

# Extending Physical Collections Into the Virtual Space of a Digital Dome

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## Abstract

*The Earth Theater at the Carnegie Museum of Natural History (Carnegie MNH) in Pittsburgh is an all-digital partial dome display, an immersive theater. Our current offerings include an Egyptian temple, a virtual dinosaur exhibit, a Seneca Village, and a simulated Ant Mound. Each one is a three-dimensional virtual world, which a docent can navigate at will while providing a guided tour. Each virtual world is thematically tied to one of the physical collections at the museum, effectively extending it into virtual space. To produce these shows, the CMNH has collaborated with PublicVR (a Boston area non-profit) and the Art Institutes (Pittsburgh and Boston), a chain of colleges in the electronic arts. Under PublicVR's supervision, students from the Art Institutes earn course and internship credit making artifacts for the environments (Egypt) or the entire environment itself (Seneca and Ant Mound).*

Categories and Subject Descriptors (according to ACM CCS): J.5 [Computer Applications]: Arts and Humanities—Arts, fine and performing

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## 1. Introduction

Many museums have large-format theaters (e.g., domes) showing educational movies [IPS10], and a fast-growing number use all-digital projection systems. Today, reasonably priced computers can drive these projection systems, producing imagery in real-time, under the control of a docent or operator. In this way, the theater screen acts as a window into a three-dimensional virtual world, with the docent as the tour guide. The idea is similar to classic presenter-led planetarium shows, except that technology supports any kind of virtual space, not just the night sky. Examples include ancient temples, landscapes on other planets, forests from the time of the dinosaurs, undersea adventures, and electronic puppet/shadow shows.

Public offerings based on these virtual spaces are educational in their own right, but they are even more effective when thematically linked to physical collections and other offerings. Museums have always acted as a conduit for ideas from other places and other times to the here and now, both through direct display of artifacts, dioramas, fossils, recordings, replicas and other holdings and through interpretation

of these exhibits. The virtual world is a further step, allowing museums to break the barriers of time, space, and size. They can disregard limitations imposed by requiring a safe environment for patrons and access delicate, irreplaceable items. Virtual worlds compliment (not replace) reality, creating a unified experience for the museum patron.

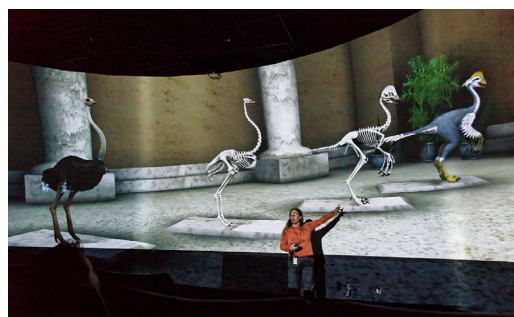


Figure 1: *OvirapTour*, a virtual extension of Dinosaur Hall.

Since 2006, the Carnegie Museum of Natural History in

Pittsburgh has used the Earth Theater, an all-digital partial dome display (Figure 1) to extend key exhibits into virtual space. The main display is driven by low-cost game-based technology and freeware provided by PublicVR, a Boston-based non-profit dedicated to educational virtual reality [JP10][P10]. The museum collaborated with PublicVR, the Art Institute of Pittsburgh, the Art Institute of New England, Mechanimal Inc., independent contractors, and others to help create these virtual spaces, develop them over time, and develop the supporting educational narratives.

Using low-cost game technology and skilled student labor, the museum and partner organizations manage the virtual space much like a physical exhibit. These virtual spaces can be thematically independent or closely tied to the other offerings at the museum.

The most straightforward example is OvirapTour, a thematic extension of Carnegie MNH's Dinosuars in Their Time exhibition. Even at more than 18,500 square feet, the hall cannot hold all the stories the museum wanted to tell. One evolving topic is that of the connection between dinosaurs and birds. The new unnamed oviraptorosaur looks like an ostrich at first glance, and careful comparison shows it to be very similar. A thematic cornerstone of the exhibition is displaying animals and plants together only if they lived together in time and space; there was no place for a modern ostrich skeleton near the oviraptorosaur.



**Figure 2:** Guided tour of the Virtual Egyptian Temple in the Earth Theater. Compare to Figure 2

However, the virtual museum in OvirapTour places them side by side, and in other virtual rooms includes related fossils, models and supplementary material to support all aspects of the connection between dinosaurs and birds. The virtual museum illustrates another strength of the model of using a virtual world in a museum. Carnegie MNH, for example, has over 20 million objects, and the vast majority will never get to the physical floor. But the virtual world can grow to house many objects, and once a world is build, few

resources are needed to maintain it. The virtual world for OvirapTour was created by Jason Bannister at Mechanimal. The show is displayed in the Earth Theater using freeware, CaveUT and VRGL, developed by PublicVR [JP10]. OvirapTour has been shown to general public and K-12 school audiences since the opening of the physical hall in 2008.

## 2. A Mixed-Reality Egypt Collection

Carnegie Museum of Natural History has acquired Egyptian artifacts since its founding and now holds about twenty-five-hundred ancient Egyptian artifacts. The most significant of these objects, over six hundred of them, are displayed in The Walton Hall of Ancient Egypt. In the hall the artifacts are displayed in relation to the daily life and traditions of the people who made them, so that the objects are seen in the context of the culture. To present a cohesive picture of ancient Egyptian society, its technology, its social system, and its beliefs, we arranged the objects by theme.



**Figure 3:** Crockery, some of it duplicated in the virtual temple as shown in Figure 2

In content, theme and presentation, the Virtual Egyptian Temple complements the Carnegie MNH's physical exhibition, the Walton Hall of Egyptology. The temple does not represent any particular site but is instead an exemplar (idealized example) of a temple from Egypt's late (Ptolemaic) period [TJ10][P10]. The main figure in front of the physical exhibition is a statue of the god, Horus. His duplicate is the focal point of the virtual world as the divine image of the god of the temple (Figure 2). The physical exhibit concentrates on the everyday life of artisans and workers. The Virtual Egyptian Temple allows museum patrons to visit the temple as they would have as members of the community in ancient Egypt. Certain objects in the physical collection are duplicated in the virtual temple, as you can see in Figure 2 and Figure 3. The temple has been a useful educational tool, featuring in a learning study conducted jointly by the Carnegie MNH and PublicVR [HJM10][J10].

## 3. Developing the Narratives

The temple supports multiple narratives to serve different audiences. Middle school classes studying Egypt apply what

they learned in school to topics such as ecology and the environment, geology, cultural ritual, agriculture, demographics, and astronomy. Younger audiences consider life as a child, and the experience of visiting the temple. The visual immersion provided by the Earth Theater, in a life-size virtual temple, makes this technique especially effective. Shows for general audiences draw from all the productions and include a mini-play to emphasize the importance of the relationship between the people and the gods. Volunteers from the audience role-play the people, priest, pharaoh, Horus, and other gods using replicas of objects in the collections, surrounded by the virtual space in which the offerings occur. The audience members can make connections between their own personal daily life and that of counterparts of the same age in ancient Egypt. Other versions of the show serve specific audiences such as art or architecture classes or groups studying comparative religion.



**Figure 4:** *The Virtual Seneca Village.*

Development of a new narrative is usually in response to a request or opportunity to support other museum programming. A survey of available assets, both virtual and physical, is followed by an iterative process involving educators, content experts, and test audiences. As the product nears completion, test audiences include coherent groups such as scouts or classes, who understand that their role is to test the product. They and their parents are interviewed to determine both content gains and enjoyment. The narrative continues to evolve, but more slowly once it is in front of public audiences.

As the Carnegie MNH works to incorporate inquiry-based education into all aspects of the programming, a wide variety of techniques have been tried to go beyond engaging audiences and move to supporting audience members' own questioning and exploration. Some have been found to be successful and are incorporated into the program. Many of the audience-interaction and story-telling techniques developed from the virtual heritage programming (described next) inform this dinosaur show and vice versa.

#### 4. Developing the Virtual Collections

At the same time members of the public and younger students learn from our existing virtual exhibits, college students from the Art Institutes learn by helping us create them. In 2007, college students at the Art Institute of Pittsburgh (AIP) created artifacts for the virtual Egyptian temple as projects for Jeff Zehnor's object modeling class. They developed the models using 3-D Studio Max, created textures with Photoshop, and exported the models to UT2004, the video game software platform for the virtual environments [JP10]. Some of the artifacts are duplicates from the physical collection, which the students saw and photographed, while others were created from images found in literature. Egyptologist Lynn Holden provided the scholarly content and supervision, Kerry Handron prioritized educational needs, Jeffrey Jacobson provided technical management, and PublicVR paid the incidental costs. Artifacts of excellent quality became a permanent part of the temple and the show. Each student contribution is recognized in the project credits, a useful resume-builder for the student author [E10].

We did this again in the fall 2009 with Ricardo Washington's object modeling class at AIP, with Robyn Gillam serving as Egyptologist and others as described in the credits. Occasionally we have hired professionals to make more advanced improvements or add key artifacts. Importantly, the software tools are ubiquitous and fairly low-cost, and schools such as the Art Institutes provide large numbers of talented individuals with the requisite skills.



**Figure 5:** *Inside the leaf-cutter ant mound.*

The Virtual Seneca Village (Figure 4) is a highly successful student project produced entirely by a team of Jeff Zehnor's students at AIP. The students knew from the beginning that the goal was an accurate world with enough realism to support a show. They were able to watch the Egypt show live, so they had a good idea of how it was to run. The topic of the Seneca was chosen, as that is the best-understood native group that lived in the area of Carnegie MNH. Though no longhouses remain, archeological sites define the sizes by the post holes, and some anthropological accounts describe the houses. The museum has long taught programs about the Seneca, and this virtual world was created to support some of the main themes, including the gardens with the three sisters, the defensive nature of the placement of the village and

the palisade, the matriarchal nature of the society, and the way available materials and landscape defined the society. The students worked with museum staff content expert Susan McJunkin, and Ruth Hartman [H10] was the lead student while at Art Institute of Pittsburgh [A10].

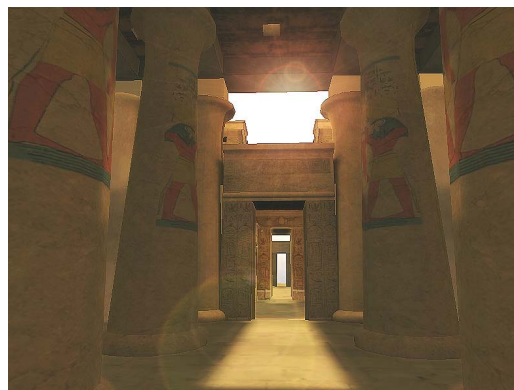
A single AIP student, Clinton Severs, produced the Leaf Cutter Ant Mound (Figure 5), a stand-alone show, which takes advantage of the dark enclosed space of the Earth Theater. The content explores the several types of ant, including the queen, different workers, and soldiers. Participants are supported as they explore the virtual world and investigate the complexity of the ants, leaves, fungus farming, nursery, waste removal, and defense. The warren of tunnels is challenging to navigate by sight alone, which helps emphasize the importance of the ants' other senses [RJ07].

### 5. New Exhibits and Production Model

In Boston, PublicVR develops virtual environments and supporting materials with student interns from local area colleges and experts in the field. Since summer 2009, we have had two or three students per semester from the Modeling and Animation program at the Art Institute of New England, two from the Berklee College of Music in Spring, 2010, one from the department of Egyptology at Brown University in the 2009-2010 academic year, and an independent study from the Harvard School of Education [E10] Some of the students work at the PublicVR offices, while others work remotely, and all are organized into a single professional team.

We constitute a new team each semester and briefly rehire some of the previous term's students to train the new team. We also rehire previous interns for contract work, where appropriate. Dr. Jacobson supervises and supports the entire process. So far, we have constructed a completely new version of the Virtual Egyptian Temple (Figure 6), repaired structural problems in the Virtual Theater District of Pompeii model, composed music and ambient sound for temple rituals, and developed a new narrative for the Egyptian Temple. We showcase and credit the students' work on the PublicVR website and in publications in the literature. Two of our students have published papers on the work themselves [TJ04][JJ10]. The virtual worlds produced this way are open-source and will be made available to the public through the PublicVR website. In the coming year, we will finish the temple and make a virtual forest for the myDome project.

Based on the success of the virtual temple and other immersive format productions, the "MyDome" project is exploring deeper connections between audiences and the virtual world. It employs smaller portable domes that Carnegie MNH and other museums regularly bring to K-12 schools and uses a new software platform, Unity [UN10]. The project team is developing several worlds for user exploration to support archaeoastronomical and biological investigation. The power of the virtual world to take participants



**Figure 6:** *Inside the leaf-cutter ant mound.*

to physical places and other times that are not possible to experience in the real world is one of the main drivers of this research. Another is the goal of improving the user's connections with the virtual world through the technology of production and presentation devices. This work is funded by NSF grant 0916098 through the Human Centered Computing Program. The principal investigator is Annette Schloss at the University of New Hampshire, and the Houston Museum of Natural History [HMNS10] is a partner museum along with Carnegie MNH.

PublicVR will produce a virtual forest, which will support a narrative for K-12 students seeing it in the portable dome. It will be part of a larger curriculum which depends also on field trips to a real forest. While the real forest has detail and authenticity, the virtual one can represent other types of forest, other times of year, different cloud cover, and different zones (canopy, understory, floor, and possibly underground), and can include additional visualized information. Things in the real forest can also be represented in the virtual forest, in a way analogous to how the virtual temple interacts with the physical collection of Egyptian artifacts.

### 6. Conclusion

The use of virtual worlds to support and extend the Carnegie MNH's offerings has been successful, and they are less expensive to build than many physical exhibits. Other informal science education institutions such as science centers, zoos, botanical gardens, and living museums could do the same. The software and hardware are readily available, and the growth of the video game field supports further refinement of tools and a pool of trained individuals. Further research is needed on connecting the audience more closely to the physical world, on what types of topics best utilize the immersive nature of most of these spaces, and in moving from an engaging and interactive presentation to one in which the audience members don't just synthesize knowledge but further develop their own process of inquiry. We

are working towards a product where users will be able to interact directly with the virtual world to explore, measure, manipulate, and affect it in support of both scientific inquiry and anthropological investigation.[FH93]

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