PASSING EXCELLENCE, THE INTERACTIVE ART VISUALIZATION OF THE KIZHI ENSEMBLE

D. Tsoupikova [a], Robert Kooima [a]

[a] Electronic Visualization Laboratory, University of Illinois at Chicago,
851 S. Morgan St. Rm. 1120 SEO, Chicago, IL, USA 60607-7053 – datsoupi@evl.uic.edu

KEY WORDS: Architecture, Cultural Heritage, Visualization, Virtual Reality, Computer graphics, Digital Reconstruction

ABSTRACT:

This paper describes the development of an artistic visualization project that restores the architectural history of the world famous wood churches and architectural museum, Kizhi. Kizhi is the architectural complex located on an island in Lake Onega in northern Karelia, Russia. The Church of Transfiguration, the Church of Intersession and the Belfry form the central part of the complex. The churches were built in harmony with the surrounding landscape and contain a priceless collection of icons and relics of Russian heritage. This historically important site is included in the List of Most Endangered Sites of the World Monuments Watch protected by World Heritage List of UNESCO. This project aims to restore the original architecture of Kizhi museum and to visualize the architectural changes of the museum area over the last 300 years. The visualization is being developed based on high resolution photographs, video surveys, textural data obtained during the initial visit of the site and resources from the Kizhi State Open-Air Museum archives. The project strives to capitalize on the advances of computer graphics technology and stereoscopic high-resolution display technology to advance the development of historical restoration in an artistic direction.

1. INTRODUCTION

1.1 History

The Kizhi site presents an authentic museum of an ancient wood building tradition and is an outstanding example of medieval and post-medieval orthodox settlements that present unique artistic achievement. Kizhi buildings are unique in that all joints and structural elements were made entirely from wood without the use of metal nails or ties (Fig. 1, 2).

Currently the Kizhi ensemble consists of the Church of the Transfiguration last remodeled in 1714, the Church of the Intercession remodeled in 1764 and the Belfry, an octagonal bell tower that was restored in 1874. The master carpenter Nestor reconstructed the Church of the Transfiguration during the reign of Peter the Great. An old legend tells that Nestor threw his axe into Lake Onega with the promise never to build another church because he was greatly astonished by the church he had created with God's help (Opolovnikov, 1989). The basis of the Church is the octagonal structure crowned by 22 domes each covered with aspen wood. Reflections of the various aspen

Figure 1. The Church of Transfiguration and the Belfry.

Figure 2. The domes of the Church of Transfiguration.

wood surfaces to the northern atmospheric light create a unique coloration effect. The aspen wood undergoes beautiful transitions in color cycling from golden and silver to black during the sunlight and sunset. The onion-shaped domes shine silver and reflect brilliant colors in the changing light. This effect gave "the fairy tale church" name to the Transfiguration because of its stunning beauty.

1.2 Concept

The focus of this project is to enliven the past centuries of the history of Kizhi in the form of an interactive high-resolution visualization. The objective is to restore the Kizhi site's original state to preserve its cultural value. The remote island of Kizhi is hardly accessible for global communication and tourism. The interiors of the Church of Transfiguration were closed since 1980. The current condition of the Church of the Transfiguration remains insecure and endangered. This project's animation and interactive visualization restores step by step the dynamics of the architectural changes of the ensemble interior, exterior and the Kizhi island in a real-time interactive 3-D environment based on the historical restoration and research. The visualization is being created based on high resolution photographs, architectural and geometric measurements, textural data, video surveys and resources taken during a visit to the Kizhi State Open-Air Museum and its archives in the summer of 2006. The obtained visual material is now being implemented in the design of the digital 3D model of the ensemble. The interactive digital visualization will make the past and present history of Kizhi's beauty accessible for a larger audience to share its cultural value and historical importance. I believe the preservation of these cultural objects in a digital format tailored for art, sceince and history fosters the trasmission of culture to future generations.

The project was inspired by the recent research and achievements of the Electronic Visualization Laboratory (EVL) in the field of interactive stereoscopic computer graphics and high-resolution VR and tiled graphic displays. The latest advances in electronic digital computer technology and high-resolution visualization display systems offer great possibilities for historic visualization. Computer generated interactive visualization can render highly dynamic and stunning realistic environments that closely reflect historic and architectural accuracy.

1.3 Historical Stages of Restoration

Kizhi architecture has undergone multiple changes over a period of more then 300 years. The visual look and feel of the original buildings and coloration of its wooden surfaces were altered by time, weather, deterioration, reconstruction, natural disasters such as fire and storm, and the introduction of new homes or wooden churches south of Kizhi Island. The project aims to visualize bygone architectural stages and show the historical stages of its restoration in a time-based sequence.

The first chronicles from 1496 did not mention the Belfry and described only the Church of the Transfiguration and the Church of the Intercession. The Belfry was first mentioned in 1616 describing "*wooden church with domed cover with bell tower and bells…*" This original site was lost due to a severe thunderstorm with lightning that caused a fire at the end of the 17th century. The only structure that has survived the fire was the old Belfry (Gushina, 2004; Krochin, 2006).

The first stage of restoration was to build churches in the same place from wooden logs. At that time there was a passage connecting the Belfry and the Church of the Transfiguration designed for communication during cold winters (Fig. 3). The Church of the Intercession was rebuilt three times: in 1694, in 1749 and in 1764. The new church consisted of two parts: for winter and for summer. However, stylistically it did not match the Church of the Transfiguration and the Belfry and had

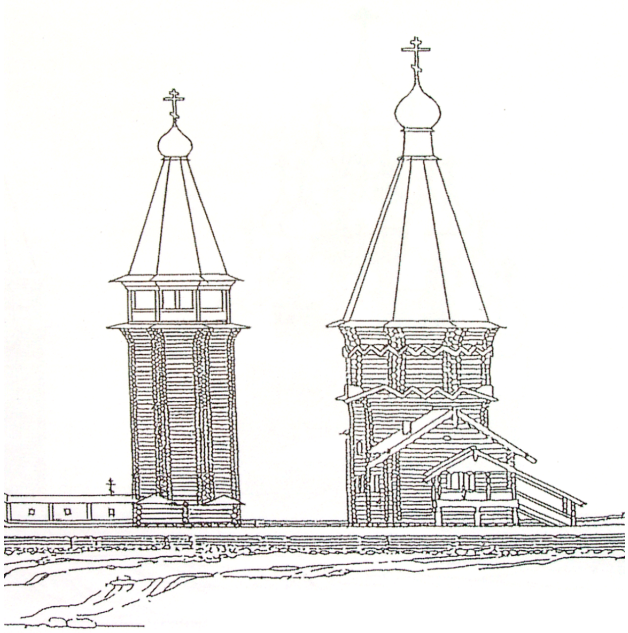

Figure 3. The Church of Intersession and the Belfry in1720. First stage of restoration. (Krochin, 2006).

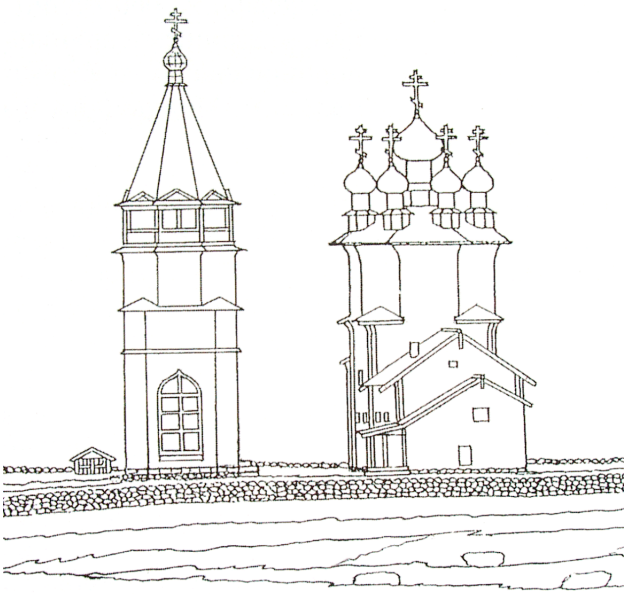

Figure 4. The Church of Intersession and the Belfry in 1874. Second stage of restoration. (Krochin, 2006)

previously undergone several architectural updates. The first update changed the roof to be covered by a single onion shaped dome in 1749. The second update covered the roof with nine domes in 1764. The nine domes organically united both churches into a harmonious and balanced ensemble. One of the view perspectives merges the Church of Transfiguration and the Church of Intersession into a single dome covered structure. The Church of the Transfiguration was rebuilt in 1714. Its structure remains the same even though the Church has undergone numerous restorations. The Belfry was rebuilt two times: in 1862 and in 1874. The last rebuilt defined the contemporary silhouette and stylistically united the Belfry with churches. At that time the Belfry was covered with plywood.

The second stage of restoration covered the Church of the Transfiguration with plywood and its domes with green-painted iron surfaces in 1818-1824. Later in 1865, the Church of the Intercession was also covered with plywood. In 1870 the walls of the Church of the Transfiguration were re-covered with fresh plywood coloured by white paint (Fig. 4). In 1871 its interior walls were covered with plywood and new floors were laid. The priceless masterpiece, the iconostasis of the Church of the Transfiguration consisting of icons and golden frames was disassembled During World War II. The top part of iconostasis called “the Sky” was lost to fire during the war. The rest of the icons were returned to the Kizhi museum in Petrozavodsk after the war in 1944. Shortly after Kizhi became a state reserve, the unique monuments of wooden architecture were transferred to the Kizhi area from nearby islands.

The third stage aimed to restore the original state of the Kizhi churches as they were built from the log structures in 1949-1959. All plywood covers and iron covers were removed from the exterior, interior and the domes. At the same time the iconostasis was restored in the Tretiakov Gallery in Moscow.

The fourth stage dismantled the iconostasis and installed a supporting metal frame inside the Church of the Transfiguration. Since that time the engineering repairs are being made to strengthen the Church of the Transfiguration.

2. DEVELOPMENT

2.1 Realization

This project is being developed using Electro, an application development environment for the tiled-display high-resolution graphics visualization system (Kooima, 2005). Tiled displays provide a remarkable high-resolution display environment that can be connected to the advanced network for fast data transmission. They allow interaction and real-time exploration of high-resolution imagery. Driven by the clusters of computers maximizing their computational performance, tiled displays enable artists and scientists to create real-time interactive networked applications comprised of gigabits of image, 3D, video and animation data. EVL Ph.D. doctoral candidate and computer scientist, Robert Kooima, designed the application development environment, Electro. Electro provides an easy-to-use scripting system for interactive 3-D applications spanning multiple processors and displays such as tiled display, Varrier and C-Wall (EVL, Varrier, C-Wall).

The development stages include the 3-D modeling and texturing of the current condition of the ensemble and the island landscape, the 3-D modeling and texturing of the selected stages in architectural reconstruction, animated historical evolution and the interactive application controlled by the user.

The 3-D models are being created using Autodesk Maya software. The modeling is based on high-resolution photographs taken during the initial island visit and architectural restoration plans from museum archives. The unclear measurement data is being calculated from various versions of restoration plans (Fig. 7, 8, 9). The size and proportion of the 3-D models are being built disregarding the symmetrical discrepancies caused by restoration and time (for example the original symmetry of the Church of the Transfiguration was lost through time despite a variety of interior and exterior support structures). 3-D models for visualization do not include the supporting structures, flaws of constructive logs, destroyed and lost details. The goal is to model the original proportional structures of the buildings designed with symmetrical balance. The details of the churches such as window frames, locks, utilitarian objects, and small details of construction are being generalized.

The textures are being developed based on the photographical data taken during the initial island visit (Fig. 5). The texture images are being digitally manipulated to leverage the lighting of the resulting textures to achieve accuracy in colour, resolution and the level of details. Montage techniques are being frequently used to reconstruct missing texture data on the photographs required for the power of two resulting images (Fig. 6).

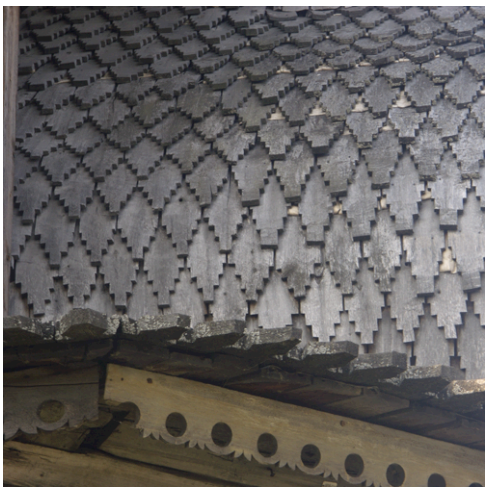

Figure 5. The photograph of the aspen wood surface (fragment).

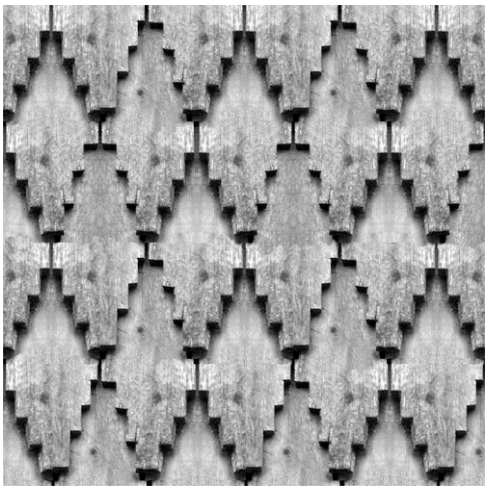

Figure 6. Finished texture for the aspen wood dome.

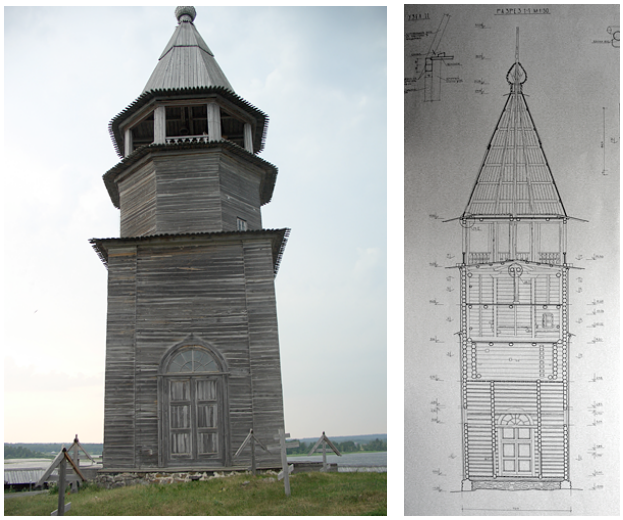

Figure 7. Belfry in 2006. The architectural plan of the Belfry.

The development of this project strives to capitalize on the latest achievements in computer graphics techniques such as pixel-controlled lighting and bump mapping. For precise light control and shading effects to render subsurface scattering effects and generate realistic images, designers utilize per-pixel lighting calculations. To recreate a detailed naturalistic surface of deteriorating wood and logs with maximum historic accuracy and photorealistic rendering bump mapping is used, a technique that simulates the bumps or wrinkles in a surface without the need for geometric modifications. These techniques can allow realistic re-creation of the material properties of the structures under different lighting effects.

2.2 Advancement

Design a 3-D models of the current architectural stages of the Church of the Transfiguration, the Church of the Intercession, the Belfry, and the surrounding territory enclosed in the wooden fence.

Design a 3-D model of the island terrain based on the topographical maps and archival plans.

Develop high-resolution exterior textures.

Figure 9. The 3-D model and textures of the Belfry (detail).

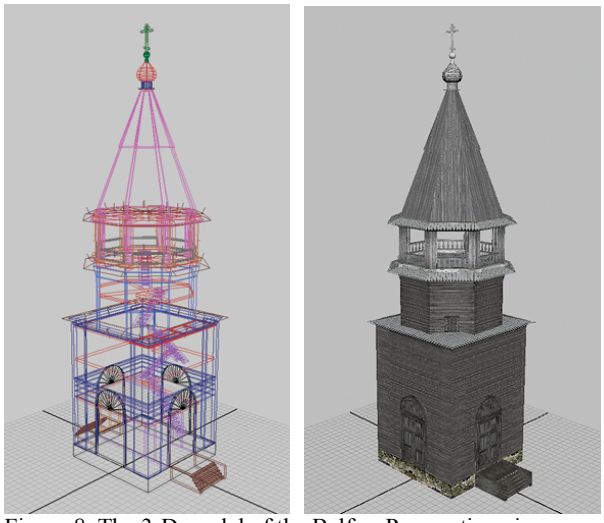

Figure 8. The 3-D model of the Belfry. Perspective view.

Develop high-resolution interior textures and 3-D models of utilitarian and interior objects.

Develop 3-D models of the churches according to the five stages of Kizhi historical restoration.

Develop animation unveiling the dynamics of the architectural changes on the museum area in the last six centuries.

Develop the interactive stereoscopic application for the museum and exhibition experience.

3. GOALS

This project was conceptualized to address several artistic, historical and cultural goals:

- Develop a virtual prototype of the current state of the Kizhi complex as an interactive 3-D environment.
- Develop a virtual model of bygone architecture of the Kizhi ensemble by reconstructing vanished structures; lost interiors, iconostasis and other related material.
- Create an animated stereoscopic visualization of the history of the Kizhi ensemble covering last 600 years.
- Create an interactive real-time application for the high-resolution tiled display and for the Varrier, a head-tracked autostereo virtual reality display.
- Share Kizhi's unique cultural heritage, beauty and dramatic history with the larger international community.
- Contribute to the international scientific restoration work of this site.
- Contribute to the body of knowledge about computer visualization and virtual reality for arts.

4. CONCLUSION

Recent advancements in computer graphics offer a new type of experience for history, art and education. Advanced digital networks provide a global digital space for interactive digital environments. They are fostering traditional museums to adopt the rapidly changing and growing digital space ensuring that our cultural record is being equitably accessible and becoming a part of the experience of future generations. The utilization of the latest research in computer graphics technology for artistic practice and historic restoration can foster the advancement of historic and cultural transmission.

4.1 References

References World Heritage Site
http://www.worldheritagesite.org/sites/kizhipogost.html
(accessed 6 May 2007)

UNESCO site
http://whc.unesco.org/pg.cfm?cid=31&id_site=544 (accessed 6 May 2007)

Opolovnikov A., 1989. *Treasures of Northern Russia*. Stroiizdat, Moscow.

Opolovnikov A., 1989. *The Wooden Architecture of Russia.* Harry N Abrams.

Gushina V., 2004. Transfiguration: 290 Anniversary of the Church of the Transfiguration in the Kizhi island. PIN, Petrozavodsk.

Krochin, V., 2006. New features in the formation of the Kizhi ensemble, PIN, Petrozavodsk.

Kizhi news, 2005. The Kizhi State Open-Air Museum of History, Architecture and Ethnograp, Science Center of Karelia RAN, Petrozavodsk.

Kooima, R., Electro documentation.
http://www.evl.uic.edu/rlk/electro/

EVL tiled display is 100-megapixel display, an11×5 array of 1600×1200 pixel LCDs.

Varrier™ is a head-tracked autostereo virtual reality display, which consists of 35 LCD panels tiled in a 7x5 configuration with a 6'x8' footprint. The display eliminates the need to wear special glasses to see the stereoscopic image, and yet still affords the user an effective sense of immersion.

The C-Wall or Configurable Wall is a high-quality, tracked, circularly polarized passive stereo wall based on the CAVELib™ software.

4.2 Acknowledgements

I would like to acknowledge my collaborator Robert Kooima for technical expertise, development contribution and active support of the project realization. Special thanks to personnel of the Kizhi State Open-Air Museum of History, Architecture and Ethnography and the KIZHI State Museum Archives, Fonds and the Computer Center for their generous support and help, historians and restoration specialists who inspired this article with their work; Averyanova Elvira, Director, Popov Uri, Melnikova Natalia, Lubimtsev Alexander, Koskanen Anna, Computer center : Titova Olga, Director, Archives and Fonds: Chernova Larisa, Nabokova Olga, Frolova Galina, Popova Ludmila, Charebova Ludmila, and also Nezvitskaia Tatiiana, Protasov Uri, Borobyeva Svetlana and many other specialists at the Museum.

We would like to acknowledge the support of the University of Illinois at Chicago's Electronic Visualization Laboratory (EVL), Office of the Vice Chancellor for Research and Institute for the Humanities at the University of Illinois at Chicago (OCVR-AAH), Kizhi State Open-Air Museum of History, Architecture and Ethnography, the Kizhi State Museum Archives. This material is based in part upon EVL work supported by the National Science Foundation (NSF), notably equipment awards CNS-0224306 and CNS-0420477 and international networking infrastructure awards OCI-0229642 and OCI-0441094.