4th International Symposium on Virtual Reality, Archaeology and Intelligent Cultural Heritage
(2003), pp. 1–6
D. Arnold, A. Chalmers, F. Niccolucci (Editors)

# Presenting Past and Present of an Archaeological Site in the Virtual Showcase

Florian Ledermann and Dieter Schmalstieg

Interactive Media Systems Group,
Vienna University of Technology
{ledermann | schmalstieg}@ims.tuwien.ac.at

**Abstract**

*In this paper, we present our effort to use augmented reality technology to present an archaeological site inside the "Virtual Showcase". A real scale model of the ruin of the roman "Heidentor" is complemented with virtual overlays to provide the visitor with additional information about the exhibit and interact with it in various ways. Using an authoring framework developed by us, it is possible to create complex interactive presentations that allow the visitor to explore different paths of a story about the history of the building.*

Categories and Subject Descriptors (according to ACM CCS): H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems—Artificial, augmented, and virtual realities
General Terms: Human Factors, Verification

## 1. Introduction

Archaeological sites and exhibits are static by nature, and presenting them and their history to a public audience always involves additional media to add information about their original state and the findings of the researchers working on the site. For presenting whole buildings or even historical settlements and towns, two approaches are possible: to have the visitors walk around on the site and examine its remains by themselves, or to present an overview of the findings on maps and scale models.

The first approach offers visitors a more direct impression of the dimension and environment of the findings, and also offers a lot more space for placing additional information to accompany them. Of course, this requires visitors to travel to the site themselves, but they are rewarded with a unique impression and possibly a nice day in the countryside. A lot of work has been done trying to improve the experience of outdoor archaeological sites, and to build information systems to make additional information available to the visitors [8, 9, 10]. Some sites hire actors to walk around in historical costumes, or perform historical plays to recreate the atmosphere of the time when the buildings were used. The visitors can imagine to be part of a *story* happening long time in the past.

Presenting archaeology with scale models and replicas will never create the same fascination as wandering around in such an ancient ruin. However, there are several advantages that sometimes make it the preferred or single possible solution. First of all, a model can be transported to any destination with reasonable cost, and it might be replicated to create additional exhibits. On a perceptual side, maps and models give an overview of the whole building or area, and allow the illustration of abstract information such as traffic routes, dedication of different buildings or parts of a building, reconstructions of borders and many more. Recently, computer animation and virtual reality technology has been widely used to create impressive presentations about the background and history of such sites. However, these movies and images always exist on seperate displays, offering very limited interaction possibilities and making it neccessary for the visitors to switch between the models and artifacts presented in showcases and the multimedia content shown on monitors and billboards. Although the quality of rendered images has increased dramatically over the last years, real models and artifacts are still unsurpassed in terms of visual quality and intelligibility.

The "Virtual Showcase" allows us to overlay static exhibits inside a showcase with three-dimensional computer graphics and multimedia content, sharing the same space. Presentations running inside the showcase can add a layer of dynamics and interactivity to the otherwise static exhibits, to create an exciting atmoshpere and tell stories about the findings. These interactive presentations motivate the visitors to explore the subject on their own, and combine the advantages of traditional museum showcases and virtual reality presentations.

In the following sections, we present ongoing work on an archaeological presentation inside the virtual showcase. This is still work in progress, but we hope to be able to already provide interesting insights to the possibilities of enhancing exhibits with interactive virtual storytelling.

## 2. The Virtual Showcase

The Virtual Showcase [1, 3] (Fig. 1) is an assembly of monitors and half-silvered mirrors, accompanied by tracked shutterglasses and interaction devices, that allows to augment the space within its glass casing with high-quality stereo computer graphics.

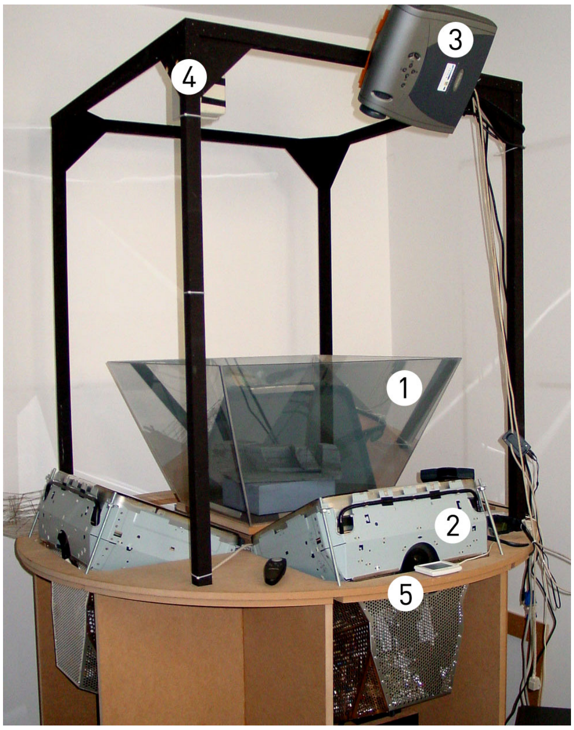


**Figure 1:** *The Virtual Showcase in our lab setup. The indicated parts are (1) half-silvered mirrors, (2) monitor for image generation, (3) light projector, (4) tracking system, (5) touch-pad for user interaction*

The half-silvered mirrors reflect the high-resolution images from the monitors, to create a virtual image plane inside the showcase. By using frame-interleaved stero imagery and tracked shutterglasses, a truly 3-dimensional image can be generated and aligned with the real content of the showcase. Since the eye position of the user must be measured to render the images perspectively correct, we use a tracking system for locating the shutterglasses to calculate the viewpoint of the user. In our setup, the virtual showcase can provide up to four users at a time with stereographic images.

In addition to the graphics displayed by the monitors, we use a projector to illuminate the contents of the showcase [2]. Therefore, we can control the lighting of the real objects on a per-pixel basis, and hide or highlight parts of the exhibits by rendering the appropriate lighting directly onto their surface. Against a constantly lit background, the reflected virtual images look semi-transparent and often lack contrast and saturation. By selectively darkening the parts of the background that are "hidden" by virtual objects, we can further increase the overall visual quality and give an even more realistic look to the virtual parts of the presentation.

## 3. The Heidentor presentation

The Heidentor (Heathen Gate) [4] is an ancient roman ruin, located in Petronell-Carnuntum/Austria, and probably the most well known roman ruin in Austria (Fig. 2). Originally, the Heidentor was not a gate, but it had 4 pylons forming a so called tetrapylum, a double-passage arc, located at the intersection of two major roads. The pylons were supporting a 2-floor building on top of them. Today, only 2 of the pylons are still intact, and form an impressive, gate-like ruin that is visible from far away. The exact purpose of the Heidentor remains unclear; it might have been a tomb or a triumphal arch. Due to its impressive size and location in the countryside, it has inspired artists and storytellers over the last centuries and a lot of myths center around this historical site.

**Figure 2:** *The Heidentor ruin, located in Carnuntum/Austria. A low-tech augmenteation device is used on site to show a possible reconstruction of its original state.*

For the virtual showcase, we have built a scale model of the current Heidentor ruin, to be augmented with additional explanations and reconstructions of the original building. The focus of this presentation lies on user interaction; users should be able to interactively explore the model and discover explanations about the historical facts as they go along. As the presentation is targeted towards a younger audience, the interactive features should help to gain attention and raise interest in the subject by offering the possibility to explore it individually instead of just watching a linear presentation.

The scale model was built out of cardboard based on exact archaeological plans and measurements. It was then laser-scanned to obtain a virtual model, around which the presentation was constructed. A virtual model of the real object is also necessary to render the parts of the virtual content, that appear behind of the model, correctly. For the virtual part of the presentation, we use two different historical reconstructions of the original building, as well as photographs, sketches and a video to show to the user.

As the visitor approaches the exhibit, she is introduced to the subject by an animated virtual character (Fig. 3). The character tries to get the attention of the visitor, and presents the model of the ruin inside the showcase. After a basic introduction, the visitor can either use virtual buttons to advance the presentation in a linear fashion, or use the provided tools for interactive exploration to get additional explanations for certain parts of the building.


**Figure 3:** *An animated virtual character introduces the Heidentor.*

Since the model is enclosed inside the showcase, visitors cannot interact directly in the space of the model. Instead, we use a virtual laser pointer to enable users to point at parts of the model that they are interested in (Fig. 4). When a part is selected, it is highlighted and the appropriate information is shown. This might be an image or a video displayed on a plane inside the showcase, possibly accompanied by audio commentary, or a whole scene involving virtual actors and audiovisual information.

Another possibility for user interaction is the use of a virtual clipping plane, to "cut away" the virtual model and make the real model underneath it visible (Fig. 5). This helps the visitors understand the relationships between the ruin that can be seen today, and the original state of the building. The same technique can also be used to blend between and compare different possible reconstructions of the same building.

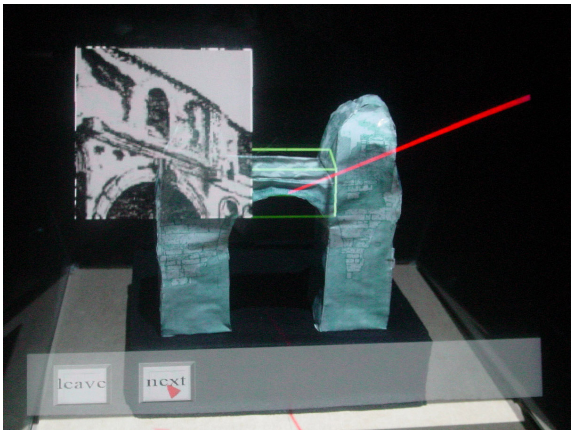


**Figure 4:** *Using a virtual laser pointer to explore additional information. Here, a sketch of the reconstruction of a similar building is shown.*

In the future, we want to include human-like actors scaled correctly to recreate a historic scene that could have taken place at the Heidentor.


**Figure 5:** *Blending between the real model and its reconstruction with a virtual clipping plane.*

## 4. Authoring Presentations

The interactive presentation is authored and controlled using an authoring framework developed by our group, called APRIL [5]. APRIL provides concepts for hardware-configuration, story authoring, animation and interaction in an XML-based file format, easy to use also by non-experts in computer graphics or programming.

### 4.1. Interaction

For interacting with a volumentric display like the virtual showcase, Balakrishnan et al. [7] list a wealth of possible interaction tools and techniques. The list of interactions that proved to be useful, sufficiently robust and easy to learn, given the target location in a museum, is quite short after exploring and evaluating a lot of possibilities. The types of user interaction directly supported by our interaction toolkit are:

- *Head tracking*
  A central component of all VS installations is tracking the users head and rendering the graphics displayed dependent on the users estimated eye point position. Head tracking can also be used for detecting new users approaching the installation, and, for example, triggering a restart of the presentation.
- *Buttons*
  Buttons are the most basic hardware interaction tools that can be used in a VS installation, but due to their robustness and versatility are a very important interaction tool for presentations. Buttons can be used as simple presentation controls (“next scene”, “previous scene”), but can also change behavior depending on the context of the presentation. Buttons can also be hidden under the carpet or realized as photo-sensors to detect the user’s movement. In addition, buttons can be easily simulated by rendering them onto the display surface, if the presentation runs on different hardware setup with fewer or no hardware buttons installed.
- *Hotspots*
  Hotspots are “virtual buttons” in presentation space - they might be parts of the real or virtual content of the presentation, and mark significant parts of an artifact that might be selected by the user. The normal scenario would be that additional information about parts of an object is displayed when the user selects it. Note that, because hotspots are located in presentation space, and are therefore behind the half-silvered mirror optics of the showcase, no direct interaction (e.g. pointing) is possible - the user has to use indirect pointing techniques (see below) to be able to select them.
- *2D Pointing*
  2D Pointing is realized by connecting a trackball or trackpad to the showcase, that can be used like a normal computer mouse to perform 2D input and pointing. The 2D input can be either used directly to select virtual buttons or other 2D user interface components on screen, or it can be mapped to a plane in 3D space to perform constrained 3D input in presentation space - for example, to select hotspots located at the ground plane of the showcase, to choose between various artifacts displayed inside the showcase. This could be used on maps of whole sites to select single buildings or locations.
- *3D Remote Pointing (Raypicking)*
  Since it is not possible to reach inside the showcase and interact directly in presentation space, we have to use remote pointing techniques to freely select objects or hotspots in the showcase. Remote pointing is realized by using a laser pointer metaphor, selecting the nearest object that is intersected by the beam. By using this technique, users can intuitively and precisely point at parts of the presentation.
- *Timeouts*
  Besides direct user interaction, also the absence of user actions can be used to drive presentations. We provide a timeout mechanism, to be able to trigger events if for a certain period of time, no significant user interaction took place.

### 4.2. The Story

Because of its operation in a public setting with possibly untrained visitors, interaction tools that can be used for VS installations are limited to very simple, robust ones. However, we want to drive complex, interactive presentations with these tools.

To overcome this apparent contradiction, we introduced the concept of state-engine driven stories. The “story” of the presentation is represented as a hierarchical state-engine, where states represent behaviors exposed by the components of the presentation, and transitions denote possible user interactions (Fig. 6). Within a state, objects in the scene can be shown or hidden, changing position or size, or lighting effects can be triggered by using a simple animation syntax. Transitions in the story can be bound to any of the interaction tools listed above; if a transition is bound to a button, for example, this would mean that if the story is currently in the source state of the transition, pressing the button would trigger a transition to the destination state, and all the behaviors defined there would be played back.

Modelling the presentation as a state engine allows users to walk through multiple paths of a complex, nonlinear story by using comparably simple interaction tools. This encourages visitors of the Heidentor presentation to leave the linear path of the presentation, and start exploring the exhibit on their own, with the environment reacting accordingly to their actions.

## 5. Future Work

At the moment, the Heidentor presentation follows a comparatively simple storyline, and only the basic content has

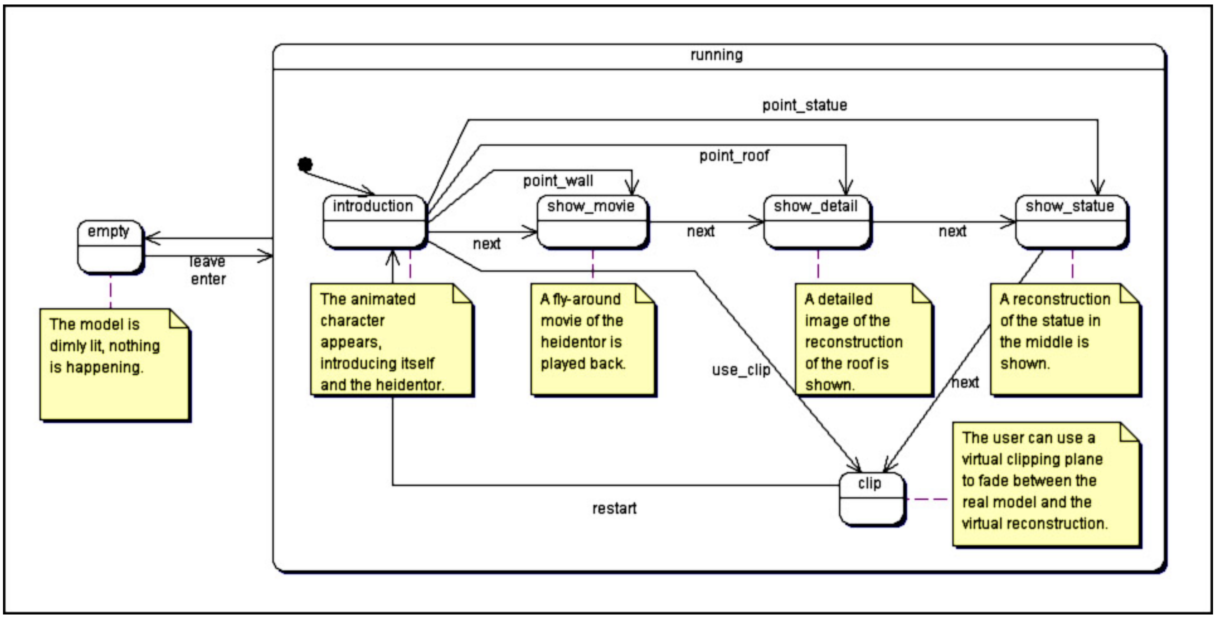


**Figure 6:** *The Heidentor presentation, modelled as a hierarchical state machine. Nodes in the graph represent behaviors, edges represent possible user interaction.*

been created. With the help of our authoring framework, we hope to be able to rapidly develop this presentation into an immersive story, without any programming skills required to create complex interaction possibilities.

By simply changing the mapping of transitions to interaction tools, the same presentation can be run in different modes – a fully interactive presentation for younger audiences, and a linear, movie-like presentation driven by timers and automatic transitions, if no interaction tools are available. Because APRIL separates presentation content and hardware configurations, the story developed for the virtual showcase could then also be run outdoors at the real location, using outdoor AR equipment [6] and GPS tracking of the participants.

## Acknowledgements

This research was funded in part by the EU IST contract IST-2000-28610 “Virtual Showcases”, and Vienna University of Technology contract GZ9006.10/003/2001. The “Ippy” character is used by courtesy of Imagination Computer Services GesmbH, Vienna. 3D scanning provided by the innovative project ’3D technology’ of Vienna University of Technology.

## References

1. Bimber, O., Fröhlich, B., Schmalstieg, D., and Encarnação, L.M., “The Virtual Showcase”, *IEEE Computer Graphics & Applications*, vol. 21, no. 6, pp. 48-55, 2001.
2. Bimber, O. and Fröhlich, B., “Occlusion Shadows: Using Projected Light to Generate Realistic Occlusion Effects for View-Dependent Optical See-Through Displays.”, *Proceedings of International Symposium on Mixed and Augmented Reality (ISMAR’02)*, 2002.
3. Bimber, O., Encarnação, L.M., and Schmalstieg, D., “The Virtual Showcase as a new Platform for Augmented Reality Digital Storytelling”, *9. Eurographics Workshop on Virtual Environments*, The Eurographics Association, 2003.
4. Jobst, W., “Das Heidentor von Carnuntum”, *Verlag der Österreichischen Akademie der Wissenschaften*, Vienna 2001.
5. Ledermann, F., “APRIL - The Augmented Presentation and Interaction Language”, *http://www.studierstube.org/APRIL*, 2003.
6. Reitmayr G., Schmalstieg D., “Mobile Collabora-

tive Augmented Reality”, *Proceedings of International Symposium on Augmented Reality (ISAR’01)*, 2001.

7. Balakrishnan, R., Fitzmaurice, G.W., Kurtenbach, G., “User interfaces for volumetric displays”, *IEEE Computer*, March 2001, p. 37-45.

8. Vlahakis, V. et. al., “Archeoguide: first results of an augmented reality, mobile computing system in cultural heritage sites”, *Proceedings of the 2001 conference on Virtual reality, archeology, and cultural heritage*, pp. 131-140, 2001.

9. Kretschmer, U. et. al., “Meeting the spirit of history”, *Proceedings of the 2001 conference on Virtual reality, archeology, and cultural heritage*, pp. 141-152, 2001.

10. Hall, T. et. al., “The visitor as virtual archaeologist: explorations in mixed reality technology to enhance educational and social interaction in the museum”, *Proceedings of the 2001 conference on Virtual reality, archeology, and cultural heritage*, pp. 141-152, 2001.