The Egyptian Oracle;  
Recreating Egyptian Religious Ceremony in Mixed Reality

Jeffrey Jacobson  
PublicVR, jeff@publicvr.org  
AND  
Robyn Gillam  
York University, gillam@yorku.ca

The Egyptian Oracle is a live reenactment of a public ceremony from ancient Egypt’s Late Period. A life-sized projection of the Virtual Egyptian Temple extends the physical theater into virtual space. The central actor is a virtual priest, controlled by a professional puppeteer, offstage. The main supporting actors are a real person in costume and a (virtual) sacred boat bearing the spirit of the God, Horus. Audience members participate in the role of the ancient populace, an immersive learning experience. The show introduces an essential idea that religious ceremony was central to ancient Egyptian culture. The processional oracle is especially well documented in the third intermediate and Graeco-Roman periods, figuring directly in the life of community. We developed the show to educate the public, inspire empathy for other cultures, and advance our understanding of immersive media. Preliminary evaluation data gathered will be the basis for follow-on research. The National Endowment for the Humanities funded this work in 2010-2011 (Digital Humanities Startup Grant: HD-5120910), and the resulting production has toured in Boston and Pittsburgh. The code, artwork, and script are open-sourced and available through the project website, http://publicvr.org/html/pro_oracle.html.

Categories and Subject Descriptors
General Terms:
Additional Key Words and Phrases: Educational Theater, Virtual Reality, Mixed Reality, Telepresence, Egyptology

1. Introduction

The Egyptian Oracle performance is a live reenactment of an authentic public ceremony from Ancient Egypt's Late Period, the processional oracle (Cerný, 1962, 36). We project our Virtual Egyptian Temple (Troche, 2010) on the wall at life scale extending the physical theater into virtual space, as shown in Figure 1 (Jacobson, 2011a). The temple is a true three-dimensional space, which the audience navigates during scene changes. The central actor is a high priest, an avatar controlled by a live human puppeteer, hidden onstage. The supporting actress, in costume, stands to one side with a clear view of the screen, mediating the experience. Audience members represent the Egyptian populace acting out brief roles in the drama. Finally, the sacred boat (left) is another puppet also controlled by the puppeteer. In the drama, the will of the temple god moves the boat.
Figure 1: The priest interrogates two audience members playing the part of neighbors in a dispute. Next, the priest will appeal to the spirit of Horus in the sacred boat for judgment.

The ceremony and the temple conform to a high level of historical accuracy, suitable for any museum setting. Members of the audience come before the god with questions to be answered and problems to be solved. The priest poses questions to the god, and interprets the movements of the boat as divine revelation, with the force of law; the processional Oracle was an essential feature of Egyptian public life during this period. The National Endowment for the Humanities (USA) funded the development of the performance, evaluation, and open-source software (HD-5120910). This 90-second video of sample scenes illustrates the interactive nature of the show better than any written explanation:

[http://publicvr.org/egypt/oracle/shortvid.html](http://publicvr.org/egypt/oracle/shortvid.html)

Our immediate goal is to show audiences how ceremony and drama were essential to ancient Egyptian culture, something not well represented in most museum exhibitions or textbooks. More broadly, we want to sharpen their empathy for other cultures and connect ancient civic life with that of today.

We also want to investigate the educational power of low-cost technologies constantly being developed by the game industry. The same approach could represent other times, places, scales and topics. The puppet could be a Roman emperor, a dinosaur, or Mr. Protein, guiding the audience through a human cell. By mixing physical and virtual reality, we gain many of the advantages of both, producing an immersive experience. The current performance captures the central idea of the processional oracle but it is still a prototype, and developing a full implementation is a top priority.

The Egyptian Oracle is game-like, as the audience interacts with the narrative, an essential feature of educationally serious games (Ang, 2008). Also, a few audience volunteers play minor roles embodying persona plausible for that historical era, a small but important example of role-play (Barab, 2009; Dickey, 2006; Squire, 2008). Our interaction design is an example of a new class of mixed-reality game interfaces that resemble virtual reality installations and arcade experiences (LaViola, 2008). Finally, the virtual temple is more than just a backdrop; it is an important part of the experience. Anderson (2010) lists an older version as an example of serious games for cultural heritage.

The performance is also an example of educational theater, which has a long history in museums and as special events at K-12 schools. It is an important and useful way to excite students about the subject matter and convey certain ideas that are not easily represented in any other way. These events are best employed as part of a larger
curriculum; they can illustrate ideas in unique, interactive ways that help students synthesize information they recently learned in the classroom. Egyptian Oracle is designed for children 8-12 years of age, although older children and adults enjoy it too.

Figure 2: The spirit of Horus moves the sacred boat to choose the woman (center) for a great honor. This is the moment when many realize the priest is a puppet and not a program.

In this article, we will begin with a survey of the relevant literatures, especially the historical basis of the show. Next we will provide the reader with pointers to materials that describe the Egyptian Oracle performance, primarily the script and a recording of a full performance. Then we will describe the results of our data gathering from a questionnaire and evaluator scorings of the performance. Our inquiry was only exploratory, intent on gathering general information and forming the basis for a more serious inquiry later. Finally, we will look to the future with a detailed self-review from an historical perspective and a summary of intended improvements, many based on audience suggestions. True to the intent of the National Endowment for the Humanities’ Digital Startup program, which funded this project, the current Egyptian Oracle is a prototype. It is intended to launch a larger project. We have applied for additional funding to produce a more complete rendition of the performance and conduct in-depth research on how it supports learning. For the test materials, the script, Institutional Review Board documentation, and much more, refer to the project final report (Jacobson, 2011a). All of the code and source materials are available at the project website,

http://publicvr.org/html/pro_oracle.html

PublicVR is a 501(c)3 non-profit corporation dedicated to free software and research in Virtual Reality for Education and Human Factors, especially something that the player works to achieve, (2) has rules, and (3) is considered a form of play or competition (Oxford, 2010). While this encompasses “skill and drill” types of games, most are much more complex, providing flexible and responsive narrative in which the player must test hypotheses, synthesize knowledge, and respond to the unexpected (Dondlinger, 2007). The fundamental goal is to motivate the student to learn something (Ang, 2008), but successful educational game design is not easy (Baker, 2008).

According to Ang (2008), the student can be motivated by ludology and narrative. Ludology is the iterative and creative competition or work toward goals, focusing on the game play itself. Narrative is the story itself, which the designer hopes will capture the student’s attention because it is interesting. Within narrative, the student can embody a character or persona (Barab, 2009; Dickey, 2006; Squire, 2008; Slater, 2009). The student (as the character) must understand the virtual context and ultimately transform it. In good game design, goals are structured flexibly, so that
the student can rise to a level that challenges his or her abilities (Dondlinger, 2007). The goal is to keep the student in his or her “zone of proximal development,” in Vygotsky’s terms (Vygotsky, 1978).

However, an educational game must motivate the student to learn what it was designed to teach, not just to play or “win” the game itself. Games can motivate through extrinsic or intrinsic rewards and goals (Dondlinger, 2007). Extrinsic rewards, such as earning points or encountering something fun or pretty, are defined in the structure of the game itself, but they do not have any direct relationship with the material the student is expected to learn. Extrinsic rewards can engage the student, but they also may interfere with learning. According to Fisch (2005), when appealing elements are added to keep students interested, the students often remember those appealing elements and forget the content they were supposed to learn. Intrinsic rewards, on the other hand, are situated within the educational content itself. For example, in Dede’s educational game, River City, the goal of the game is to figure out what is making the townspeople sick, a perfect union of game and content (Dede, 2005).

Employing these terms, the Egyptian Oracle motivates students through narrative and not ludology. Participants are not seeking goals, but they are definitely playing, and the experience has rules. Of course we are employing game technology and interface techniques. Most importantly for a cultural heritage application, the rewards are intrinsic. The historical material, itself, is the star of the show and the reward for participation.

A growing number of applications for cultural heritage have harnessed game technology and techniques (Anderson, 2010; Mortara, 2011; Champion, 2008b). Many simply employ game engines to produce a navigable 3D model (DePaolis, 2011; Belotti, 2009; Jacobson, 2005e, 2005p), while a small but growing number of applications are examples of true games (Chen, 2011; Mikovic, 2009; Jacobson, 2009, 2011b). Most employ interesting user interfaces, often using augmented reality techniques to bring game play into the real world or a museum collection (Papagiannakis, 2004b). Importantly, several cultural heritage games include a pedagogic agent, usually a guide (Hulusic, 2011; Neto, 2011; Jacobson, 2009). Finally, there is a large class of warfare simulation games (Anderson, 2010).

1.1 People in Virtual Heritage

"Virtual Heritage" is the use of electronic media to recreate culture and cultural artifacts as they might have been or interpret them as they are today (Moltenbrey, 2001; Roehl, 1997). The central element is usually a three-dimensional computer model of a person, place, or thing, especially an ancient monument, temple, home, or other social space (CAA 2009; VAST 2009; VSMM 2009). So far, most official virtual heritage applications are intended for a desktop computer and are often web-delivered, and very few include virtual people. At the conference only the presentations by Fortel and Pietroni and the one by Jacobson and Handron described the use of one or more virtual people (CAA 2009).

Applications that do include people fall into four categories. (1) Virtual people are simply there in the environment, going about their business. They could be simple crowds (Ulicny, 2002) or participants in a complex drama (Andreadis, 2010). (2) The virtual people interact with the user in some meaningful way (Champion, 2008a, 2008b). (3) In online worlds such as Second Life (2009), users represent themselves as ancient peoples and interact with each other and artificial people (Bogdanovych, 2009). (4) The experience is personal, as the user interacts with a single complex virtual person (Hulusic, 2011; Neto, 2011; Jacobson, 2009; Economou, 2001.). These same categories of virtual people can be implemented in augmented reality, which is some mixture of the physical world and VR. For example, the LIFEPLUS EU 1st system (Papagiannakis et al, 2004b) describes a proposed and later built hybrid where virtual humans, as ancient Romans, are visible to observers in the physical ruins of Pompeii. The augmented reality also includes reconstructions of some of the architecture but is primarily focused on the people.

The Egyptian Oracle is an augmented reality with interactive people, both physical and virtual.

1.2 Educational Theater and Cultural Heritage

Dramatic productions for educational purposes have a long and productive history. Today, many large science museums have small theaters and workstations where educators give demonstrations and talks, often with audience participation. Children’s museums stage puppet shows, introducing children to science topics and social issues. Theater is also educational for student actors in K through 12 schools and higher education. Since the 1920s, students have learned a wide range of subjects and developed their personalities by learning stagecraft (Ward, 1957). In theater, the games, improvisation, and role-play foster communication skills, problem solving, social awareness,
and positive self-image.

One of the most widely used forms of theater in education is reenactment of scenes from an historical time period: “An enactment may be cast in the past, the present, or the future, but happens in the ‘now of time.’” (Wilhelm, 2002, pp. 8) This strategy encourages students to interact with the material, challenging them to take on the viewpoint of a character. For example, undergraduate students perform rituals documented in Egyptian religious texts from the Late or Graeco-Roman periods (Derchain, 1981), the Mysteries of Osiris in the Month of Khoiakh (Gillam, 2005, pp. 100-8), and Confirmation of Power in the Egyptian New Year ceremonies (Gillam, 2010). These enactments provide a powerful learning experience for the students and reveal aspects of the ceremonies not easily evident in the text.

A much less structured approach is the Living Museum (Gillam, 2005). Actors and the reconstructed or restored historical architecture together simulate a community from the past, which visitors can explore and with which they can interact. The actors play an interesting balancing act between staying in character and recognizing the reality of the modern person talking with them. Examples include Historic Williamsburg (www.history.org) and Fort Snelling in Minnesota (www.mnhs.org). The live actress in the Oracle performance also does this. The public wants to see history acted out (Gillam, 2005).

1.3 Digital Puppetry

Today, the game industry has provided a host of online virtual environments, where each player controls an avatar. Depending on the structure of the game, the avatars interact with each other, with artificially intelligent “bots,” the virtual environment itself, and the narrative generally. The most famous example is World of Warcraft, but there are many other of these Massively Multiple Online Role Playing Games (MMORPG) and a host of acronyms to describe them. Especially when an avatar is visible to other players, the avatar is literally a digital puppet. The one thing that all puppets have in common is control by one or more human beings at performance time.

This is profound, because puppetry is an ancient art with highly developed techniques and technology for representation, illusion, evoking emotion, and conveying information. And yet, most avatars are very primitive puppets, indeed, controlled through a keyboard and mouse, having a very limited range of expression. If we can convey even a fraction of the expertise in the traditional puppeteering to the game industry, we will really have made a contribution.

Jim Henson created the first modern digital puppet, Waldo, in 1988. It interacted directly with physical puppets. Today, most of the advanced digital puppets are used for film production, as in the series “Sid the Science Kid” (Henson, 2009). The Henson Company and other practitioners have developed a range of innovative control devices, most of them involving the manipulation of physical models. The marionette in Figure 3 by Mazalek (2007) is an example of this approach.

![Figure 3: This physical marionette is the control device for its virtual doppelganger (Mazalek, 2007).](image-url)
Most of the highly realistic or lifelike digital puppets, such as Gollum from the Lord of the Rings (Allison, 2011), are driven by live motion capture of an entire human figure. For Gollum, the actor’s movements were directly translated to the virtual body, which was digitally captured and merged with the live footage. The effect is expressive and human, perfect for detailed humanoid figures. However, it is not the ultimate control interface. The reason why the Henson Company and others use more abstract control mechanisms is the power of caricature. They want to deliberately exaggerate or abstract puppet motions to achieve dramatic effect in a way that would not be efficient or possible with full-body motion capture. Unfortunately, the great majority of digital puppets, the avatars in games and online virtual environments, are controlled by keyboard and mouse, which is limiting. One of our long-term goals is to make better low-cost control schemes accessible to the public.

Puppetry has a close connection with shamanic ritual. A ritual object, such as a mask or puppet, is used by the shaman who enters a trance state of consciousness. This results in a performance of great excitement, public engagement, and reflection of community (Ryu, 2008). Our goal is to capture some of the excitement and meaning of the original ritual. Beginning with the Egyptian Oracle, we are attempting to enact and further “extend” the meaning of ritual for the digital age, exploring the psychological and technical dimensions of the virtual. The puppet is a transformative vehicle for both the performer and the community, in this case bridging ascending layers of abstraction and sacredness in the Oracle performance.

### 1.4 Digital Puppets for Educational Theater

A small number of dramatic productions use a sophisticated avatar/puppet for direct viewing by an audience. Ryu (2005) and her digital puppet performed a shamanistic drama for a live audience. Andreadis and his colleagues (2010) created a live performance by avatars/puppets in a virtual Pompeii, which was projected onto a large screen for a live audience. Anstey et al (2009) staged a number of dramas with a mixture of virtual and live actors. As with a traditional play, the audience is “along for the ride.”

Egyptian Oracle is an interactive performance, where audience members may communicate directly with the puppet. There are other notable examples. In “Turtle Talk with Crush,” at Disney theme parks, children see and converse with a virtual digital puppet projected onto the glass of an aquarium (Trowbridge, 2009). In a cultural sensitivity training scenario employing the *Gepetto* system (Mapes, 2011), a trainer-puppeteer controls virtual Arabs with a single user/audience member. In the *TeachMe™* system, used to help middle school children resist peer pressure, a single puppeteer controls five virtual characters, who interact directly with the user/audience (Wirth, 2011).

Much similar work is being done with artificially intelligence (AI) of human figures that interact with the audience/user. These are neither puppets nor avatars, but agents or bots. Sophisticated agents require a great deal of skill and expense to program but have the obvious advantage of being portable, tireless, and potentially connected to databases not directly accessible to human readers. Kenny (2007) and Swartout et al (2006) describe their own cultural sensitivity trainer, an AI-driven direct competitor to the puppeteered system *Gepetto*, described in Mapes (2011). The Intelligent Virtual Environments group at Teeside University developed another sophisticated AI system. In their “Madam Bovary” simulation, the user takes the role of a major character, the foil for the protagonist (Cavazza et al, 2007). Each of these systems is intended for a single user in a CAVE-like (Cruz-Neira, 1993) display.

Good AI-driven interactive storytelling can be developed without extreme cost. For example, Anstey (2009) and Pape have also staged interactive psychodramas that respond to the emotional state of the user. Ryu (2008) developed a shadow puppet that responds directly to the user. In both systems, the programming for the artificial intelligence is relatively simple, but the artistic and narrative design makes it a powerful experience.

Actually, the *TeachMe™* system is a hybrid (Wirth, 2011). When the puppeteer is not directly controlling an avatar, it acts according to a set of pre-programmed rules and behaviors. In this way, all five avatars are active in a way throughout the scenario. Many adventure games allow a single user to control a group of characters, using a similar strategy (e.g., Everquest).
2. Historical Sources and Interpretation

2.1 The Processional Oracle

The Egyptian oracle cannot be directly documented before the New Kingdom (1539 to 1075 BCE), when temples in large urban centers became the focus of religious and political display. Thutmose III (1479 to 1425 BCE) describes how he was chosen to be king by the god Amun during a festival, and other rulers of this period describe private conversations with the god. However, it is not until the reign of Rameseses II (1279 to 1213 BCE) that the processional oracle is fully documented. This event, in which the spirit of the god caused its image to move in response to spoken or written questions on legal and personal matters, is attested at great state festivals as well as at village gatherings.

During the Third Intermediate Period (1075 to 712 BCE), when the priests of Amun ruled southern Egypt on behalf of the god, the oracle intervened directly in state affairs. It is from this time that the most detailed descriptions of oracular procedure survive. Although the oracular decisions appear, for the most part, to be foregone conclusions, occasionally the god acted unexpectedly.

Applications of the oracular functions proliferated at this period. The Brooklyn Oracle Papyrus (651 BCE), with its striking vignette, shows that this form of the oracle survived into the late Period, and classical writers such as Herodotus attest to the importance of oracles in Egyptian culture, as well as the respect they garnered in the Greek-speaking world. During the period of Greek-Macedonian and Roman rule (332 BCE to 638 CE), new forms of oracular consultation were imported from Greek culture, but the processional oracle survived into the Christian period.

Although the Egyptian temples lost their political influence and much of their wealth under the Romans, all oracular decisions were carefully monitored and recorded in Greek, testifying to their continuing importance. Certain events occurring in modern Egyptian culture, such as funerals and religious festivals, provide ethnographic parallels that may shed light on the practices used in ancient oracular performance.

2.2 The Virtual Egyptian Temple Project

The formal Egyptian temple represented a royal palace (Bell, 1997, p. 133) and was a focus for community gatherings (McDowell, 1999, pp. 91-104) as well as being an important cultural and economic multiplier (Kemp, 1989, pp. 193-97). The temple kept the vast majority of the population at a distance from the vital daily cult rituals at its heart (Spalinger, 1998), but it also invited the participation of the general population in large open-air festivals and provided a place for public prayer at the back wall of the sanctuary, which represented the bedroom or throne (“great seat”) of the god (Cabrol, 2001, pp. 580-1).

Religious experience was based on “seeing” the god (Assmann, 1996, pp. 222-4, and Spalinger, 1998, pp. 251-2) and knowing that the temple and its staff kept a “balance” (Maat in Egyptian) (Gablin, 2007, p. 337) between the human and divine. This reciprocal arrangement was personified by the King, who was the transmission point between these two spheres (Hornung, 1982, pp. 138-142, 201-4). Successful balance maintained the necessities of life, including the flooding of the Nile and the social stability of the population. The social stability meant that all the people kept to their social stations and were gainfully employed in their appropriate occupations in a harmonious and non-threatening natural environment (Assmann, 1979).

Our virtual temple is the setting for our mixed reality performance of the Oracle. The temple embodies the typical forms and constructions of the later period of Egyptian history (650 BCE to 200 CE) but with reference to earlier architecture (Troche, 2010). It does not represent any actual house of worship, but is instead an idealized example, an exemplar (Barsalou, 1992, p. 28), of its type. Its intentional simplicity supports focused educational narratives, free from the idiosyncrasies of any specific temple. We chose to build a late period temple because most of our performance scripts date from that time. Also the greater complexity of the wall decoration of that period better documents the various activities that went on inside and around the temple.

The Virtual Egyptian Temple project began in 1993 using some of the earliest computer graphics hardware and software available for common use. In 1994 it showed in the Guggenheim Soho as an example of how to exploit the new artistic medium, Virtual Reality. Over the years, the temple has evolved through several versions, using several
technologies, always with the same goal in mind: to educate the public about Egypt and explore the capabilities of new media. Like the ones before it, the current virtual Temple is available to the public for noncommercial and educational use. It is currently the subject of guided tours at the Carnegie Museum of Natural History in Pittsburgh.

2.3 The Temple We Used (Version Five)

In summer of 2009, we researched the original sources for the wall decoration of the temple, chiefly the reports of the Oriental Institute Epigraphic Survey (1939-40) on the temple of Ramesses III at Medinet Habu (12th century BCE), now also freely available online. In addition, we reviewed the other main source for the temple architecture, the temple at Edfu (3rd-2nd century BCE) (Rochemonteix and Chassinat et al., 1892-1985). These were the sources for the original VR temple, and remain so as they are, of all Egyptian formal temples, the best preserved in their entirety. However, we did supplement these sources with comparable materials from Oriental Institute Epigraphic Survey publications (1936) of other temples of Ramesses III, chiefly for architectural elements. For the decorative programs of the wall decorations, especially interiors, we further explored Ptolemaic and Roman temples at Dendera and Esna (1st centuries BCE-CE) using the Napoleonic Description de l’Égypte (Jomard, 1809-28) and the Institut Française d’Archéologie Orientale publication of the Dendera temple (Chassinat and Daumas, 1939-52). Among many other sources consulted, numerous works of Dieter Arnold (1992, 1994, 1999) have proved indispensable. In spring, 2010 our team rebuilt the temple in line with this new research and planning.

Although our virtual temple is an exemplar and is not intended to represent an actual building, we have made every effort to address the diachronic and synchronic aspects of how these structures were used and how they developed. The formal Egyptian temple is attested between the mid 2nd millennium BCE and the early 1st millennium CE. Although its basic layout remained constant over this period, there were many developments and regional variations. In our later editions of this temple, we have tended to focus on the later period (post 5th century BCE) for several reasons. Firstly, the performances Dr. Gillam coordinated with her undergraduate students at York University are all based on texts from this later period, during which they are most plentiful. Secondly, with the exception of the Medinet Habu temple, the Graeco-Roman temples are the best preserved. Their walls are also covered with a wealth of inscriptional and pictorial evidence that gives valuable details about what activities were done where, when, and for what reasons in the temple (Fairman, 1954, 165-6). The later period is also a time of great cultural interaction brought about by foreign domination, raising issues around multiculturalism and postcolonial discourse that are still highly relevant to our current audiences (Lloyd, 2000; Bingen, 2007).

Currently, our temple is part New Kingdom (12th century BCE) and part late period or Graeco-Roman. The gates and courtyard are earlier while the festival hall and sanctuary are later, a situation that can be paralleled in the actual temple at Mendes in Lower Egypt (Redford, 2010, p151-7). Although our temple does not represent an actual building, it should be historically plausible. To be architecturally and environmentally plausible, its sacred enclosure should be revised to include subsidiary buildings such as granaries, priestly housing, storerooms, and food preparation areas – components that made it a functioning social and economic unit. Its sacred character would also be enhanced by a birth house (Daumas, 1977) where the god renews himself yearly, as well as a precinct for the worship of the god Osiris (Coulon, L., Leclère, F., and Marchand, S., 1995), who represents the death of the temple god. The only addition we have been able to make recently is the sacred lake, representing the water of creation and the site of many water-borne ceremonies.

The precinct needs more sacred trees to flank the processional way to the front of the pylon, which should also be lined with sphinxes (Cabrol, 2001). Outside the gate, in the world beyond, we would like to construct a quay for the sacred boat that took the god on journeys on the Nile, as well as the bustling town, with its mud-brick houses, of which the temple was the focus (Grajetski, W. and Quirke, S., 2002-3).

3. Narrative Structure and Sample

Apart from seeing the performance, the best way to understand it is to watch a film of the complete May 20 performance at Puppet Showplace Theater (PST, 2012), available at:

http://publicvr.org/egypt/oracle/longvid.html

or this preview video:

http://publicvr.org/egypt/oracle/shortvid.html
For the complete narrative and all the materials needed to stage a performance, see Jacobson, (2011a, p. 44). The same materials, as well as the open source software are available at the project website at http://publicvr.org/html/pro_oracle.html. Here, we provide a brief overview of the narrative we used in the mainline performance. It is important to note that the puppet movements and scene changes afforded by the software still leave a lot of room for variation in the script and the audience interactions.

3.1 Physical Setup

We project the Egyptian Temple onto a wall or large screen to create the impression that we are extending the physical room into virtual space (Figure 4). In all of the scenes, the priest is on the right side, in virtual space, while the boat is roughly in the center or on the left. The live actress stands slightly to the left of the screen, where she can engage with both the priest and the audience easily. The puppeteer, who controls the priest avatar, is hidden away, seeing the audience through a webcam at the front of the room.

The physical arrangement uses an immersive spatialized sound system developed for the project (Nambiar, 2011, 2012). The actress and puppeteer both wear mobile microphones, so their voices are fed through the sound system, putting them both in the same sonic “space.” The sound system also provides sound effects, over music during scene changes and quiet ambient music during scenes. The ambient sound conveys a sense of space. Finally, the actress has a mobile microphone she can hand to audience members when they are going to speak.

The play begins at the front of the temple with just the actress introducing the audience to the temple and the event. The first three scenes are brief, really just a guided tour of three areas of the temple. While the audience is (virtually) in the festival hall, the procession emerges from the inner sanctuary, with the High Priest, Petiese, leading. After a prayer, he engages the Oracle to choose a new mayor for the town and elevate several young priests to higher rank. For details of the entire script, see Jacobson (2011a, pp. 44-58). Next, there is a scene change where the audience viewpoint moves from the Festival Hall to the Courtyard to the arrangement shown in Figure 4: Layout of the mixed reality space.
3.2 Dispute over the Shared Wall

In this scene, the god Horus adjudicates a dispute between quarreling neighbors with the assistance of the priests. Pronouncements of the Oracle had the force of law at certain later times in Egypt’s history, as described in the previous section. Two members of the audience were selected ahead of time by the cast or their sponsors to play the parts of the two homeowners. Each one received a card, which said:

You have a lovely home, which shares a wall with your neighbors. They do nothing to take care of it on their side, and it finally collapsed. You will be called to stand in the front of the sacred boat, and Horus will decide whether you or they will pay for the repairs. When the Priest asks you questions, do not accuse your neighbors, but defend your own conduct.

Follow the captions for Figures 5–9 for a description of how the scene plays out.

Figure 4: Layout of the mixed reality space.
Figure 5: Artemerdis explains that “…An enormous hole has opened up in the wall between two houses, and neither of the owners will take responsibility for it.” They will petition the oracle for judgment over who shall pay for repairs.

Figure 6: Artemerdis guides the petitioners to stand in front of the screen. The boat has two animations the puppeteer can use to point to someone on the left or the right of the stage.

Figure 7: Petiese interrogates the litigants.
It is especially important and interesting that the volunteer audience member visible flinched away from the boat as it appeared to approach him. It shows that he was either dramatizing for the audience and/or the boat had become real enough in his imagination that he began to, willingly, react to it physically. This is clear evidence that he is experiencing a degree of presence (Slater, 2009).

In the last scene, performed (virtually) at the foot of the monumental front of the temple. There, the puppeteer and actress prompt the audience to ask general questions about life which can be put to the oracle. The puppeteer and the actress ad-lib responses, bringing the experience as close as possible to the spirit of the original ceremony. Finally, the oracle bestows a blessing upon a child and selects a young maiden to play the part of Isis in next year’s play. The show ends, and is followed by a discussion.

4. Evaluation

Obviously, we wanted to gather and analyze other data on what people learned and how they felt about the show, so that we could know how to make it better and gain insight on its impact. We implemented rigorous data collection procedures and ethical review procedures to set the stage for proper research.

4.1 Protocol and IRB.

We devised a simple questionnaire, which we administered at the end of each performance. The first half of the questionnaire asks two demographic questions (age and gender), two questions about the participant’s role in the performance, two general assessment questions (Did you like it? Did you learn something?), and two knowledge questions. The back of the questionnaire asked for short answers, one testing knowledge and the rest asking for suggestions and opinions.
We administered no pretest and we had no control groups. We also filmed each performance, and had an independent evaluator catalog and rate moments during the performance, such as when an audience member asks a good question. We developed this process on advice and eventual approval from the accredited Institutional Review Board at Carnegie Mellon University. It is appropriate for general audiences and K-12 venues under school supervision. In all our performances, no one objected, and we received a great deal of cooperation. Audiences were also eager to offer their suggestions for improvements to the show.

The overall purpose was to gather some preliminary data, which would help us to posit a more formal study later. Nevertheless, some interesting trends emerge already from the data. For full details, including the tests, the scoring rubric, raw data, IRB materials, and detailed protocol, see the project final report (Jacobson 2011a).

4.2 Results from Page One of the Questionnaire (Specific Questions)

Generally, our results are based on a total of 150 audience members responding, approximately 50% of attendees. Puppet Showplace Theater, Boston (May 20): General public audience of all ages, including three children, 25 respondents. Immersive Education Conference, Boston (May 13): An audience of at least K-12 educators and educational researchers, some graduate students, and one child. Ages (not counting the child) ranged from the mid-twenties to the eighties, 36 completing the questionnaire. Carnegie Museum of Natural History, Pittsburgh (July 21): Twelve teen volunteers at the museum, all responded. William Diamond Middle School (September 19): Nearly all of them were at or near eleven years old. The show was part of their required studies on ancient civilizations, but was presented as a special treat. Seventy-seven students had the necessary parental permission to fill out the questionnaire. Of the total number of respondents at the first three shows, there was a fairly even distribution of ages from teens to septuagenarians. Across all shows, gender balance was good, with 80 males, 63 females, and 7 not reporting.

Across all groups, responses to the question, “Did you enjoy the show?” showed that most did, according to the percentages in Figure 10. We expect that people who did not like the show tended to avoid the questionnaire, so they are probably underrepresented. Nevertheless, audience reaction was generally positive, and we have received requests for future performances based on what people saw.

![Figure 10: Basic acceptance question.](image-url)
Responses to the question, “Did you learn anything interesting?” were similar, with the average of all responses being a solid “Yes.” See Figure 11. Just as importantly, self-reported enjoyment and self-perceived learning were strongly correlated (Pearson’s R = 0.435, P < 0.001). The effect was even stronger in the data for the middle school alone (Pearson’ R = 0.527, P < 0.001). This parallels one of the more frequent suggestions in the free response section of the questionnaire; audiences want more depth and detail.

We also saw a small but statistically significant difference in the self-reported learning for students at the middle school versus everyone else at the show (P < 0.05, two-tailed, uneven samples T-Test). The school children reported a slightly higher level of learning, but they showed no significant advantage in the two actual knowledge questions, “What was MAAT?” and “Who was the High Priest?” The difference may have more to do with their own expectations in the school setting.

About three quarters of respondents answered the question “Who is the High Priest?” correctly (the man talking to us and to the actress). About half of the audience members chose the correct answer for “What was MAAT?” (harmony, peace, and justice). We found no significant relationship between performance on these questions and age, gender, or venue. It takes more than two questions to really probe learning effectiveness, but the responses we did get showed that the audience was listening and was absorbing information.

Another result is that women may have enjoyed the performance somewhat more (P = 0.093, 2-tailed, uneven samples T-Test), although we can only guess why that may be.

Finally, we must caution the reader that these are only quick and simple measures, intended to give us a little more insight from which we can posit a more serious study.

4.3 Audience Comments

Despite how different these test audiences were, there was a remarkable degree of consistency in their feedback. Here are the dominant suggestions:

- Make the show longer.
- Deepen the narrative, and give it more of a plot.
- Provide more information about what we are seeing and doing. This includes more historical background.
Give the audience more to do. They liked the interaction and want more of it. The most popular scene was the one in which the god took questions from the audience. Provide more visual detail, especially for the virtual Egyptians.

Improve the animations. Have the priest do more and do it better.

Make the screen larger, so that the experience would be more immersive.

In all of the after-show discussions, we asked the audience this question (paraphrased here): “When did you realize that the priest was not just a recording or a program following some particular script? When did that happen for you?” Each audience member who answered the question identified a point in the narrative, where the priest interacted with a volunteer audience member on stage. For some it was almost the first interaction, but for others it was not until later in the performance.

4.4 Results from the Videos and Discussions

For each performance, we had two independent evaluators watch the film and fill out the video scoring rubric (Jacobson, 2011a, pp. 96-101). The following descriptive statistics characterize the results, while the full, raw data is available in Jacobson (2011a, pp. 101-105). Note that the video for the CMNH performance was for an overnight camp of Girl Scouts in grades 4 through 7 who came with family members and younger siblings, about 40 people. This was a different CMNH performance from the one that produced the completed questionnaires. At this point, there is not enough data to justify statistical analysis, so results are anecdotal. But some interesting trends emerge.

Audiences definitely had no trouble following the action and behaving appropriately.

Our strategy of selecting people for specific parts (e.g., the disputing neighbors) ahead of time appears to have worked well. Most volunteer actors did well.

The show works better if there are at least some children in the audience. Even a few children engaging with the show seemed to have a strong positive effect on the adults.

Children aged 6 and 7 do seem to get something out of the show, but they do not engage fully. Those aged 8 to 12 do very well.

The adults tended to do well acting out their parts, but they were less enthusiastic in the general interactions, such as the Egyptian style applause.

The show depends on audience feedback and does not usually work well with an adult crowd of less than 20 people.

Many audience members liked how one of the priests carrying the boat kept scratching his leg with the other foot.

When the priest is addressing someone or pointing to something, the live actress often has to interpret for the audience. With a monoscopic projection, the direction the priest is pointing looks different depending on the location of the observer. Experimentation with the new 3D projectors is warranted.

The puppeteer’s ability to engage with the audience through the avatar was remarkable, even though he could see them only through a single low-resolution webcam.

4.5 Other Lessons Learned

Making an early prototype of the Egyptian Oracle performance was a good experience for us, exposing a number of issues that we might not have anticipated had we attempted a full implementation. In no particular order, these are some of the lessons learned:
• It appears to be nearly impossible to describe the performance in words alone to anyone who has not seen something similar. Fortunately, our 90-second introductory video works well and needs very little additional explanation (http://publicvr.org/html/pro_oracle.html)

• We are quite pleased with Unity as a software platform for this work.

• Projects like this would benefit from having a single art director, someone to look after the artistic nature of the whole production. We will do that next time.

• We must spend more effort on music and sound effects, involving a sound person from the very beginning of the design.

• Our very best ideas came from the original historical sources, which makes sense. The Egyptian processional oracle was a highly developed genre of religious performance.

4.6 Egyptologist’s Critique

(The following is Dr. Gillam’s review of our prototype Egyptian Oracle performance. As expected there are many improvements to be made on the way to a full production.)

Although no actual boat shrine of the type used in processional festivals has survived, many depictions can be found in Egyptian visual art of the second and first millennia BCE. Although these objects represented the character of an actual boat, they lacked the technical details found on real waterborne craft. However, they made up for this with very elaborate decorations that centered on a closed shrine or openly displayed image of the god of the festival. This image was, in turn, surrounded by statuettes of other divinities or kings and with decorative features, often including gold and semiprecious stones. The whole ensemble was decorated with flowers, precious cloths, and small ostrich feather fans (Kruchten, 1986, 7-8; Brand, 1999). These latter features indicated the presence of the spirit of divine royalty. Larger examples of these fans were carried by priests walking alongside the shrine, but not engaged in carrying it (Kruchten, 1986, 8).

The number of priests actually carrying the shrine varied according to the importance of the god and the level of royal patronage (Černý, 1962, 36). References to the number of carrying poles for the shrines found in Egyptian texts are subject to interpretation but indicate that as many as perhaps 50 persons could be engaged in this activity, which was regarded as a great honor (Černý 1962, 36). Obviously such a large numbers of shrine bearers would make the work of the programmers and puppeteers impossibly complex, and the number used at present is an acceptable compromise. However, in order to make the Oracle performance more realistic, it is essential to make the movements of the bearers both more convincing and with more individual variation.

For the sake of simplicity and also to lower expenses, the boat shrine, priest and bearers have been constructed as a single unit. While this allows both the programmers and operators to create and animate a seamless and coherent whole, it has also created a scenario where the movements and character of the components making up the puppet are not sufficiently differentiated from each other or sufficiently legible or complex in themselves. Also, although a great deal of progress has been made with the walking movement of the bearers, the programming of their walking movements across the ground surface needs to look more realistic. An important desideratum for the further development of this project would be the greater differentiation of these individuals, as regards physical appearance, facial features, or even gestural mannerisms. As the bearers are conceived to be acting together under the influence of the god, they would appear much more convincing if they exhibited more fluid movements and individual character.

Of far greater importance is the appearance and movement of the high priest himself. As the master of ceremonies, he is main dramatic focus of the performance, and the figure to which the audience devotes most of its attention. He also provides the main interface between the real and virtual worlds. While I regard the general appearance and costume of the priest as satisfactory, both his stance and gestures require some improvement. While it is an important part of both the philosophy and practice of this project that the priest is not too lifelike, but displays some of the exaggeration of physiognomy that we find in puppetry (Engler, et. al., 1973), this can sometimes be inappropriate. I refer in particular to the stance commonly assumed by the priest, with legs apart and hips thrust forward. This stance is found nowhere in formal Egyptian art and is at variance with ideas of decorum expressed in this culture (Baines 2007, 1-30). It is particularly inappropriate for the exalted and dignified figure who comes face
to face with the god every day in the temple sanctuary and communicates directly with that god on public occasions (Fairman 1954, 179-81).

A more serious issue that could be addressed with further funding is the refinement of the technical or specialized actions of the officiating priest. In practice, he would proceed before the boat shrine, walking backwards so as not to turn his back on the god, at the same time as he would be waving the incense burner in front of the boat (Černý 1962, 42, Figure. 9). Due to lack of sufficient funding, it has not been possible to program both of these movements. This is unfortunate, for without having the incense burner to manipulate, the priest appears to be moving his hands in an ineffectual or meaningless fashion. His backward movements also need to be improved, because, at the moment, he appears to be hopping up and down or dancing, actions inappropriate to the dignity of his office and the decorum of the event.

The manipulation of the incense burner is also quite complex in and of itself. The whole unit, which represented a human hand holding an offering on its palm at its outer end, terminated where it was grasped in the head of the falcon Horus (Beinlich, 1978). The hand held the metal or clay receptacle where glowing charcoal dissolved grains of incense. In the middle of the arm of the burner was another receptacle filled with fresh grains of incense. Numerous representations confirm that while the priest was moving the burner to and fro, he was also throwing fresh pellets from the middle receptacle into the burner at the end, one grain at a time (Schäfer, 1986, 228). Such a movement would have required excellent hand and eye coordination and was no doubt learned from years of practice. Still, it would have been central to his role in the processional festival. The coordination of the censer movements during the oracular consultation raises questions about the continuity of the censing activity and raises the possibility that the high priest could have handed the censer to another priest while interacting with petitioners. A possible solution to this problem would be to follow the procedure used in large temples, where the high priest confronts the god somewhere outside the temple in the course of the procession (Kruchten, 1986, 39), rather than the routine followed at the village temple at Deir el Medina, where the priest walks backwards in front of the boat (Černý, 1962, 42, fig. 9).

The grandest of oracular ceremonies, held in the great temple of Amun at Karnak in the early 1st millennium BCE even featured more than one divine boat, although only one was active in oracular sessions (Kruchten, 1986, 3). Further funding would allow these aspects of the ceremony to be researched in more detail and would permit the construction of other puppets or the elaboration of the existing one, to add more actors attendant on the god, including the above-mentioned fan bearers, assistants to the high priest, or even musicians and singers found in some representations.

5. Future Work

We are currently seeking additional funding to build a full implementation of the Egyptian Oracle, based on what we have learned from the prototype. First and foremost is our intent to complete the historical accuracy of the representation. Summarizing from the previous sections, we would do the following.

Improvements to the production:

- Conduct more research into the processional oracle to support improvements.
- Expand and deepen the narrative, with much more opportunity for audience participation.
- Improve the music and sound effects.
- Improve the appearance and movements of the Priest avatar, adding an incense burner.
- Make the sacred boat larger and grander, adding flowers, feathers, offerings, etc.
- Add more priests to those carrying the boat and differentiate them.
- Add more senior and attendant priests, and add musicians and singers.
- Add some everyday Egyptians in the virtual space.
- Make physical props for the audience.
- Make a program or booklet for the show.
- Make major improvements and additions to the temple, using information gathered in a recent trip to Egypt by Dr. Gillam and other sources.
- Add a bit more of the village around the temple, especially the quay.
Supporting materials and activities:

- Make a comprehensive package of materials for K-12 schools who wish to stage the show.
- Produce an instructive website and booklet with historical information.
- Continue to support and expand the open source code and materials.
- Develop the user community around the show, i.e., individuals and organizations who wish to stage the performance, develop variations on it, or use the code for their own work.
- Develop a nonprofit theater group that travels to different locations during the performance. The same group would also show institutions (usually museums) how to stage the show themselves.

Research:

- Create a much more detailed test to track learning outcomes and the influence of the event on K-12 curricula.
- Analyze audience activity and interaction in much more detail, perhaps using Vygosky’s activity theory.
- Stage an all-live version of the show, a completely online version (e.g., similar to Second Life), and one in a visually immersive digital dome. Compare results and impacts.

Experimentation: At the time this article was written, Siddhesh Pandit had just completed improvements to the Egyptian Oracle open source, which allows the puppeteer to control the avatar from the remote location via a LAN or the Internet (Pandit, 2012). We will soon experiment with projecting a version of the Oracle performance into classrooms in this way. In a modified script, the teacher could interact with the priest, instead of the live actress doing that interaction. Or the whole thing could be recast as a conversation with the priest. Telepresence for presentations in K-12 schools has been around for a long time, but previously required expensive AV equipment. This type of presentation would be kept technically simple, markedly different from the large-scale theater productions.

6. Conclusions

Human beings do not live in physical space; we live in psychological space. In that sense, we have always augmented our reality in many ways. These range from the invisible realities of social space to the deliberate illusions built into art and architecture. The introduction of computers and all of their display and interaction devices and techniques has expanded our ability to stretch our reality in new ways. We do this to explore, create, communicate, and just live better. However, most successful projects in new media are grounded in well-established principles.

Mixed reality human-to-avatar theater has been done before (Trowbridge, 2009; Ansty, 2009; Mapes, 2011; Swartout, 2005; Kenny, 2007) and similar efforts have been made with AI-driven human forms (Cavazza, 2007; Mapes, 2011). These have been relatively rare, but we believe they will become more commonplace, as supporting trends in technology and culture converge. This convergence includes the move towards ever larger and more immersive digital displays, the mass use of puppeteering in online virtual worlds (e.g., Second Life, World of Warcraft), increasingly visual telepresence in everyday communication (e.g., Skype), and the introduction of evermore interesting VR-like applications produced by the game industry.

The Egyptian Oracle has successfully employed very new communications technologies (virtual/mixed reality and telepresence), ancient theatrical techniques (e.g., puppeteering), and highly developed theatrical form (Egypt's processional oracle) to create an entertaining and educational experience. Importantly, the technology we employed is available to everyone at low cost. The code and the script are open source, available to anyone who may wish to stage the show or build their own experience that is in any way similar.

We are well pleased with this prototype production and look forward to full implementation. Early evaluation results are promising, showing good audience acceptance and evidence of learning. With this production, we bring to the public an appreciation for Egyptian religious ceremony, a critically important aspect of that great culture. To understand ourselves, we must understand where we came from, and many of the legal social norms that we take for granted today originated in Egypt. By participating in the oracle performance, audience members can connect the experience with their own lives, and hopefully gain empathy for other cultures.
7. Acknowledgements

The list of contributing individuals and institutions is long; for details refer to the project final report (Jacobson, 2011a, p14-15) or the website at http://publicvr.org/html/pro_oracle.html.

Senior staff were Jeffrey Jacobson (director), Robyn Gillam (Egyptologist), Brad Shur (puppeteer, dramaturgist), Friedrich Kirschner (programming, animation), Kerry Handron (Script), David Hopkins (artwork, animation), Asa Grey (music). Essential contributors were Brenda Huggins (actress), Ajayan Nambiar (sound system, software), Natthaphol Likhitthaworn (software), Siddhesh Pandit (new networking), Michael List (puppeteer). Advisory Board members were Lowry Burgess (CMU), Christopher Innes (York U.), John Baek (Oregon U.), Michael Nitsche (GA Tech), Semi Ryu (Virginia Tech). Other Friends were Josephine Anstey and David Pape (advice and venue), Jon Hawkins (additional music), Kenneth Hargrove (evaluation), Ted Grinrod (evaluation) Heather Bloss (evaluation), Brianna Plaud (costume). Institutional Contributors were the National Endowment for the Humanities (funding), PublicVR (additional funding and staffing), Puppet Showplace Theater (staffing and venue), Carnegie Museum of Natural History (staffing and venue), Carnegie Mellon University (IRB), William Diamond Middle School (venue and data gathering). Boston Cyberarts (venue), Boston Children’s Museum (venue), Grid Institute (venue), Boston College (venue).

REFERENCES


Dickey, M. D., Game design narrative for learning: Appropriating adventure game design narrative devices for the design of interactive learning environments, Educational Technology Research and Design, 54(3), 245-263.


Draft Submitted to the ACM Journal of Computing and Cultural Heritage 07/13/2012

Jacobson, J. (2011a). Egyptian Ceremony in the Virtual Temple; Avatars for Virtual Heritage, Whitepaper and Final Performance Report to the National Endowment for the Humanities. Digital Startup Grant #HD5120910. (I was also the PI and project director.)


Draft Submitted to the ACM Journal of Computing and Cultural Heritage 07/13/2012


