(This submission has an accompanying video)

ARCHAVE: A Virtual Environment for Archaeological Research

Daniel Acevedo, Eileen Vote, David H. Laidlaw, and Martha Sharp Joukowsky
Brown University, Providence RI

We have developed a software system for evaluating the merits of several virtual environments for archaeological tasks. The ARCHAVE system, developed at the SHAPE lab at Brown University, presents archaeological excavation data and site information via a virtual reality interface. These data come from the Brown University Great Temple excavations in Petra, Jordan [1].

As Bowman proposes [2], we are designing several user studies that utilize the following virtual environments: a Cave, Barco Baron table, head-mounted display and the desktop (see accompanying video and Fig. 1), to evaluate the hypothesis that virtual reality is useful for this kind of research. This type of study is one of the "Hot open challenges" in VR research [3].

Archaeology. Following standard archaeological practice, artifacts recovered from the excavation site are recorded with precise three-dimensional characteristics. The database for the Great Temple excavation contains more than 115,000 artifacts, recorded since 1993. Unfortunately, the full potential of archaeological databases is rarely realized. Most archaeologists are not able to analyze the geometric characteristics of artifacts and their spatial relationships with other elements of the site [4].

For analysis, it is essential to maintain the artifacts in their architectural and topographical context. Following what Forte proposes in [5], we believe that a virtual environment will be particularly useful in helping researchers understand their data to develop new conclusions and hypotheses about the history and evolution of Nabataean culture.

The System. The ARCHAVE system displays all the components of the archaeological excavation in the context of an architectural reconstruction of the temple. The virtual site is divided into a grid of trenches where the dirt is excavated and important objects recovered and analyzed. Each trench is organized into layers, and artifacts are plotted in their exact find locations.

As the user enters the site, different artifacts can be interactively retrieved from the database and viewed, together or separately, for spatial analysis. For example, a user can bring up pottery finds and coin concentration data to explore the relationship between the two.

In a fully developed environment, a researcher will be able to study the site by navigating through different stages of the excavation or important historical phases of the building. He or she will also query the database of artifacts using speech recognition, gesture-based commands, or automatic query generation depending upon the state of the user in the virtual site.

Significance. This application will help us answer the following specific questions: What virtual reality environment, if any, performs better in giving archaeologists the adequate interface and contextual information they need for analysis? What context is necessary for performing archaeological tasks? Which interaction techniques allow the user to navigate through an archaeological site and access a database of artifact information? How do we display the results of those queries in a way that he or she can gain maximum insight about the data?

From a number of informal tests and demonstrations, we have observed that users get a good sense of immersion, and those who have visited Petra report that using the system is similar to being at the actual site. We have also observed that, because the temple is large, users need to look up to see important parts. In our Cave this is problematic because the ceiling is not a display surface. One of the main problems we have detected is that scale is hard to convey accurately. We are currently developing a pilot user study to compare how important this factor is in the different platforms and how it affects the archaeologists studying the site.

The system we have described allows archaeologists to preserve and visualize the data they collect in a 3D environment. It enables them to better understand the context of the excavation data and gain freedom of movement through the dataset (i.e., site, trenches, trench layers, architecture and artifacts). It is also significant because it allows the user to easily manipulate objects and variables and query information for analysis.

References. [1] Joukowsky, Martha S., Petra Great Temple: Volume I: Brown University Excavations 1993-1997, E.A. Johnson Company, USA. 1998.

[2] Bowman, Doug A., Interaction Techniques for Common Tasks in Immersive Virtual Environments - Design, Evaluation and Application, PhD Dissertation, Georgia Tech., 1999.

[3] Brooks, Frederic P., What's Real About Virtual Reality, IEEE CG&A, December 1999, 16-27.

[4] Crescioli, M. and Niccolucci, F., P.E.T.R.A.-Data: an Integrated Environment for Archaeological Data Processing, New Techniques for Old Times: Computer Applications and Quantitative Methods in Archaeology, Proceedings of the 26th Conference, Barcelona, March 1998. BAR International Series 757, 133-134.

[5] Forte, Maurizio, About Virtual Archaeology: Disorders, Cognitive Interactions and Virtuality, BAR International Series 843, Archaeopress, England, 2000, 247-259.

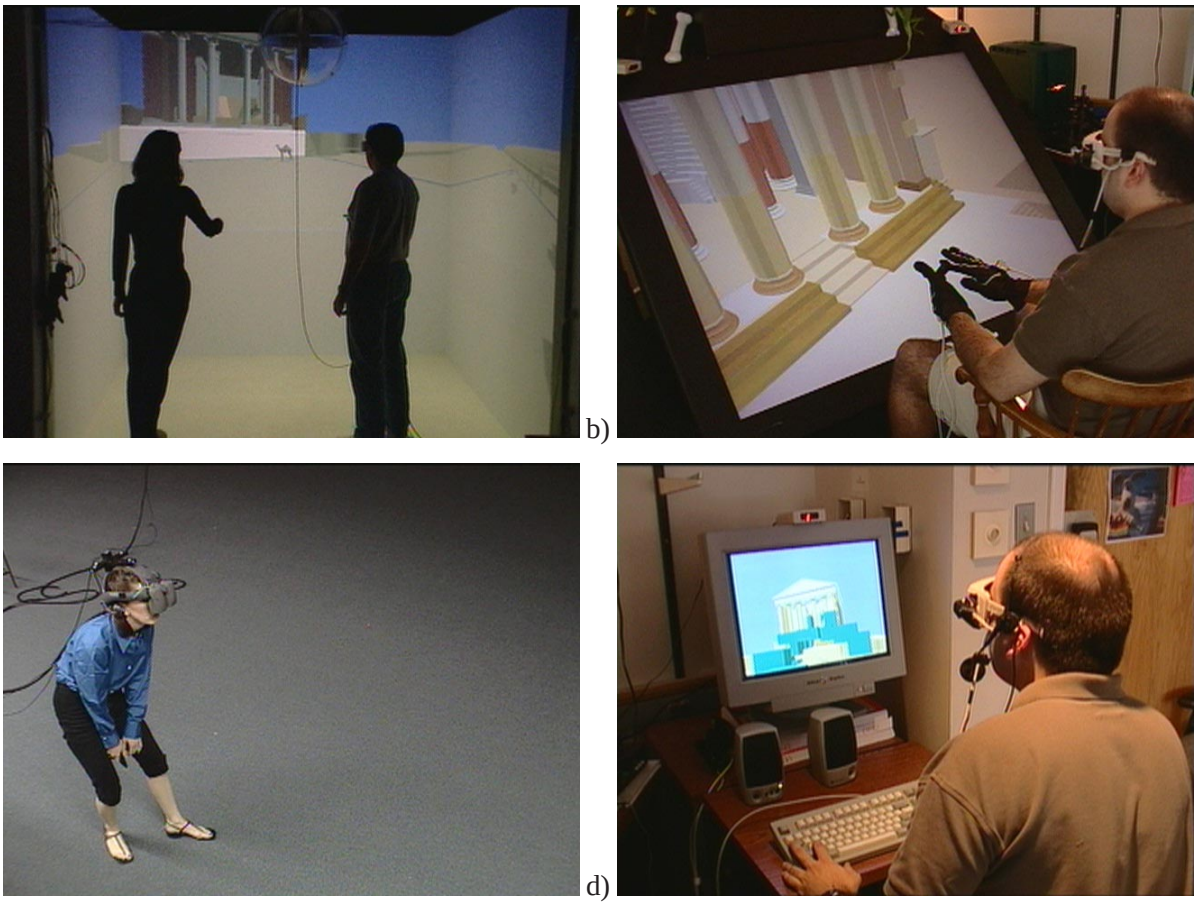

Fig. 1. ARCHAVE runs in different virtual environments: a) Cave, b) Barco Baron table, c) Head-mounted display and d) Desktop. This will allow us to test their relative merits for archaeological tasks.

Fig. 2. The user can simultaneously plot two artifact concentrations over the layers of one of the excavation trenches. The system provides the adequate framework to evaluate new data visualization methods and navigation techniques in information-rich environments like the virtual Great Temple of Petra site.