

# **Virtual Spaces in Portable Digital Domes for Learning in Science and Cultural Heritage**

Jeffrey Jacobson, PublicVR, Boston  
Kerry Handron, Carnegie Museum of Natural History, Pittsburgh

*Digital dome displays situate the students and instructors in virtual worlds representing otherwise inaccessible places, times, and dimensions. Combined with formal or informal curriculum, these experiences are powerful motivators for learning. Not only is inherently spatial information best seen spatially, it provides a direct and visceral connection to the material. Portable digital domes bring all this to K-12 schools and other venues, especially to underserved groups who cannot easily travel to museums and science centers. We will demonstrate one such dome, provided by the Carnegie Museum of Natural History. We propose a forty-minute presentation based on the Virtual Egyptian Temple and another based on a virtual forest. We will also present research showing the effectiveness of immersive displays like this.*

## ***Educational Value of Portable Domes***

Digital domes and other immersive theaters have been powerful learning tools at museums and science centers for years (Lantz, 2007). These theaters support both interactive and passive (movie) virtual worlds which visually transport audiences to places, times and dimensions where one cannot normally go. Immersive displays can also present inherently spatial information in three dimensions, making it more accessible. For example, giving students access to an immersive inside view of a magnetic field enhanced learning in Dede (1999). Jacobson (2010) found an analogous effect for learning with the Virtual Egyptian Temple, which we propose to demonstrate, here.

Virtual worlds can also extend exhibits beyond the space or artifacts available at the museum. For example, the Carnegie Museum of Natural History has a permanent exhibition, *Dinosaurs in Their Time*, which carefully and accurately portrays plants and animals together, but only when they lived in the same time and place. This is an important part of understanding geologic time and geography, but it inhibits comparison across time and space. To fulfill this need, they developed a program for their immersive Earth Theater (a partial dome), OvirapTour. It places the modern ostrich and a Cretaceous Oviraptor next to each other for direct comparison to understand the relationship between dinosaurs and birds (Handron, 2010).

The greatest advantage of this type of virtual reality is the way it motivates students by providing a direct and visceral connection to the subject matter (Sumners, 2008). This is why K-12 schools regularly bring large numbers of students to museums and science centers for day trips which include visits to their immersive theaters. Properly chosen, these experiences augment traditional curricula and help schools meet their state standards, primarily by motivating the students.

Now, portable digital domes bring immersive programming to students at informal learning events and directly to K-12 schools. Portable planetariums have a long history, and the number of full view immersive video units has expanded greatly. One model, the Discovery Dome has over 150 units around the world, and there are at least as many produced by other companies. Because they are portable, these systems reach a diverse audience not limited by geography or traditional attendance patterns at museums. Content producers are a diverse group and generally are well aware of common techniques of focusing products on underserved audiences making the universally accessible, especially in the K-8 curriculum. For example, many 3<sup>rd</sup> and 4<sup>th</sup> grade curricula emphasize cycles in nature, a core scientific concept which can be well represented in virtual reality. Finally, the cost of providing immersive experiences this way is significantly less than a field trip to a traditional fixed-dome display, as little as a third. Refer to Sumners (2008) for a sample list of immersive shows and case studies showing on effectiveness.



**Figure 1:** Dome shows are popular and educational (Sumners, 2008).

Figure two from Sumners (2008) shows “...a line of middle-school girls waiting to enter the Discovery Dome at the Sally Ride Festival at Rice, October 28, 2006. Nearly 1000 students plus parents and teachers attended; more than half were able to visit the dome. For the 2007 Sally Ride Festival, over 1400 girls attended and again more than half received instruction and inspiration in the domes.” Portable domes are popular with the students.

## ***Physical Installation***

The Discovery Dome is an inflatable hemisphere with a door structure that allows people to walk in, and allows wheelchair access. It works like an all-digital planetarium or Imax dome theater, except that it is small, portable, and low cost. The projection equipment consists of a laptop computer, a LCD/DLP projector, and mirror system, all of which is concentrated in the back of the dome, allowing seating in the middle. Portable domes come in many sizes, but for reasons of space and transportation, we propose a small one, 16 feet in diameter requiring a 16ft square floor space, a standard power plug, and an 11-ft high ceiling, and seats 35 people comfortably (E-Planetarium, 2010). If space is still a problem, we can bring the 13ft diameter version which seats 15 people (figure 2).



**Figure 2:** An inflatable, portable, dome.

## ***Script***

We wish to demonstrate our dome during an ARVEL-SIG session, which are usually one hour and forty-five minutes long. We propose two demonstrations, 40 minutes each, for 35 people at a time--a total of 70 attendees during the session. A single presenter will work with the audience while moving their shared viewpoint through the virtual world. Each demonstration will be 20 minutes of presentation and 10 minutes of discussion. The presenter is the discussion chair.

In both sessions, the presenter will describe the purpose and value of portable dome displays in formal and informal education, outlined in “Educational Value of Portable Domes,” above. The first presentation will demonstrate learning in the Humanities with the Virtual Egyptian Temple (below). The second presentation will demonstrate science learning with a virtual forest (below).

While the presentations are happening in the dome, a second presenter will be on the exterior, having informal conversations with anyone interested. We will bring printed literature on our research in this area, especially the virtual temple (Jacobson, 2009, 2010) and a third project, OviRapTour (Handron, 2010).

We also offer to keep the dome installed for longer than a single session, perhaps a full day or two. We have many other films and interactive programs available to show audiences. We could also invite other groups to produce and display their content on the dome, particularly if ARVEL does another workshop at the conference.

### ***The Virtual Egyptian Temple***

In content, theme and presentation, the Virtual Egyptian Temple complements and extends the physical exhibition, at the Carnegie Museum of Natural History, the Walton Hall of Egyptology. The temple represents *no* particular site, but is instead an exemplar (idealized example) of a temple from Egypt's late (Ptolemaic) period (Troche, 2010; PublicVR, 2010). The physical exhibit concentrates on the everyday life of artisans and workers, and some of their artifacts are duplicated in the virtual temple. In the portable dome, museum patrons can visit the temple as members of the community in ancient Egypt would have visited the real temples. Figure 3 shows the temple in the CMNH's Earth Theater, a medium sized partial-dome display. PublicVR produced the temple and lead the evaluation.



**Figure 3:** The Virtual Egyptian Temple in the Earth Theater at the CMNH.

The temple has served regular museum goers and school groups for years. It is part of the regular tours of the Egypt collection and compliments single day classes conducted at the museum. The study of Egypt is a part of the Pennsylvania state requirements for middle school students. The latest version of the temple is now installed in the portable dome we describe here. The museum brings its portable dome to local area schools as part of its outreach programme, and the temple

will be one of the regular offerings. Finally, a game based on the temple featured in a learning study conducted jointly by the Carnegie MNH and PublicVR (Jacobson, 2010). The study showed that students playing the game in a visually immersive display learned more than those who used a standard desktop computer.

### ***Virtual Forest***

The science learning portion of our demonstration will be based on virtual forest, currently under development. The presenter will demonstrate how the visualization reveals information not easily seen in a real forest. For example, we can rapidly change the virtual environment to show the forest in different seasons or stages in growth (young forests vs. old growth) etc. The virtual forest will be part of a larger curriculum where students gather data in the simulated environments as well as real forests, and compare the two. This connects with their general science and environmental literacy curricula at school, making information readily visible in a way different and complimentary to classroom study.



**Figure 4:** Gathering data in the real forest to compare with the virtual forest.

## ***Going Forward***

Both the temple and the forest are part of the “myDome” project, an investigation into the effectiveness of portable displays through case studies. The 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 (HMNS, 2010) is a partner museum along with Carnegie MNH.

The demonstration we propose will be useful and informative to members of ARVEL SIG and conference goers interested in our track. We also offer to keep the dome installed longer than a single session, perhaps a full day or two. We have many other films and interactive programs available to show audiences. We could also invite other groups to produce and display content on the dome, particularly if ARVEL does another workshop at the conference.

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