White Water Shaker Village: Exploring Historical Photographs as Data Sources for Virtual Reconstructions

Jose M. Kozan and Iara Beduschi Kozan

University of Cincinnati
Cincinnati, OH, USA
kozanj@uc.edu

Abstract

This paper presents the results of the digital reconstruction of a section of the White Water Shaker Village as it was in mid-19th century, featuring buildings, landscape settings, and the main meeting space of the community. The three-dimensional modeling process focused on references from historical images with support of a photographic site survey. In the absence of archaeological and documented data, historical photographs provided unique information about the probable original dimensions of one vanished structure, and enabled visualization of previous formal features of the extant buildings and surrounding topography. Photogrammetry was employed to produce as-built elevations of the remaining structures, and to determine unknown building dimensions. The computer generated imagery was presented in multiple formats, providing visualizations through still images, animations, cubic Quicktime Virtual Reality (QTVR) panoramas, and synchronized panoramas, and as the major element in a sequence of videos introducing the village's history and culture.

1 Introduction

Since the pioneer work of Meydenbauer with architectural photogrammetry (Bräuer-Burchardt and Voss 2001a:1), historical photographs have proven to be fertile sources of the unknown dimensions of partially or completely destroyed buildings. The use of such images by virtual heritage reconstruction projects, and the acknowledgment that photographic records are incomparably objective documents (Wiedemann et al. 2000:7), demonstrate established scientific confidence in photogrammetric processes today. The advent of digital photogrammetry, with low-cost, off-the-shelf solutions, has helped disseminate the use of the technology by professionals interested in the geometric documentation and reconstruction of cultural heritage.

The virtual reconstruction of White Water Shaker Village followed this tradition and adopted a computer aided design (CAD)-based photogrammetry system to produce updated architectural drawings for the buildings, aiming to provide a satisfactory response for inquiries concerning the origin and reliability of the information supplied by the data sources. The research combined the extraction of data from rectified photographs with analysis of high-resolution historical imagery in a procedure that converged information from multiple images into a unique set of drawings. The process transformed photographic records into architectural data to support the reconstruction of the probable appearance of the village's early structures from the mid 1800s.

1.1 Project Overview

The Center for the Electronic Reconstruction of Historical and Archaeological Sites (CERHAS–University of Cincinnati) was called in by the Friends of White Water Shaker Village, a citizen group concerned about the future of the village. To further the Friends' goals of public education, publicity, and support for the restoration and preservation of the remaining buildings and lands, a prototype program was produced containing a sequence of short videos narrating aspects of the village's architecture, culture, and historical evolution. The main component of the narrative comprised imagery from the digital recreation of the village during the Shaker years. The initial goal for distributing the content via the Web and through a CD-ROM was later expanded to include the production of a DVD.

The project produced photorealistic rendered images from a digital model of a section of the village: the northernmost portion of the site, called the North Family. The area was the first to be occupied by the Shakers in White Water and contains the best preserved constructions. It is also the original location of structures that have long been demolished. Four buildings and one internal space were included in the scope of the three-dimensional (3D) modeling: the exterior and interior of the Meeting House; the North Family Dwelling House with its nearby Woodshed; and the Sisters' Shop, now destroyed. The digital work focused on recreating the probable appearance of the buildings and surroundings in the mid-19th century, after the completion of the very first structures on the site. The analysis of a set of three historical photographs provided evidence about previous architectural features of the selected buildings, and allowed us to establish the probable original dimensions of one demolished structure.

1.2 Site Background

The Shakers were a religious society that originated in England but flourished in the United States from 1774 through the early 20th century, establishing communities first in the Northeast and later in the Midwest (Nicoletta 1996). They were known as the United Society of Believers in Christ's Second Appearing and were nicknamed Shaking

Quakers, or Shakers, due to their shaking dances during communal spiritual worship services (Schiffer 1979:5).

White Water Shaker Village was established in 1824 in southwestern Ohio. The community was divided into three "families," following the Shakers' tradition of building a series of integrated structures, including workshops, dwelling houses, barns, mills, and a meeting house in 1827 (Schiffer 1979:179). From the original structures built on the site (Figure 1) only a small number remains (Figure 2), and even these have been altered and used in diverse ways since the Shakers left in the early 1900s.

Several parcels of the original Shaker lands were sold to private owners, although much of the village now belongs to the Hamilton County Parks District. The existing Shaker buildings are not open to public visitation, though the Parks District is currently developing a strategy to preserve and restore the remaining structures.

Figure 1. North Family buildings in the 19th century.

Figure 2. Current view of the Meeting House.

2 Project Data

Virtual reconstruction projects share the same basic requirements for numerical values or proportions to build digital representations of sites, buildings, and artifacts. The dimensional data may be directly found in sources like drawings and texts, or may be present but not immediately available, as in photographs. In some cases the data are nonexistent and need to be created through further processes, such as analogies and deductions, to determine probable original dimensions or geometric configurations.

2.1 Data Sources

The White Water reconstruction depended on all the data sources listed above to generate a complete 3D model of the selected portion of the village. The data originated as follows:

- *Direct access*: Architectural drawings dating from the 1990s were located for two out of the four existing buildings, the Dwelling House and Woodshed, portraying as-built conditions. A manual site survey provided dimensions of the Meeting House interior and the exteriors of the three extant buildings, plus the structures' locations on the site, and topographic references. Also, the Friends of White Water Shaker Village provided the color reference for the interior of the Meeting House. Later in the project, the existing drawings of the Dwelling House and Woodshed were reviewed and replaced by new, more accurate 2D drawings, matching the precision criteria for the project.
- *Indirect access*: The design features of three façades of the vanished Sisters' Shop were derived from the photogrammetric evaluation of the old photographs. The historical images also provided visual evidence for retrieving the features of all buildings' façades in the mid-19th century.
- *Process based*: In cases where no sources supplied information to reconstruct architectural attributes, the project applied analogy with similar Shaker buildings, and deduction based on known aspects of other façades in the same building. This procedure was used for the west façade of the Sisters' Shop, and portions of the north and south façades of the Woodshed.

2.2 Data Processing

A key objective in the Shaker project was attaining results based on a well founded set of drawings. Photogrammetry provides the necessary technical objectivity to build accurate references to the model (Wiedmann 1997:4). Besides bestowing scientific credibility on a 3D reconstruction, the photogrammetric process constitutes a practical tool that allows a modeler to extract additional building measurements without further site visits. The complete geometry of the structures becomes available after the rectified photographs are produced.

The production of scaled images used Photoplan, an AutoCAD plug-in, followed by the non-automated extraction of architectural features, which generated the façade drawings for all buildings. These drawings were adapted to the buildings' appearance in the mid 1800s by the addition or suppression of elements after the analysis of digitally enhanced versions of the historical images.

The following is an example of the design decisions applied to the Dwelling House to recreate its 19th century features (Figure 4):

- *Removed*: East and West porches, annex to the North façade, chimney metal caps, the wooden connector to the woodshed, and wood panels in the roof tower (Figure 3).
- *Replaced*: masonry stairs with wooden steps, four-subdivision window panels with twelve-subdivision windows, asphalt roof with wood shingles, and modern doorknobs with 19th century door hardware (Schiffer 1979:46).
- *Added*: basement entrance in the North façade, window shutters, bell to the tower, double wood handrails at the front entrance, a single wood handrail at the rear entrance, and windows in the North façade.

The scale for the Sister's Shop image rectification derived from an analogy with elements of the neighboring buildings, as suggested by Hemmleb (1999:1). The measurements of a typical window from the second floor of the Dwelling House provided the necessary data to calculate the dimensions of the front and lateral façades of the vanished structure. Three images were submitted to digital rectification, although only one allowed unobstructed visualization of the building (Figure 5). As the results confirmed that the dimensions of the Sisters' Shop front door were coinciding with those of the Dwelling House rear door, the window analogy was accepted as valid for the scale reference. According to Bräuer-Burchardt and Voss (2001b:10) it is difficult to determine the precision of the measurements in rectified photographs of vanished buildings. In the case of the Sisters' Shop (Figure 6), the accuracy of the results may be evaluated after archaeological investigation of the site or in the event of finding new documented data.

3 Modeling

The 3D work followed some basic principles established in earlier stages of the project. The modeling goals aimed at providing support for future site investigation and virtual reconstruction of other sections of the village by:

- Creating a realistic 3D model recapturing the original Shaker presence on the site.
- Using accurate data for the proposed reconstruction period.
- Providing scientific credibility for the virtual reconstruction at site and building levels.
- Allowing future development of the project based on a reliable dataset.

The buildings and terrain were modeled in AutoCAD and exported as 3DS files for additional tasks of surface texturing, lighting, animating and rendering, developed in Lightwave.

Figure 3. Dwelling House at present.

Figure 4. Dwelling House with 19th century configuration.

Figure 5. Sisters' Shop rectified photograph.

Figure 6. Reconstruction of the demolished Sisters' Shop.

Figure 7. Meeting House interior: virtual reconstruction with 19th century configuration, in the early 20th century, and in 2004.

The base textures for the external walls, pavement, roofs, woodwork and terrain were produced in Photoshop. The brick texture originated from site photographs, matching the specific pattern presented by each building façade.

The landscape became a major component in the model, because photorealistic images could greatly enhance the atmosphere we wanted to convey in the accompanying audio storytelling about the village's history (Figure 10). At first we adopted the usual "summer look," with greenish grass and leafy trees positioned and scaled according to characteristics observed in the historical photographs. The results were satisfactory in relation to realism, but the foli age of the trees inhibited a satisfactory view of the buildings. After some experiments we decided to adopt more unusual wintry surroundings for the village, removing the leaves from the trees, and covering the ground with sparse grass and snow. This solution kept the desired realist effect and provided optimum camera viewpoints throughout the site. The current data for the topography was adapted to correspond to the conditions depicted in the historical photographs.

The communal space of the Meeting House (Figure 7) was recreated after site measurements and analysis of a set of photographs taken by Ray Pearson shortly after the Shakers left the village. The interior features of the ground level were extensively modified over the years. The wide open space used by the Shakers for their religious activities and celebrations was subdivided and adapted to accommodate a kitchen, dining and living room, with additional electrical outlets and other modern necessities. The digital reconstruction restored the original configuration of the substantially modified woodwork with its characteristic pegs around the wall perimeter. The meeting space was furnished according to descriptions in text references, while conventional clothing and round sconces were placed along the walls following the Shaker tradition.

4 Visualization Outputs

The Shaker project produced a sequence of still images and animations of the 3D model which were assembled in a sequence of narrated videos presenting historical and recent photographs, graphics, and Shaker music. The product is intended to be available for Internet download and as a CD-ROM (Figure 8) for targeted distribution. The total length of the four videos is approximately of 8.5 minutes, showcasing the buildings and introducing the village's most remarkable features. The video editing work used Premiere Pro with additional support of After Effects, and Audition for audio production.

The program is interactive, allowing the user to play all the content in a pre-programmed sequence or to create a viewing order by clicking on a building (CD-ROM), or selecting the building name (DVD). The CD-ROM interface was developed with Macromedia Director, while the DVD was authored with Encore DVD. Our experience demonstrated that the DVD format had wider public acceptance due to its broader compatibility with home DVD players and computer DVD playback.

During the project development, a review of visualization formats pointed to other possible outcomes for the imagery generated from the 3D model. Due to the high polygon nature of the built geometry, real-time options were discarded and only pre-rendered alternatives were evaluated. The following are some alternatives selected to present the project results:

- Cubic panoramas using Quicktime Virtual Reality technology – QTVR (Figure 9).
- Panoramas based on the 3D model images (Figure 10) and on current photographs (Figure 11).
- Synchronized comparative panoramas developed in Macromedia Director showing in a split window the current village conditions and the historic village, as presented in the virtual reconstruction.
- A video clip: A Winter Day in White Water, a one minute segment presenting a series of selected animations with highlights of the virtual reconstruction.

5 Conclusions

The process applied to the Shaker village reconstruction confirmed that the analysis of historical photographs may provide unique data on previous site and building features, constituting a valid source either by direct examination or when submitted to a photogrammetric process.

The dynamic comparison side by side of the virtual reconstruction and present site conditions had an impact when presenting the project for the community, proving to be effective for demonstrating the damage inflicted on the structures, and stressing the need for alternatives to minimize a decay process under way. Such visualization of present conditions simultaneously with the simulated historical state requires a careful choice of the viewing angle. The two panoramas must look similar enough to enable the viewer to experience the images as different versions in time of the same scene.

Exploring additional visualization formats to disseminate virtual reconstruction results maximizes the potential benefits brought by a usually costly 3D modeling project. In many cases this added value may be gained easily through a fresh review of possible visualization alternatives for existing digital models of heritage sites.

Acknowledgements

The authors would like to thank Patrick Snadon for his contribution to this project on the topic of Shaker architecture, and Cathryn J. Long for her research on the history of White Water Shaker Village. We also thank the Hamilton County Park District for allowing access to the site and for sharing their archive. The project has been funded by the Friends of White Water Shaker Village and CERHAS – University of Cincinnati.

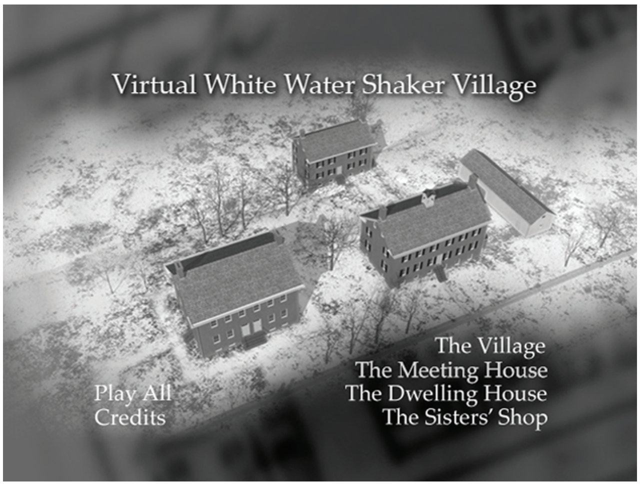

Figure 8 Menu of the DVD and CD-ROM.

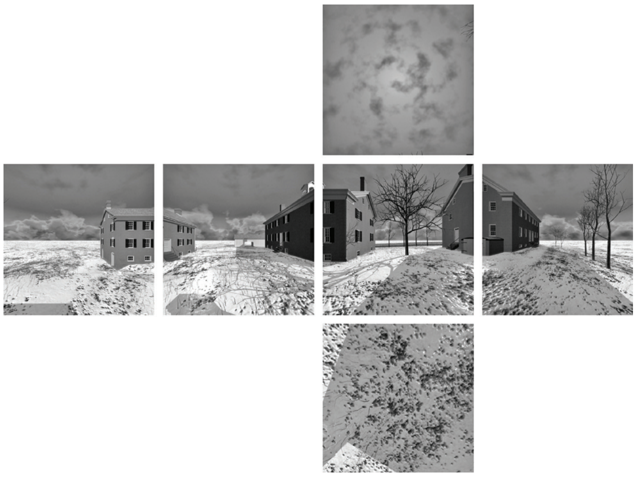

Figure 9 Rendered images for the cubic panorama.

Figure 10 3D model image used for the synchronized panorama.

Figure 11 Site image used for the synchronized panorama.

References Cited

Bräuer-Burchardt, C., and Voss, K. 2001a. Facade reconstruction of destroyed buildings using historical photographs. In, *CIPA 2001 International Symposium*, Potsdam, Germany. Electronic document, http://cipa.icomos.org/fileadmin/papers/potsdam/2001-22-cb04.pdf

Bräuer-Burchardt, C., and Voss, K. 2001b. Image rectification for reconstruction of destroyed buildings using single views. In, *VAA, International Symposium on Virtual and Augmented Architecture*, Dublin, Ireland. Electronic document, http://pandora.inf.uni-jena.de/cbb/Vaa.pdf

Hemmleb, M. 1999. Digital rectification of historical images. In, *CIPA International Symposium 1999*, Olinda, Brazil. Electronic document, http://cipa.icomos.org/fileadmin/papers/olinda/99c806.pdf

Nicoletta, Julie 1996. *The Architecture of the Shaker*. Woodstock: The Country Man Press, Inc.

Schiffer, Herbert F. 1979. *Shaker Architecture*. West Chester: Schiffer Publishing Ltd.

Wiedemann, A., Hemmleb, M., and Albertz, J. 2000. Reconstruction of historical buildings based on images from the Meydenbauer Archives. In, *IAPRS*, Vol. XXXIII, Amsterdam 2000, B5/2, pp. 887-893. Electronic document, http://www.fpk.tu-berlin.de/~albert/lit/isprs00.pdf

Wiedemann, A. 1997. Digital architectural photogrammetry for building registration. In, *Internationalen Kolloquium über Anwendungen der Informatik und Mathematik in Architektur und Bauwesen*, Weimar, Germany. Electronic document, http://www.fpk.tu-berlin.de/~albert/lit/IKM97.pdf