesy of the author.)

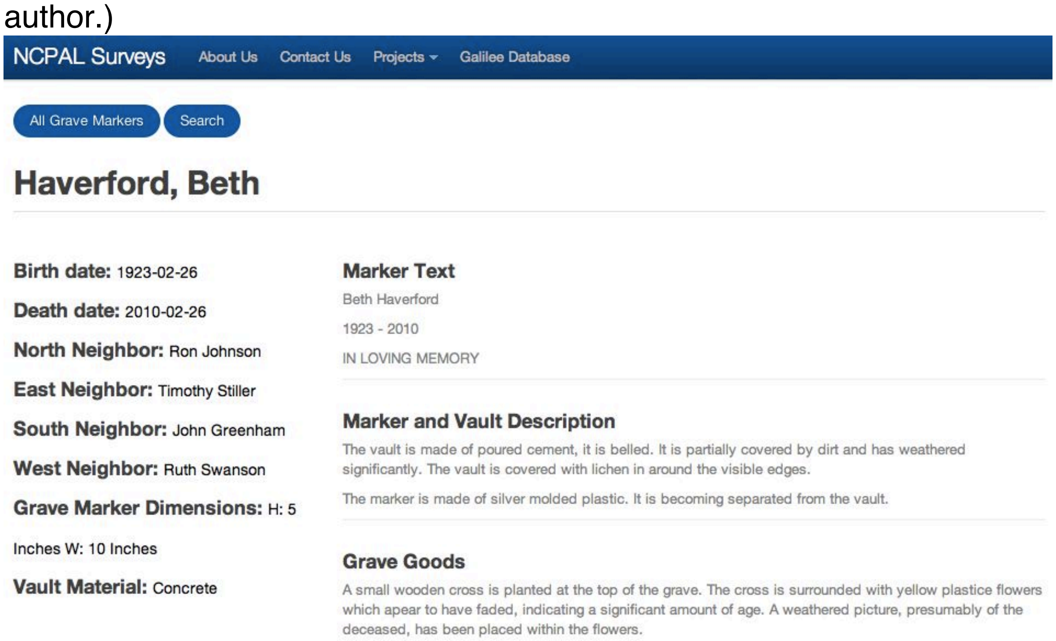

Figure 4.8: Pages for individual grave markers contained detailed information

such as grave goods, marker condition, marker dimensions, marker text, and neighboring graves. Potentially sensitive information can be withheld and information currently not exposed can easily and quickly be made public. (Screenshot courtesy of the author.)

Django and the data it manages are flexible. Varying degrees of privacy can be achieved with the data used. For example, if grave goods or grave marker motifs were the focus of research, the database can display only pertinent information and withhold personal information such as names. If desired, the website can also be used as a password-protected private data repository or intranet accessible only by those who have appropriate credentials.

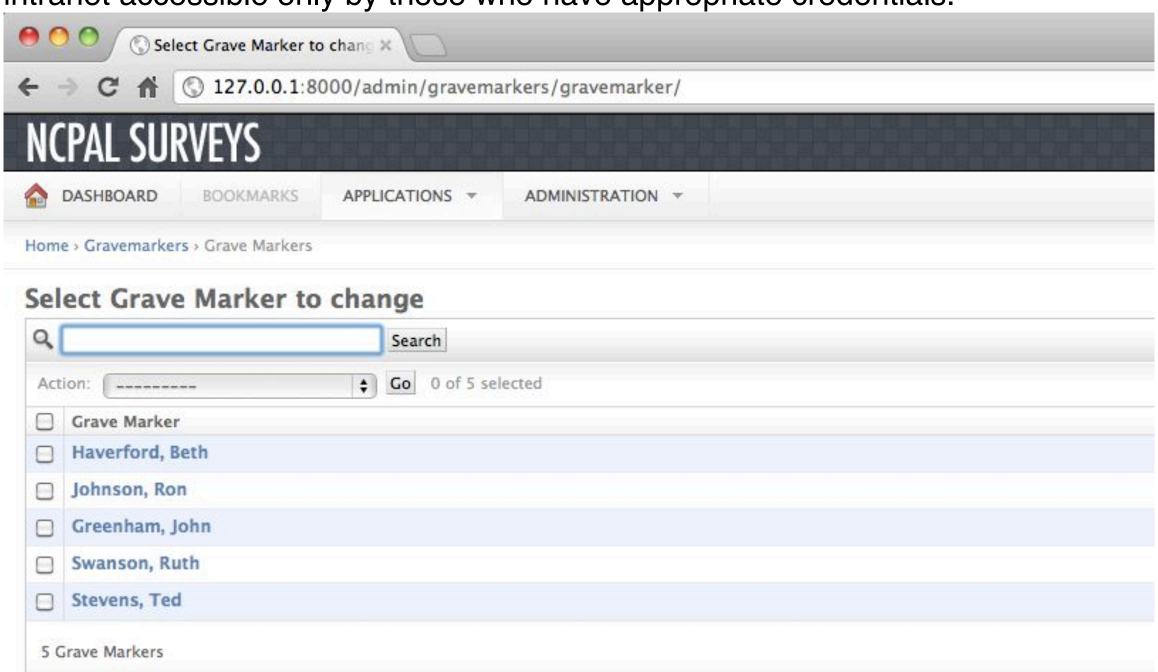

Figure 4.9: A great benefit of Django is that it automatically generates an administration interface to add, delete or change data. This page shows a list of

grave markers in the database. (Screenshot courtesy of the author.)

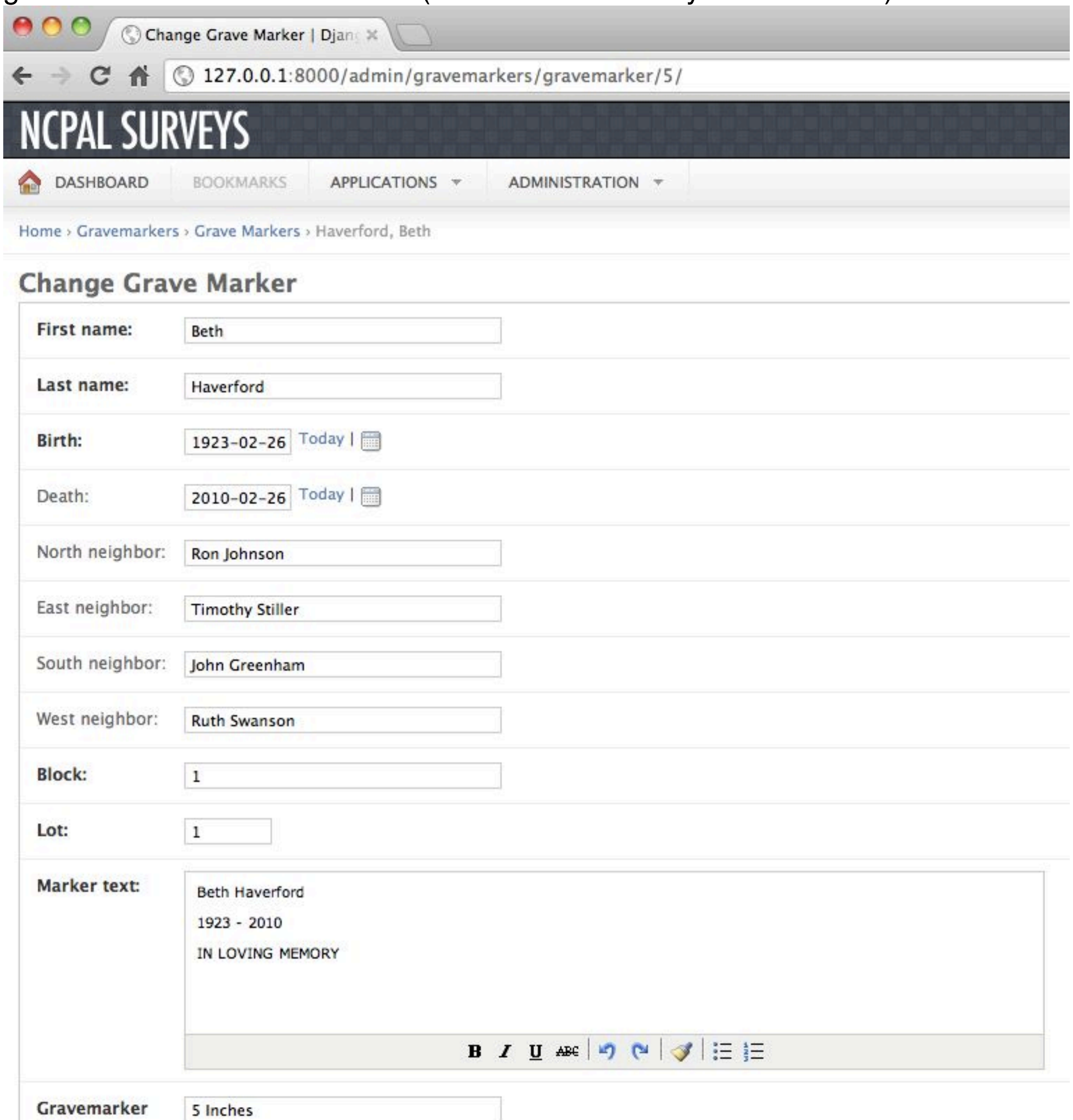

Figure 4.10: This is the administration section of the database where new grave marker data can be entered. Since the repository is accessible through the Internet, data can be entered directly through the administration section using a laptop, tablet or mobile phone. (Screenshot courtesy of the author.)

For now, the Galilee Cemetery database is not publicly accessible as it is located on a test server within NCPAL. Since historical archaeology aims to give voice to those who have been silenced, omitted or forgotten in recorded history, the documentation of cemeteries is routine (Little 2007). As physical records, cemeteries can provide some insight about people who may have been left out of written historical records. The data collected by Professor Baram and New College students at the Galilee Cemetery is an example of similar datasets that can benefit from an online repository.

After having focused on the benefits of three digital technologies, the next chapter examines potential issues, particularly those of representations, that each technology holds.

Chapter 5: Issues of Representation

Throughout the "writing culture" movement of the 1980s, anthropologists such as Clifford Geertz began to address what has been called the "crisis of representation" in anthropological, specifically ethnographic, texts. At the center of the crisis are texts which assume an anthropological authority to speak for the subjects studied and assert that the information conveyed is the only accurate portrayal of the topic at hand. After much discussion within the field, it became clear that a reflexive anthropology was needed; one where anthropologists understood how their situation within the field affects their research and included the views of their subjects within their work (Bourdieu 2006; Geertz 1973; Geertz 2006; Marcus and Clifford 1986; Ortner 1994).

Although the crisis of representation was discussed mainly with regard to anthropological texts, representations in museums were riddled with similar problems. "'All Museums are exercises in classification,' and it is precisely from their position as 'classifying houses' that museums become institutions of knowledge and technologies of power. In collecting some objects and not others, in describing and naming them, in displaying them in one way as opposed to another, and in constructing contexts for them, museums establish their sense of authority" (Kahn 1995: 324).

By assuming an authoritative role, museums were prone to promote an un-reflexive view to be taken as the absolute and comprehensive truth. For example, museums were used to validate the 19th century preoccupation with an evolutionary progress of mankind from savagery to civilization through the representation–and consequent belittling–of other cultures in exhibits categorizing them from least to most “civilized.” “For it [anthropology, through museums] played the crucial role of connecting the histories of Western nations and civilizations to those of other peoples, but only by separating the two in providing for an interrupted continuity in the order of peoples and races–one in which the ‘primitive peoples’ dropped out of history altogether in order to occupy a twilight zone between nature and culture” (Bennett 1994: 143).

A closely related issue of representation is that museum exhibits also become a product of their own time, crystalizing and encapsulating the scholarly imperatives and values of the period in which they were created. “Any museum of this [American Museum of Natural History] size and ambition is today saddled with a double status; it is necessarily also a museum of the museum, a preserve not for endangered species but for an endangered self, a “metamuseum”: the museal preservation of a project ruthlessly dated and belonging to an age long gone whose ideological goals have been subjected to extensive critique.” (Bal in Kahn 1995: 334)

For example, In “Heterotopic Dissonance in the Museum Representation of Pacific Island Cultures,” Miriam Kahn addresses issues of representation through analyses of the American Museum of Natural History’s *Margaret Mead Hall of Pacific Peoples* and the Field Museum of Natural History’s *Traveling the Pacific* exhibits. Kahn finds that these two embody the imperatives of the field during the time they were created:

> Indeed, a stroll through the *Margaret Mead Hall of Pacific Peoples* is

> an excursion into museum exhibition of the 1970s, or 'the world of a dated anthropology' (Clifford 1988: 201). Noting the overall layout of the exhibit, viewing the arrangement of the artifacts, and reading the labels, one hears the message echoing loudly through the tomb-like hall: primitive cultures and traditions are dying; science is saving them; what you see here exists no longer other than in these halls. In contrast, *Traveling the Pacific* is a 1990s product, a 'museum-as-Disneyland' (Terrell 1991: 152). It is engaging and full of immersive experiences. Its message invades our senses: travel to exotic places at the whiff of a scent or the gentle caress of a breeze. Pacific peoples and places are ours to experience and know. (Kahn 1995: 334)

As artifacts of their time, the exhibits embodied the imperatives of their era. The *Margaret Mead Hall of Pacific Peoples* expressed the need for Western science to preserve the "dying" cultures of others, while *Traveling the Pacific* embodied the commodification of heritage that swelled in the 1990s. Similarly, representations of archaeological sites and artifacts created with augmented reality (AR), video mapping and online repositories will also represent the values of their era and those who created them.

Exhibits are not only representations of the theoretical tools used in their conceptualization, but also of the technologies used to create them. Cutting-edge technologies age as well, and could become symbols of the technological progress when the representation was created. This could potentially foster a sense of nostalgia towards outdated representations, shifting focus from the archaeological site or artifact itself to the technology used to present it to the public.

For example, the self-entitled "World Famous Fountain of Youth" in St. Augustine, Florida uses a planetarium to demonstrate how the Spanish conquistadors navigated with constellations as their guides (Figure 5.1). The planetarium, which opened in 1958, used the same 1958 Model A-1 Spitz Planetarium projection dome, replete with 17 buttons and knobs. The projector was the last of its kind in operation in North America until it was replaced in early 2011 because of periodic malfunctions and the ease of use a digital projector promised. Now residing behind a glass pane as its own exhibit in the entrance to the planetarium, the projector is effectively considered a part of the museum's heritage. According to a sign within the exhibit, the projector was used in an estimated 284,000 presentations with an estimated 10 million total viewers throughout its 52 year history.

Figure 5.1: The exterior of the planetarium at the "Fountain of Youth." A sign proudly notes that the projector was purchased by Senator by Senator Walter B. Fraser for $7,016.10 in 1958, approximately $54,764.19 in 2009 adjusted for

inflation. (Photo courtesy of the author.)

On a practical level, the problem with aging technology is that with enough time, representations will not only look dated but face the possibility of being less effective in communicating information to the public. Users may eventually consider an exhibit outdated and dismiss, ignore, or only halfheartedly engage with it. Because digital technologies change and develop so rapidly, representations will inevitably pale in comparison to what newer technologies–or even more refined uses of the same technology–will allow. However, representations should not be updated just for the sake of using new or updated technology, but only if it can be used to more effectively communicate information. If a new technology can improve a representation's effectiveness in terms of immersion, interactivity–and most important of all–understanding, it should be considered for implementation. Thus, exhibits must be re-evaluated periodically to determine if an update is necessary.

On the other hand, there has been some concern that some new digital technologies may distract and divert emphasis away from artifacts in displays. "Referring to the trend in many museums to put collections in storage and replace them with theatrical and interactive displays, Spalding (2002:23) asserts that artifacts can 'help restore the gleam of wonder to our jaded gaze, and reinvigorate our appetite for experiencing life in all its ultimately unfathomable glory'' (Moser 2010: 29). While artifacts certainly have the potential to spark and engage the public's interest in a topic, interactive displays should not be discounted. So long as digital technologies do not distract from the topics at hand, they should be used if they can improve a representation's effectiveness in terms of immersion, interactivity and understanding.

Another potential pitfall of digital technology's use for representation is the issue of access, whether potential users have the means to use a certain technology. Because smartphone ownership is rapidly increasing, the mobile computing devices are becoming a popular platform for the development of cultural heritage-focused applications and are at the center of issues of access. According to Nielsen data, 40 percent of all mobile phone users in the U.S. use smartphones as of July 2011, an approximate 16 percent increase since the fourth quarter of 2009 and a figure that will continue to increase (Nielsen 2011). Despite the increasing numbers of users, there are still many who do not own smartphones.

However, lack of access for some should not be used as an excuse to ignore technologies completely, especially when ownership is growing rapidly. Instead, lack of access should be addressed appropriately with the use of different delivery methods to increase accessibility as much as possible. For a smartphone application, one possible solution is to make the same content available on a companion web site so that those without smartphones are still able to access the information. Another solution would be to have devices available for visitors to use if the specific situation allows it.

Exhibits and representations that rely on digital technology also face the same issues of authenticity and multivocality that traditional exhibits and recreations have long grappled with. The potential to sanitize history or to omit, thereby censoring, certain groups has always been an inherent problem with representations when preparing archaeological sites for public presentation. There is a tendency in some instances to replace "that part of history which is unpleasant–conflict, class divisions, poverty in the midst of plenty, and even the exploited classes themselves: slaves, itinerants, the 'lower orders' in general" (Gable and Handler 2004: 178). For example, Colonial Williamsburg has made omissions in its portrayal of its past regarding class divisions, slavery and conflict, creating "a kind of would-that-it-were world, into which they [visitors] can temporarily escape a dying present" (2004: 178). An awareness that digital technologies are not inherently immune to the same dangers is essential to prevent the creation of sanitized pasts.

Archaeologist Joan Gero rightly notes that power relations at work in archaeology often results in the exclusion of local communities from the process of representing archaeological sites. "Many of the oldest and most splendid sites are located in the poorest countries in the world and are considered 'world patrimony.' They are studied and reconstructed in nonnative languages and nonnative imaginations, put forward as repositories of knowledge about MAN (in general), while access to knowledge about these sites is controlled–at least in part–by the agendas, funding agencies, and cultural institutions of hegemonic regions such as the United States and western Europe . . . locking out other interpretive voices" (Gero 2000: 1).

Though there are very few in the privileged positions that create traditional representations of archaeological sites, even fewer are in positions to do so with technology because of the specialized skills required. The need for additional specialized knowledge adds another layer of power relations to those which are already at play between archaeologists and local communities that have vested interests in the archaeological sites being represented. Each of the technologies highlighted in this thesis require specialized knowledge to use. Augmented Reality applications require 3D modeling skills and some knowledge of software development. Access to projectors and knowledge of image editing software is essential for video mapping. Online repositories require web development skills and familiarity with database design. As a result of this, it is imperative that archaeologists be keenly aware of their privileged position and the issues it poses, train others to use the digital technologies of the craft and leverage technology's potential to be a democratizing force to include the viewpoints of invested communities. In short, archaeologists must not only be aware of the skills they take for granted, but be critical of them as well:

> First, it requires that we be critical of our assumptions and taken-for-granteds — that we be reflexive about what these assumptions reveal about our own ideologies, and that we be aware of how they play out within our various 'publics'. Second, it means that we must be 'multivocal, plural, open and transparent so that a diversity of people can participate in the discourse about the archaeological process.' Third, it means that we must be interactive – we must provide ways for people to question our interpretations, and ways for them to approach the material from a variety of angles – through different lenses, if you like. We must also provide ways for us to respond to their questions and challenges. Fourth, it means that we need to communicate how our interpretations are contextual, or relational – we must communicate how this archaeology depends on history, on ethnography, and on the continuities and conflicts between past and present – 'everything depends on everything else.' (McDavid 2012, citing Hodder 1997)

One example of striving for multivocality in digital-based representations comes from the Macula's project on Pragues' astrological clock tower (See Chapter Three). Rather than relying on a specialist with no connection to the city of Prague to develop the presentation for the clock tower's 600^{th} anniversary, the Macula relied on local talent to produce the video, in a way incorporating the local community to express why the tower is important to them. Though the community of Prague could have been more actively engaged in the creation of the video, cooperation with local talent is a step in the right direction.

Another effort that uses digital technology to promote multivocality, is QRator. A collaborative project among the University College London (UCL) Centre for Digital Humanities, UCL Centre for Advanced Spatial Analysis, and UCL Museums and Collections, QRator engages museum visitors in conversations. Currently in use at the Grant Museum of Zoology and the Petrie Museum of Egyptology, QRator enables museum visitors to submit their thoughts about the museum in addition to answer questions inspired by museum objects. Museum visitors use iPads to scan QR codes placed throughout exhibits to reveal questions and submit replies or comments. In addition to submitting their own opinions, users can read the answers submitted by previous users. Questions such as, "Is ecotourism an answer to local environmental and biodiversity conservation?," "Should human and animal remains be treated any differently in museums like this?," "Should we only be conserving things that have a potential human benefit?," and "Should science shy away from studying biological differences between races?" have been posed by the Grant Museum of Zoology

(QRator: About the Project).

Rather than passively accepting museum exhibits as they are, QRator pushes visitors to question what is presented, integrate their own views into exhibits and enables them to think about how anthropology can inform decisions on contemporary issues. On a more basic level, it can also provide museums with valuable feedback from visitors.

Issues of Augmented Reality

While at the University of Florida, archaeologist Edward González-Tennant studied the racially motivated riot that occurred at Rosewood, Florida in 1923 as part of the larger regional and national race tensions throughout the era. Rosewood was burned down; there are no remaining structures present. In an effort to help the public visualize what Rosewood might have looked like, González-Tennant created a virtual recreation of Rosewood viewable through a web browser. Users can navigate through Virtual Rosewood, see 3D recreations of historic structures and read signs detailing the town's history. As an outgrowth of Virtual Rosewood, González-Tennant created an Augmented Reality (AR) application that can be used to view recreations of historic Rosewood buildings where they once stood. Although the context and immersion AR applications provide for the public are invaluable, looters may potentially find them more valuable. Therefore, González-Tennant has not made the application publicly available for fear of looting. He writes (2009: 22):

> While the test AR project for Rosewood is complete, the realization

> that placing historic structures back on the landscape may assist looters has stalled my plans to go live with the [AR] application. It should be noted that it is not local residents who pose the greatest danger to the site through looting, but rather other research partners who, in their haste, have gone to the site without archaeologists and removed artifacts themselves. The loss of provenience information, as well as the inability of these individuals to properly care for artifacts is an obvious cause for concern.

Although AR applications have the potential to encourage looting at unprotected sites, some precautions can be taken to prevent looting rather than completely abandoning the use of AR. For example, virtual recreations of structures could be situated in an area known not to have archaeological remains, potentially hundreds of feet away from the actual site. While locating virtual recreations of structures on the exact spot where they once stood would provide an unmatched degree of context, both the value AR applications hold for the public and the archaeological remains themselves will be preserved if the recreations are not precisely situated. In this case, AR applications would be no different than a sign marking a historic place. The applications also present an opportunity to explain why sites should be preserved, pointing out that AR and reconstructions in general are last resorts.

Location Barriers

A drawback of augmented reality is that a person's ability to use some AR applications is dictated by their location. For example, users can see pictures and read information about points of interest in the Museum of London's *Streetmuseum* app, but cannot access the "3D View" feature which superimposes images onto the landscape (Figure 5.2).

Figure 5.2: If users attempt to launch the “3D View,” they are greeted with the message above. (Screenshot courtesy of the author.)

Unfortunately, this gives preference to those who can afford to travel to such areas (not to mention those who own smartphones), further making this knowledge and experience exclusive to those more economically privileged. Again, this can be partially mitigated by making videos of the full experience available on a companion website.

Cost and Licensing

The cost of developing the AR application for the Rye case study for public use on both iOS and Android devices would be approximately $800, which goes towards purchasing the Unity 3D Game Engine (Unity Store 2012). While the Qualcomm developed AR software development kit is free to use, its licensing terms are dubious. Qualcomm claims the following on their website: “There are no license fees or royalty payments required for the use of the Qualcomm AR SDK for development or distribution of commercial applications. See the license agreement for full terms and conditions of use" (Augmented Reality (Vuforia™) 2011).

However, the following from section 2.4 No Commercialization or Distribution of their license agreement for the 1.5 version of their SDK casts doubt upon their previous claim. "You may not commercialize, transfer or distribute, any applications developed by You using the Software or any component thereof. Any commercialization, transfer or distribution of such or similar applications so developed by You requires a separate agreement with QUALCOMM, at QUALCOMM's sole discretion, prior to any commercialization, transfer or distribution of any such applications. However, you may publically display and publically perform Your such applications for purposes of demonstration only, so long as You do not in any manner commercialize, transfer or distribute any such applications" (Qualcomm 1.5 2011).

The license agreement also specifies that the resulting applications can only be used on an "internal basis." "QUALCOMM hereby grants to You a personal, non-exclusive, non-sublicensable, non-transferable, revocable, limited copyright license, during the term of this Agreement, to download, install and use the Software (other than Sample Code) in machine-readable (i.e. object code) form, on an internal basis only, solely for the Permitted Use" (Qualcomm 1.5 2011). Though the statement on their website may be correct when it says there are no licensing fees for distribution, it is only correct because no distribution is allowed.

The license for the 1.0 version of the SDK, which was used for to develop the AR app for Rye, is much more flexible. “QUALCOMM hereby grants to You a personal, non-sublicensable, non-transferable, non-exclusive, revocable, limited copyright license, during the term of this Agreement, to use and modify the Sample Code, compile into object code the Sample Code and Your modifications thereto, and reproduce and distribute such compiled object code as part of the software applications that You develop, each solely in accordance with the Documentation and the Permitted Use” (Qualcomm 1.0 2011).

Despite its flexibility in terms of distribution, the license is severely more draconian: “You hereby grant, and agree to grant to QUALCOMM and its affiliates, a non-exclusive, perpetual, irrevocable, worldwide, transferable, royalty-free license (with rights to sublicense) to make, use, offer to sell, sell, reproduce, modify, make derivative works of, display, perform, import, export, distribute and otherwise dispose of, directly or indirectly, any modifications and derivative works made by You, either alone or as part of any products or services of QUALCOMM or any of its affiliates” (Qualcomm 1.0 2011).

QCAR provides a polished and easy to use workflow that comes at a price visible only in a mire of legal jargon. It is clear that an AR SDK with an affordable or a much less restrictive–preferably open source–license is needed for heritage professionals. Below is a gird that compares current AR SDKs by license, price, features and operating system support (Figure 5.3).

SDK	Platform	License	Price	GPS	Marker	Detail Marker
QCAR/ Vuforia	Android, iOS	Unclear	Free	No	Yes	Yes
String	iOS	Commercial	$499, $999, $7000	No	Yes	No
NyARToolKit	Android, iOS	Commercial, GPLv2	Must Contact Seller for Pricing	No	Yes	No
Unifeye	Android, iOS	Commercial	$5,950 or $23,900	Yes	Yes	Yes
Junaio Glue	Android, iOS	N/A	Free	No	Yes	Yes
Layar	Android, iOS	Commercial	Cost based on Tiered usage, Free Tier available	Yes	Yes	Yes

Figure 5.3: The table above contains some of the most popular AR software development kits (SDK). New SDKs are proliferating and existing ones are steadily adding features. The detail marker column denotes whether or not the SDK can use a photograph or detailed image for a marker rather than a QR code-like graphic. (Table courtesy of the author.)

The ideal solution for those working in the cultural heritage space is to use an open source alternative with comparable features and a relatively easy to use workflow. But because highly polished augmented reality has only just become possible with the hardware in mobile devices, such a solution has not yet been developed.

Issues of Online Repositories

The largest obstacles online repositories face are logistical because of the sheer amount of data archaeologists collect. One logistical issue is cause by the vast amounts of disparate data collected by archaeologists. “This is not the result of gross theoretical differences nor should it be perceived as a failure of archaeology as a social science. Instead, it is the result of the incredibly complex and varied nature of archaeological materials and research. The reality of archaeological research is that where an archaeologist working (geographically speaking) and what they are working on (both temporally and culturally speaking) has an incredible impact on the kinds of data the collect and the way in which they collect it” (Watrall 2012: 17). With a wide array of inconsistent data types, the process of database creation – in addition to searching databases – can become a herculean task.

Another complication online repositories face is fragmentation and data interoperability. Though the proliferation of online databases is good for archaeologists as the amount of data available will increase, much of the data may be isolated from each other. If databases adopt “interoperable” standards, data within them could be linked to related data in other databases, making content easier to find. Without interoperability, multiple searches of multiple databases may be required to find appropriate data.

Data interoperability is also directly linked to metadata and the disparate data archaeologists collect as data points must have a basis for relation. For artifacts, the basis for relation would typically regard typologies and qualities of artifacts which can quickly grow in complexity. “In archaeology, much of what passes for data is instead an nth-order abstraction, approaching information but not there yet either. We can quickly illustrate, using the simple example of almost any common artifact term—say, “celt” (but you can pick almost any one). The term itself simultaneously embeds ideas of (a) shape, (b) use, (c) material, and frequently (d) time and (e) place, as well as imputed/inferred parameters of social role, trade, and on and on. We must unroll this complex web of meaning into its constituent parts if true interoperability is to be realized” (Limp 2011: 278).

Aging file formats and storage mediums also pose another problem for digital data in general. While retrieving data from outdated storage mediums such as floppy disks can prove challenging, online databases can improve the future accessibility of data by assuring the only requisite for their retrieval is an Internet connection. However, programs to read outdated file formats may be nonexistent or difficult to obtain.

Issues of Video Mapping, Authenticity and Reconstructions

It is important to note that technology for innovative representation does not justify a representation in itself, as a focus on the technology alone will likely lead to caricatures of archaeological sites and cultures. With that in mind, video mapping applications run the risk of being glorified sound and light shows if archaeological research are not at their foundation.

The sound and light show at the Pyramids of Giza demonstrates the perils of not anchoring a representation in archaeological research. The Sphinx himself narrates the entire show and proclaims, with a British accent no less, that “civilizations are islands on the ocean of barbarism” and that the “glory” of the

Pharaoh has "defeated time," lighting the pyramid with a crescendo (Sound and Light Show at the Pyramids of Giza - YouTube). The result is a representation that is romanticized, sanitized and packaged for public consumption.

Archaeologists and museologists have long noted Disney's skill at packaging experiences for public consumption. At Colonial Williamsburg, Disney's example is both an aspiration and a danger:

> Disneyland both fascinates and repels Colonial Williamsburg staffers, who envy Disney's people-handling prowess, as well as its 'Imagineering' acumen, but fear that their museum might easily become vulgar and over-commercialized in the Disney manner. Indeed, as a symbol, Disneyland represents both kitsch and inauthenticity – the very qualities which Colonial Williamsburg, as a serious educational institution, wishes to avoid. (Gable and Handler 2004: 168)

One of Disney's own archaeologically-themed transgressions is the 2000 animated film *The Emperor's New Groove*, which takes places in a mythical kingdom composed of an amalgam of Maya, Aztec and Andean cultures. Archaeologist Helaine Silverman argues that the awareness Disney might have raised about the Inca Empire is rendered void by the fiction:

> In fictionalizing Cuzco-Machu Picchu to the point of anonymity, Disney has not told a story about some mythical kingdom that never existed, rather Disney has denied the Inca Empire which did. Whereas the genre of historical movie, with all the faults of veracity that its films have, contributes positively to knowledge and curiosity about the past, such cannot be the result of Groove because the movie is explicitly set in a mythical kingdom. (Silverman 2002: 319)

In short, archaeological research is necessary to create representations of informational value for the public. If an audio presentation would accompany the stele reconstruction used as an example in Chapter 3, it should focus on facts explaining the history and importance tied to it in terms of cosmology, beliefs and other systems of significance. To ground the video mapping of the stele firmly in archaeology, the digital painting should be informed by Merle Robertson's work on Maya art and sculpture color reconstruction should be used as a reference when access to her notebooks at the Middle American Research Institute at Tulane University and the Instituto Nacional de Antropología y Historia in Mexico are possible (Robertson 1983: XVIII). Using Munsell Color Notations to document the colors of structures and stelae at Palenque and other sites throughout the Yucatan Peninsula, Robertson compiled a 200-page notebook filled with color notation sheets that could be used to accurately recreate colors used on stelae with video mapping (Robertson 1983: XVIII).

Robertson's work, which has been one of the only color reconstruction studies of Maya art and monuments, is nothing less than exhaustive and meticulous, even taking into account how lighting affected color perception. "As the perception of color changes slightly according to the amount of moisture in a piece, dates of record were kept on all notations. All readings were made in natural daylight, either in early morning or late afternoon, but not under conditions of glaring sunlight. All readings were made by me to assure uniformity in the judgement of hues, chroma and values" (Robertson: XVII).

It should be made clear to the public that all representations – especially those using digital technology – are not authentic, no matter how much research was done to ensure accuracy. The issues of representation archaeologists face and how archaeological research has informed work on the reconstructions should be made explicit to the public for the sake of transparency and in hopes that the public can gain additional insight into the archaeological process.

Conclusion

Augmented reality, video mapping and online repositories offer the potential for archaeologists to better collaborate and engage the public in cultural heritage, but there are simultaneous efforts in the Digital Humanities, archaeology and other fields to situate this branch of research, using monikers such as Cultural Heritage Informatics, Archaeological Computing or Digital Archaeology to name a few. While the ability to organize this line of research into a single field of study can lead to rapid progress, the distinct possibility exists that such an organization may not be useful in the long run as the techniques which comprise the endeavor may become naturally embedded in a variety of fields. Director of Digital Research & Scholarship at the University of Virginia Library Bethany Nowviskie has said that the same sentiment has been expressed to her by scholars outside the Digital Humanities. “Now, as a digital humanities administrator at a major research library, the question I hear most from colleagues outside the DH community is whether it even needs a name. Are these just the new humanities, the ‘new normal?’” (Nowviskie 2011)

Ultimately, what matters is that archaeologists use digital technologies to their greatest potential in both analysis and representation of archaeological sites and artifacts. With that said, all groups interested in this line of research–whether archaeologists, digital humanists, information scientists or others–should collaborate for the common goal of making representations of cultural heritage more engaging and effective using digital technology. In time, this research may find a permanent home within a specific field, but it is at a critical stage of development where a focus on the research, collaboration and on the commonalities among fields is essential. Deputy Manager of University College London's Centre for Digital Humanities Melissa Terras has similar sentiments regarding the digital humanities:

> It's the same for Digital Humanists: despite the changing definitions and perspectives that surround our field, the value and usefulness of our skills are demonstrated through what we actually do, the research we undertake, the tools we build, the people we teach, the literature we write. ... It is in the doing that we can explore what the changing information environment means for the Humanities, and scholars in the Humanities. We can argue the limits and boundaries of our constituency, and the list of essential skills that make up DH, over and over. But as digital technologies become increasingly pervasive, the work and skills of Digital Humanists become increasingly important. (Terras 2011)

Though the situation of this research in a field is unclear, a need for specialists who can use and develop new digital technologies for representation is clear. The more practical question becomes who these specialists are and how they learn to use and develop these digital tools. Currently, the number of approaches being taken are equal to the number of research efforts being undertaken. There are academics who collaborate with computer scientists, academics who hire third parties for projects, computer scientists with an interest in various fields of study and even academics who have learned how to program.

PhD candidate at Colorado State University and U.S. Geological Survey Student Geographer Eric Wolf notes that geography is experiencing a similar situation. Wolf posed the following question at a mapping conference (WhereCampTampaBay 2012) to fellow attendees. Should we teach geographers how to program or should we teach programmers how to be geographers? What seemed to be the consensus was later reiterated on Twitter by Sean Gillies, programmer at the Institute for the Study of the Ancient World at New York University. “Why not both? At any rate, I think it's program or be programmed” (Gillies 2012).

Rather than rely on outsourcing this kind of work, some archaeologists should specialize, much like some do in GIS, and add the ability to work with these technologies to their toolset. Archaeologists have a unique advantage because they are grounded in their anthropological training and, as discussed in the previous chapter, are keenly aware of issues of representation. However, this is not to say that all archaeologists should become programmers. At the very least, archaeologists should aim to have a familiarity with the concepts of these technologies, as many do with GIS, so that they may easily communicate ideas, suggestions, questions and problems with specialists. Eric Kansa at the University of California Berkeley spoke to this point on Twitter. “Some programming is really good in DH [Digital Humanities]. Helps to discipline thinking. That said, I don't think every DH person needs to be a programmer, just conversant” (Kansa 2012).

With digital technologies such as online repositories, augmented reality and video mapping, archaeologists can create experiences that enable the public to develop compelling, lasting and meaningful connections to archaeological sites and artifacts; connections that can foster appreciation for artifacts, cultures, and peoples that have long since passed. While exciting new ground for archaeologists now, their use will be routine and their benefits painfully obvious in several years. Digital technologies will constantly evolve and it is the duty of archaeologists to understand, develop and work with them so that the field of archaeology thrives, rather than copes, with its new digital tools.

References Cited

AAA Partners and Alliances

N.d. Retrieved from http://www.aaanet.org/about/partners/index.cfm, accessed on March 19, 2012.

AADMI Grant Proposal to the Mellon Foundation

2009 Retrieved from https://sites.google.com/a/archaeologyoftheamericas.com/aadmi/home/aadmi-grant-proposal- to-the-mellon-foundation on March 15, 2012.

About CAA

N.d. Retrieved from http://www.leidenuniv.nl/caa/about_caa.htm, accessed on September 30, 2011

About Chaco Canyon Research Archive

N.d. Retrieved from http://www.chacoarchive.org/cra/about/ on January 14, 2012.

Aldenderfer, Mark and Herbert D.G. Machner

1996 *Anthropology, Space, and Geographic Information Systems*. New York: Oxford University Press.

American Anthropological Association Position on Dissemination of Research

N.d. Retrieved from http://blog.aaanet.org/2012/02/03/american-anthropological-association-position-on-dissemination-of-research/ on March 18, 2012.

Andrews, Anthony P. and Wyllys E. Andrews IV

1975 *A Preliminary Study of the Ruins of Xcaret, Quintana Roo, Mexico*.

Middle American Research Institute, Tulane University, New Orleans, Publication 40.

Architectural Stabilization Chaco Canyon Research Archive

N.d. Retrieved from http://www.chacoarchive.org/cra/architectural-stabilization/ on January 14, 2012.

Around the Bend Nature Tours

2009 Rye Settlement Nature & History Walk. Re- trieved from http://www.aroundbend.com/discover/rye-settlement-history-walk.php, accessed on December 10, 2010

Augmented Reality (Vuforia™)

N.d. Retrieved from https://developer.qualcomm.com/develop/mobile-technologies/augmented-reality on March 17, 2012.

Bartman, Elizabeth

2011 *AIA response to RFI re public access*. Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/scholarly-pubs-(%23103)%20Archae.pdf on January 23, 2012.

Bennett, Tony

1994 *The Exhibitionary Complex* In Culture/Power/History : A Reader in Contemporary Social Theory. Princeton, N.J: Princeton University Press.

Bernal, Ignacio

1963 *Mexican Wall Paintings*. American Library of World Literature, New York, New York.

Bourdieu, Pierre

2006 Structures, Habitus, Power: Basis for a Theory of Symbolic Power. In Culture/Power/History: A Reader in Contemporary Social Theory. Dirks, Nicholas B., Geoff Eley and Sherry B. Ortner, eds. Pp. 155-199. Princeton: Princeton Univ. Press

Budet, Dorie

1994 *Painting the Maya Universe: Royal Ceramics of the Classic Period*. Durham: Duke University Press in association with Duke University Museum of Art.

Chapman, Sam, Fabio Ciravegna, Stuart Jeffrey, Julian Richards, Stewart Walker, and Ziqi Zhang

2011 *The Archaeology Data Service and the Archaeotools Project: Faceted Classification and Natural Language Processing*. In *Volume 1. Archaeology 2.0: New Approaches to Communication and Collaboration*. Eds. Eric C. Kansa, Sarah Whitcher Kansa, and Ethan Watrall.

CoDiFi, Center for Digital Archaeology

N.d. Retrieved from http://www.codifi.info/content/projects/codifi/ on October 12, 2011.

Cooper, M.A. and J.D. Richards

1985, *1991* *Current Issues in Archaeological Computing.* Oxford, England: B.A.R.

Costa, Stefano

2010 *Open Data in Archaeology*. Retrieved from http://blog.okfn.org/2010/02/25/open-data-in-archaeology/ on December 28, 2011.

Crews, Rozalyn E.

2012 *Archaeology Rolls into the Public Sphere: An Introduction to Florida Public Archaeology Network's ArchaeoCar*t. Sarasota, Florida: New College of Florida.

Cultural Heritage Imaging, Projects

N.d. Retrieved from http://culturalheritageimaging.org/What_We_Do/Projects/ on January 17, 2012.

Davis, William

2012 *Response to November 3, 2011 OSTP RFI – Public Access to Scholarly Publications.* Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/scholarly-pubs-(%23282)%20davis.pdf on January 23, 2012.

Deetz, James

1965 *The Dynamics of Stylistic Change in Arikara Ceramics*. Urbana: University of Illinois Press.

DSPace Registry

N.d. Retrieved from http://www.dspace.org/whos-using-dspace/Repository-List.html on November 27, 2011.

Dyke, Bennet

1981 *Computer Simulation in Anthropology* in Annual Review of Anthropology, Vol. 10, pp. 193-207.

Falkingham, Gail

2005 *A Whiter Shade of Grey: A New Approach to Archaeological Grey L- iterature Using the XML Version of the TEI Guidelines*. Internet Archaeology 17.

Geertz, Clifford

1973 Deep Play: Notes on the Balinese Cockfight. In *The Interpretation of Cultures: Selected Essays*. New York, Basic Books.

Geertz, Clifford

2006 Thick Description: Toward an Interpretive Theory of Culture. In *Readings for a History of Anthropological Theory, third edition*. Erickson, Paul A. & Liam D. Murphy, eds. Pp. 341-359. Toronto: University of Toronto Press.

Gero, Joan

2000 *Why? And Whither WAC?* Retrieved from http://www.nps.gov/seac/ gero.htm on November 1, 2011.

Gillies, Sean

2012 Retrieved from https://twitter.com/#!/sgillies/status/169439751869444097 on February 14, 2012

Greenwald, Bart

1988 *Officials still puzzled by Rye fire*. Bradenton Herald, May 13: B1-B3.

Haines, Albert

1936 *Time erases pioneer town of Rye, but memory of it is fresh in minds* *of many*. Bradenton Herald, November 27.

Henderson, Julian, Jonathan Moffett, and Ross Seamus

1991 *Computing for Archaeologists*. Oxford England: Oxford University Committee for Archaeology.

Hodder, Ian and Clive Orton

1979 *Spatial Analysis in Archaeology*. Cambridge New York: Cambridge University Press.

Hood, Jacky

N.d. *What is Orange Grove Text Plus?* Retrieved from http://www.theorangegrove.org/OGTtest.htm on March 13, 2012.

Howell, N. and V. A. Lehotay

1978 AMBUSH: *A Computer Program for Stochastic Microsimulation of Small Human Populations* in American Anthropologist Vol. 80, pp. 905-22.

Kahn, Miriam

1995 Heterotopic Dissonance in the Museum Representation of Pacific Island Cultures. American Anthropologist 97 (2):324-38.

Kansa, Eric

2012 Retrieved from https://twitter.com/#!/ekansa/status/169452726776905731 and https://twitter.com/#!/ekansa/status/169452938018824192 on February 14, 2012.

Kelty, Christopher M., Michael M.J. Fishcher, Alex “Rex” Golub, Jason Baird Jackson, Kimberly Christen, Michael F. Brown, and Tom Boellstorff

2008 *Anthropology of/In Circulation: The Future of Open Access and Scholarly Societies* in Cultural Anthropology Vol. 23, Issue 3, pp. 559– 588.

Kerruish, Jack

2010 *Streetmuseum*. Retrieved from http://www.youtube.com/watch?v=qSfATEZiUYo accessed on October 14, 2011.

KORA Multimedia Repository

N.d. Retrieved from http://www2.matrix.msu.edu/research/technology/kora/ on January 15, 2012.

Lende, Daniel

2010 *Anthropology, Science, and Public Understanding*. Retrieved from http://blogs.plos.org/neuroanthropology/2010/12/01/anthropology-science-and-public-understanding/ on April 8, 2012.

Little, Barbara J.

2002 *Public Benefits of Archaeology*. Gainesville, FL: University Press of Florida.

Little, Barbara

2007 *Historical Archaeology: Why the Past Matters*. Walnut Creek, California: Left Coast Press.

Limp, Fredrick

2012 *Web 2.0 and Beyond, Or on the Web Nobody Knows You're An Archaeologist.* In Volume 1. Archaeology 2.0: New Approaches to Communication and Collaboration. Eds. Eric C. Kansa, Sarah

Whitcher Kansa, and Ethan Watrall.

Lorenzi, Rossella

2009 *Elgin Marbles Carry Blue Paint Traces*. Retrieved from http://news.discovery.com/history/elgin-marbles-parthenon.html on January 13, 2011.

MA/MSc in Digital Humanities

N.d. Retrieved from http://www.ucl.ac.uk/dh/courses/mamsc on April 8, 2012.

Marcus, George E. and James Clifford

1986 *Writing Culture : The Poetics and Politics of Ethnography: A School of American Research Advanced Seminar*. Berkeley: University of California Press.

Membership Categories and Dues

N.d. Retrieved from http://www.aaanet.org/membership/membershipcategories.cfm on February 26, 2012.

McDavid, Carol.

2012 *Archaeology and "The Web": Writing Multi-linear Texts in a Multi-centered Community*. Retrieved from http://www.publicarchaeology.org/webarchaeology/html/carolsha.htm on April 23 2012.

Moser, Stephanie

2010 The Devil is in the Detail: Museum Displays and the Creation of Knowledge. In *Museum Anthropology*, Vol. 33, (1), pp. 22-32

Nielsen

2011 *40 Percent of U.S. Mobile Users Own Smartphones; 40 Percent are Android*. Retrieved from http://blog.nielsen.com/nielsenwire/ online_mobile/40-percent-of-u-s-mobile-users-own-smartphones-40- percent-are-android/ on October 28, 2011.

Nowviskie, Bethany

2011 What Is Digital Humanities? Retrieved from http:// digitalhumanities.org/answers/topic/what-is-digital-humanities#post-290 on October 20s, 2011.

Ortner, Sherry

1994 *Theory in Anthropology since the Sixties. In Culture/Power/History: A Reader in Contemporary Social Theory*. Dirks, Nicholas B., Geoff Eley and Sherry B. Ortner, eds. Pp. 372-411. Princeton: Princeton Univ. Press

Presner, Todd

2009 *The Digital Humanities Manifesto 2.0*. Retrieved from http:// www.humanitiesblast.com/manifesto/Manifesto_V2.pdf on September 30, 2011.

Proctor, Nancy

2011 *Mobile Apps for Museums : the AAM Guide to Planning and Strategy*. Washington, DC: AAM Press.

Public Access to Scholarly Publications: Public Comment

2011 Retrieved from http://www.whitehouse.gov/administration/eop/

ostp/ library/publicaccess on January 23, 2012.

QRator: About the Project

N.d. Retrieved from http://www.qrator.org/about-the-project/ on March 20, 2012.

Qualcomm 1.0

2011 Retrieved from https://ar.qualcomm.at/legal/license/QCAR-SDK-(iOS-c)-License-081711clean-WEB.html on February 17, 2012.

Qualcomm 1.5

2011 Retrieved from https://ar.qualcomm.at/legal/license/QCAR_SDK_(iOS-1_5b)_License_120911-clean-WEB.html on February 17, 2012.

Renfrew, Colin, Bahn, Paul and Peter Bahn.

2008 *Archaeology : Theories, Methods and Practice*. London: Thames & Hudson.

Robertson, Merle

1983 *The Sculpture of Palenque*. Princeton, N.J: Princeton University Press.

Santos, Alexis

2011 *Remembering Rye Village & the Landscape in Manatee County, Florida*. Sarasota, Florida: New College Public Archaeology Lab.

Schreibman, Susan, Siemens, Ray, and Unsworth, John.

2004 *A Companion to Digital Humanities*, Oxford: Blackwell.

Shackel, Paul and Erve J. Chambers

2004 *Places in Mind: Public Archaeology as Applied Anthropology*. New York and London: Routledge.

Silverman, Helaine

2002 *Groovin' to ancient Peru: A critical analysis of Disney's The Emperor's New Groove* in Journal of Social Archaeology 2002, 2: 298-322.

Sites Using Omeka

N.d. Retrieved from http://omeka.org/codex/View_Sites_Powered_by_Omeka on March 12, 2012.

South Africa: Overcoming Apartheid, Building Democracy

N.d. Retrieved from http://www.overcomingapartheid.msu.edu/ on January 15, 2012.

Sound and Light Show at the Pyramids of Giza - YouTube

N.d. Retrieved from http://www.youtube.com/watch?v=vbgtSwt7kgk on April 9, 2012.

Spalding, Julian

2002 *The Poetic Museum: Reviving Historic Collections*. London: Prestel.

Stone, Peter G.

1997 *Presenting the Past: A Framework for Discussion*. In Presenting Archaeology to the Public: Digging for Truths. Walnut Creek, CA: Altamira Press.

Terras, Melissa

2011 *Peering Inside the Big Tent: Digital Humanities and the Crisis of Inclusion*. Retrieved from http://melissaterras.blogspot.com/ 2011/07/ peering-inside-big-tent-digital.html on October 22, 2011.

The 600 Years on Vimeo

N.d. Retrieved from http://vimeo.com/15749093 on November 8, 2011.

Thomas, D. H.

1973 *An Empirical Test for Steward*'s *Model of Great Basin Settlement Patterns* in American Antiquity Vol. 38, pp. 155-173.

Tomato Productions

2011 Retrieved from http://www.tomatoproduction.cz on November 16, 2011. Translation aided by Google Translate.

UCL Archaeology Degrees

N.d. Retrieved from http://www.ucl.ac.uk/archaeology/studying/ masters/ degrees/ on April 8, 2012.

Unity Store. Retrieved from https://store.unity3d.com/index.html on March, 17, 2012.

Unpublished Fieldwork Reports: Grey Literature Library

N.d. Retrieved from http://archaeologydataservice.ac.uk/archives/view/ greylit/ on April 9, 2012.

Warner, Joe, & Warner, Libby.

1986 *The Singing River, a History of the People, Places and Events along the Manatee River*. Bradenton, Florida.

Watrall, Ethan

2011a Archaeology, Games, & Initiatives – Ethan's Mixed Bag of Crazy Topic Idea. Retrieved from http://chnm2011.thatcamp.org/06/03/archaeology-games-and-initiatives-ethans-mixed-bag-of-crazy-topic-ideas/ on September 28, 2011.

Watrall, Ethan

2011b iAKS: A Web 2.0 Archaeological Knowledge Management System. In *Volume 1. Archaeology 2.0: New Approaches to Communication and Collaboration*. Eds. Eric C. Kansa, Sarah Whitcher Kansa, and Ethan Watrall.

Watrall, Ethan

In press *Archaeology and the "Big Tent" of Digital Humanities*. Open Access, digital version of Debates in the Digital Humanities

Wheatley, David, Earl, Graeme and Poppy, Sarah.

2002 *Contemporary Themes in Archaeological Computing*. Oxford Oakville, CT: Oxbow Books

White, Dale.

1986 Community of Rye gone, not forgotten. Sarasota Herald-Tribune, March 2: 1B-4B.

Wobst, Martin H.

1974 *Boundary Conditions for Paleolithic Social Systems: A Simulation Approach* in American Antiquity, Vol. 39, No. 2 (Apr., 1974), pp. 147-178.