~ ~ ~

The Virtual Historical Reconstruction
of the Trinity Church
in Yeniseisk City

Ruslan A. Baryshev*

Siberian Federal University
79 Svobodny, Krasnoyarsk, 660041 Russia [1]

The article describes the experience of creating a virtual historical reconstruction of the Trinity Church located in Yeniseisk, the oldest city in Central Siberia, as well as its history and specificity.

One of the main features of the article is the description of current trends in creating virtual historical reconstructions. One of them is the creation of virtual reconstructions as close to reality as it is required by the objectives of the project. This approach is in-demand in the industry of documentary films, historical programs, etc.

Another trend is to create virtual copies of the objects as realistically as possible. This approach is used widely throughout the scientific world because it allows to show the historical authenticity of the object.

The article describes the author's approach based on the synthesis of these two trends. Thus, the technology of the virtual reconstruction of the Trinity Church presented in the article is considered to be a combination of different methods, when a significant number of references and the exact reconstruction of all parts of the exterior on three-dimensional polygons define the historical authenticity of an architectural object, and the constant control over the number of polygons (vertices), and the use of the most effective tools help to create a relatively small reconstruction. This will allow us to use the resulting material as a basis for further visualization and research. For example, this approach allows us to apply the obtained models in the interactive applications with a real-time visualization.

The virtual reconstruction of the Trinity Church is available on the web-site of the Institute for the Humanities of the Siberian Federal University: sfu-kras.ru.

Keywords: Virtual reconstruction, virtual historical reconstruction, history of Central Siberia, virtualization, three-dimensional modeling, Orthodox Church architecture.

Methods

The virtual reconstruction of the Trinity Church (Yeniseisk) is performed by using the up-to-date software for three-dimensional modeling of complex architectural objects, including 1) Autodesk 3D Studio Max 2010, 2) Adobe Photoshop CS3; 3) V-ray RC.

References for the virtual reconstruction include historical references, architectural drawings, archaeological papers, historical

* Corresponding author E-mail address: r_baryshev@bk.ru

and contemporary photographs (excavation photographs) and actual measurements.

Introduction

The virtual reconstruction is one of the youngest and rapidly developing scientific and practical directions. It became popular in 1990 due to the emergence of specialised software, and now it appears as a fully developed industry.

Application of virtual reconstructions in the field of historical sciences in the West has its beginning in the early stage of its formation. In 1993, the researchers from Brown University (USA) were among the first to use specialised software for simulation of three-dimensional objects while excavating the St. Peter's Church in Jordan which lasted for ten years. They used a computer to restore the original appearance of the object (Curtis, 2002).

Since the 1990's of the 20th century foreign research teams have carried out several major studies on the reconstruction of historical and cultural heritage: the reconstruction of the Vatican Palace of the Renaissance (Thelen, 1998), the reconstruction of the Buddhist temple Sazaedo (Virtual Shikki, 1999), and similar studies are also being conducted in Germany, Poland, Italy, Great Britain, Switzerland and France (Steuer, 1992; Ryan, 1994; Friedman et al., 1998; Visnovcova, 2001).

In Russia the development of this field initially begins in the works of the specialists whose studies are not related to the Humanities: M.B. Ignatiev, N.N. Reshetnikova, A.V. Nikitin, etc. However, since 2003, the possibility of using three-dimensional modeling technology in historical research has been discussed by the specialists in the subject area (historians) (Kalnickaya, 2005).

Nevertheless, practical developments in the field of virtual historical reconstructions in Russia appeared only in the mid 2000s, for example, the reconstruction of the Illurat fortress (N.V. Borisov et al., 2007), the reconstruction of the Tambov wooden fortress built in the 17th century (D.I. Jerebyatev, 2007)., etc.

In general, we can speak about the growing international interest in the virtual reconstruction of the historical objects. It is explained by the update of methodological principles of historical knowledge, as well as by the tendency to maintain and update the historical and cultural heritage. In his report Bernard Smith, Head of the Department of Conservation and Enhancement of Cultural Heritage of the European Commission Directorate-General Information Society, indicates the significance of the introduction of modern information technology into historical and cultural studies (Smith, 2005).

At the present time it is difficult to assess objectively the state of scientific research within the scientific and practical direction of the virtual historical reconstruction. Today there is no single classification, virtual historical reconstructions are often divided according to the form of demonstration: static images, video presentations, interactive reconstructions; according to the technological base: two- or three-dimensional reconstructions; according to the content: popular science (e.g. for the BBC-History Channel), scientific research (creation of a mathematical model to test hypotheses and experiments), etc.

Most organizations involved in the industry of virtual historical reconstructions are located in the U.S. and Europe, that is why a number of major projects are implemented overseas, such as "Vizerra", an international gallery project of virtual reconstructions of historical and cultural heritage (*http://vizerra.com*); "Rome Reborn – virtual reconstruction of ancient Rome" (*http://www.romereborn.virginia.edu*); "Reconstruction of the Moscow Kremlin" – a project created with the participation of experts from Germany (*http://www.kreml.ru*).

In Russia the field associated with the methodology for construction and visual representation of virtual reconstructions is developing in the major capital research and educational centres: Moscow State University, St. Petersburg State University, St. Petersburg State Polytechnic University, as for the regional experience in this area, it is more than modest.

Taking into consideration that the foundation of this area is a product of many sciences, primarily of history, archeology, architecture and computer science, requiring complex interdisciplinary (often financially costly) approaches, only "important" objects of historical and cultural heritage are chosen for reconstruction. One of these objects is the Trinity Church located in Yeniseisk.

Yeniseisk is the oldest city in Central Siberia (founded in 1619). Over the past three centuries (until 1900) it has been a cultural, industrial and gold mining centre of the Yeniseisk province. At present Yeniseisk is one of 116 cities in Russia that are famous for their monuments and is included in the UNESCO's provisional list of historical heritage. The Orthodox churches hold a special place in the architectural appearance of the city. At the beginning of the 20th century there were six parishes in the territory of Yeniseisk: Transfiguration, Resurrection, Navity of Christ, Assumption, Trinity, Epiphany, and two monasteries: Saviour monastery and Iberian nunnery. A Jewish synagogue and a Muslim mosque were located in the centre of the city.

As of 2011 the city has the Saviour Cathedral and the Iberian Church; the Assumption Church is closed for restoration; the Epiphany Cathedral and the Trinity Church are on a permanent closure; other religious architectural sites have been lost.

The Trinity Church is a stone monument of religious architecture in Siberia of the second half of the 18th century being one of the earliest and best works of the "Yeniseisk school" (A.I. Kytmanov, 1893). Distinguishing itself with richness and stylistic unity of the external decoration of facades, plastic expressiveness and acute rendition of architectural forms, now the church, once recognized by its contemporaries as one of the most beautiful churches in Siberia, has only survived in the lower tier (Fig. 1 and 2).

The Trinity Church was built in 1773 instead of a wooden one that was in decay. It

Fig. 1. The Trinity Church: view from the road, photo made in 2010

Fig. 2. The Trinity Church: the main entrance, photo made in 2010

was built on a small hill as a parish on the site of the emerging Barabinskaya suburb of the city at the expense of merchants and ordinary citizens. The right aisle was made in the name of the Presentation of the Lord and the left one in the name of the Mother of God, "The Life-giving source". The middle aisle was made in the name of the Holy Trinity. Consecration of the Church took place in 1782.

In 1856 a hospice was arranged for the inhabitants of Yeniseisk city which was placed in a small house of the Trinity Church where 7-10 people lived.

In 1869 the largest fire in the history of the city occurred and the church was completely devastated. Everything had burned out, including archive and religious values. Only two images of the Blessed Virgin written directly on the walls stayed untouched.

At the beginning of 1870 they started to restore the Church, two warm aisles were restored on the first priority basis. The aisle of purification of Virgin Mary was consecrated in 1872, and the "Life-giving Source" of the Mother of God aisle – in 1874. The restoration of the Church was completed in 1884.

The work on the interior decoration of the Church began in 1881. The next year, the walls and the dome were plastered and the dark stone floor was laid. In 1883, the entire Church was painted light blue, and the dome of the Church was decorated with small gilded stars. The iconostasis was made in two tiers with delicate gold-plated columns with carvings. "The icons were painted by a local artist on a gilding on polyment embossed background. The Church was provided with good candlesticks at the icons, two altar candlesticks and one bronze fire-gilded chandelier. Cleanliness, tidiness and beauty was seen everywhere." (Journey of Reverend Nicodemus, 1862) (Fig. 3, 4).

Since late 1920's there has been a gradual decline of the Orthodox Yeniseisk. Since the mid 20th century the Trinity Church that already lost the upper tiers has been used as a garage for agricultural chemicals and fertilizers. In the 1990's the Church went on a permanent closure.

Description of the object of the historical and cultural heritage

The church has the tripartite axial composition: a temple with a semi-circular altar

Fig. 3. The Trinity Church, photo made in 1916

Fig. 4.The Trinity Church in the urban area, photo made in 1915

apse, a widely built refectory with two flanking aisles and tiered bell tower stretched along the axis. The temple is a three-tiered quadrangular construction which is covered by a cloistered sail vault carrying a light drum and a small muffled drum topped by a bulbous head on a thin collar. Refectory is overlapped with an intersecting barrel vault with trays and lunettes (E.V. Hevel, 2004)

Brick decoration has many elegant motifs in wide angular petals with figured panels. Windows with keel frames look very original. The combination of embedded and prominent details enhances the plastic expressiveness of facades that in sunlight give a special light-and-dark effect due to their white smoothing paste.

Point

At the present time there are several tendencies of virtual historical reconstructions based on the methods of three-dimensional modeling. One of them is the creation of virtual reconstructions as close to reality as it is required by the objectives of the project. This approach is popular, for example, in the industry of documentary films, historical programmes, etc. The obtained "material" of such reconstructions is easy to use in further research due to its technical features (creating digital flat images, animation, etc.). One of the advantages of this approach is the high speed of the object creation. On the other hand, the details that do not carry any meaning are not necessary at all or are invisible to the audience, are simplified on purpose.

Another trend is to create virtual copies of objects as realistically as possible. This approach that allows to show the historical authenticity of the object is widely used in research. However, three-dimensional models obtained using this approach often cannot be used without application of special equipment. Another drawback of such solutions is the lack of surroundings of historical objects: everything that does not belong to the object of reconstruction cannot be visualised. Thus, despite its credibility the virtual reconstruction obtained by this method is considered to be cut off from the environment, thus dramatically reducing the interest of the amateur, mass audience.

The virtual reconstruction of the Trinity Church is an attempt to use a combined approach. A rich source base and special techniques in modeling focused on reconstruction of all parts of the Church on three-dimensional polygons defined the historical authenticity of the unique monument of religious architecture of Yeniseisk.

At the same time, when modeling surroundings of the historical and cultural heritage an increased emphasis was made on landscape and other details in order to create a solid and nice looking image. In addition, for these purposes we used a special plug-in V-ray RC as a visualiser which when rendering images through complex calculations indicates glimpses of plaster, grass, air density and others, allowing to obtain a high quality flat image.

Virtual reconstruction

The virtual reconstruction of the Trinity Church was carried out on the basis of the remaining archives and museum materials, foundation plans and actual measurements. The software for reconstruction included special software packages: Autodesk Autocad 10 (work with drawings), Autodesk 3D Studio Max 10 (creating an authentic three-dimensional model), Adobe Photoshop CS3 (photo manipulation, texturing).

The most important objective when creating the virtual reconstruction of the Church was to preserve the maximum of historical accuracy,
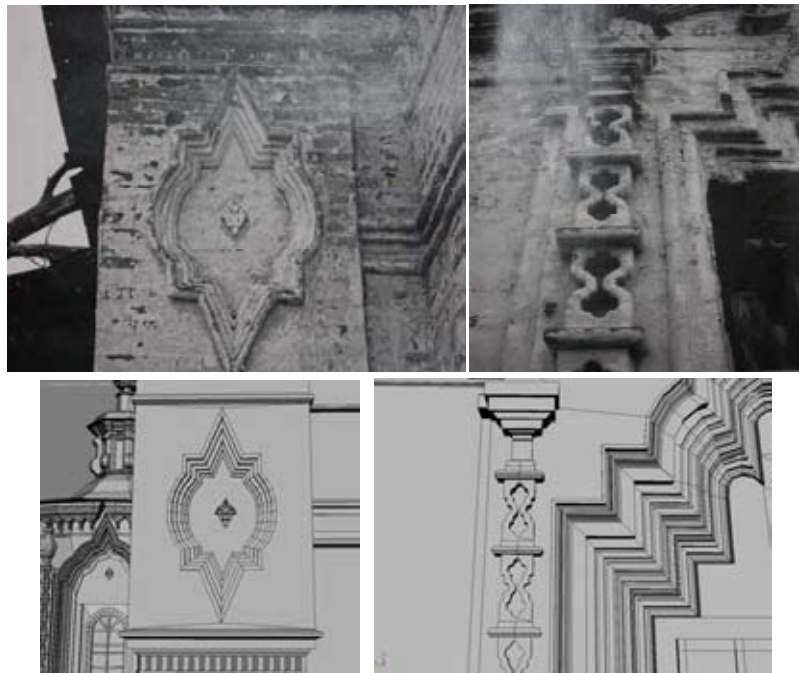
Fig. 5. Some elements of the decoration of the Trinity Church in the original (top picture) and their three-dimensional models

so we used the three-dimensional polygonal modeling for all the elements of the exterior decoration (Fig. 5).

Moreover, it was necessary to maintain the usability and the possibility of further application of the three-dimensional model which required constant control over the model's size (Mb).

A brief review of the work is described below.

The virtual reconstruction began with the development of an algorithm that had 3 basic stages:

1. Object modeling;
2. Object texturing;
3. Rendering.

The most important step in the first stage was to simplify complex forms. Thus, due to the complex structure and rich decor in the Baroque style, modeling of the Trinity Church was divided into four components that later were thematically grouped (Groups) (Fig. 6):

1) Tower1, 2) Base, 3) Tower2, 4) Tower3.

Modeling of the Trinity Church was done according to the principle of integrating various objects of the programme Autodesk 3D Studio Max: geometric primitives, Loft-objects, splines, etc.

Due to the fact that the Southern and the Northern facades of the Trinity Church are symmetrical, at first we created a model of one facade and then copied another facade using the Mirror operation.

In order to create a portal of the main entrance and corbel arches of the windows representing a complex step-recessed structure the Boolean operations were repeatedly used.

In the second stage, object texturing was done in Adobe Photoshop CS3. To this end, we used a method of collecting and comparing the external decorative materials (plaster) in historical photographs with remaining decoration elements of the Orthodox monument.

Fig. 6. Divided groups of the Trinity Church

Fig. 7, 8. The Trinity Church. The virtual reconstruction

Then, the architectural complex of the Trinity Church was completed with a fenced area simulated by the use of archival photo images.

In the final stage we set up and adjusted the lighting in a three-dimensional scene, added objects and the environment and carried out rendering. For rendering we used a special plug-in V-ray 1.5RC for 3D Studio Max 10. The result is the final image of the Trinity Church shown in Figures 7, 8.

Results

The virtual reconstruction of the Trinity Church is the realisation of the combined approach application. A rich source base and author's techniques in modeling aimed at

reconstruction of all parts of the Church on three-dimensional polygons, defined the high historical authenticity of the unique monument of religious architecture of the Yeniseisk province. In this case the constant control over the number of polygons and their vertices, as well as the application of the most effective tools of the software package for three-dimensional modeling and animation 3D Studio Max 10 allowed to create a three-dimensional scene with the size less than 120 Mb. Thus, a virtual reconstruction of the Trinity Church having the necessary historical authenticity of a practically lost original can be used for many purposes starting from the creation of flat images ending with the use in films and the 3D-engine technology. In the nearest future, the virtual reconstruction of the Trinity Church will be available on the web-site http://www.yeniseisk-heritage.ru)

Reference

R.A. Baryshev and M.V. Rumyantsev "Cyberspace as a zone of alienation" *Vestnik of Novosibirsk state university, Philosophy*. 2008. №1. pp. 34 – 36, in Russian.

R.A. Baryshev "Personality in the context of cyberspace" *Vestnik of Chelyabinsk State University, Man, Society, Culture*. 2011. №2. pp. 15 – 19, in Russian.

N.V. Borisov, V.A. Goroncharovsky, S.V. Shvemberger, P.P. Shcherbakov "Reconstruction of the Illurat fortress" *10th Anniversary International Conference "EVA 2007 Moscow"*. P. 22, in Russian.

D.V. Gruzdev and I.V. Zhurbin "Visualisation and analysis of archaeological and geographical research: challenges, modes and software implementation" *Newsletter of the Association "History and the computer"*. Issue 33. M., 2006. pp. 43 – 52, in Russian.

E.V. Hevel "Explanatory note to the Project of zones of historical and cultural monuments of Yeniseisk". V.1. Krasnoyarsk, 2004, in Russian

Journey of Reverend Nicodemus in 1862 *Yeniseisk diocesan records*, 1909. Issue 3. P. 24, in Russian.

S. Friedman, W. Jepson, C. Youngblut "Educational Uses of Virtual Reality Technology" *Institute for Defense Analyses,* Paper D-2128, Virginia, 1998.

E.Ya. Kalnitskaya "Three-dimensional modeling as a new tool of a historian of architecture". 2005. http://conf.cpic.ru/upload/eva2005/reports/tezis_725.doc. in Russian.

N.P. Koptseva "Henrich Rickert's Methodology and its Application for Solution of the Problem of Cultural Values in Contemporary Theory of Culture" *Journal of the Siberian federal university, Humanities & social sciences*. № 2. 2009, in Russian.

N.P. Koptseva and V.I. Zhukovskiy "The artistic image as a process and result of game relations between a work of visual art as an object and its spectator" *Journal of the Siberian federal university, Humanities & social sciences*. № 2. 2008, in Russian.

A.I. Kytmanov "Chronicles of the Yeniseisk county and the Turukhansk Territoy in the Yeniseisk government". 1594-1893. *MUK Funds "Yeniseisk Museum of Local Lore"*, P. 88.

M.J. Curtis "The Great Temple of Petra. Scientists, artists and archaeologists collaborate on digital archaeology". http://www.brown.edu/Administration/News_Bureau/2002-03/02-077.html., in Russian.

M-L. Ryan "Immersion vs. Interactivity: Virtual Reality and Literary Theory" *Dept. of English, Postmodern Culture,* v. 5 n. 1, Oxford University Press, 1994. http://www.brown.edu/Administration/News_Bureau/2002-03/02-077.html;

M.P. Mindarovsky "My notes and recollections". § 1891-1916 – MUK Funds "Yeniseisk Museum of Local Lore" . 333 p., in Russian.

Notes of Reverend Nicodemus on his visit to Yeniseisk devastated by fire *Yeniseisk diocesan records,* 1889. Issue 3. P. 299-301.

P.A. Slovnov Letters from Siberia. 1826, in Russian.

B. Smith "Research activities of the European Union in the field of cultural heritage". http://www.evarussia.ru/upload/doklad/%D0%9F1-3_Smith.doc.

J. Steuer "Defining Virtual Reality: Dimensions Determining Telepresence" *Journal of Communications,* 42.4. 1992: pp. 73-93.

Virtual Shikki. http://www.k.hosei.ac.jp/~pasko/Shikki/Shikki.html

J. Visnovcova "3D-Rekonstruktion und Visualisierung des Reliefs der Innerschweiz von Franz Ludwig Pfyffer" (1716 – 1802) *VPK/MPG – Vermessung, Photogrammetrie, Kulturtechnik Mensuration, Photogrammetrie,* Genie rural 7 / 2001, pp. 486 – 489.

V.T. Thelen. A. Spuren "Ausstellung in Bonn ladt zum virtuellen Spaziergang durch die рдрstlichen Palдste ein" *Aachener Zeitung,* 05.12.1998. – http://www.cad.architektur.tu-darmstadt.de/e_exhibitions/index_vatikan.html

Yeniseisk diocesan records, 1889. P. 17, in Russian.

D.I. Zherebyatiev "The application of interactive technology of 3D-simulation for the reconstruction of lost monuments of history and architecture on the example of the Tambov fortress" *Proceedings of the XIV International Conference of Students and Young Scientists "Lomonosov-2007". Section "History". Subsection "Historical Science".* M., 2007, in Russian

I.V. Zhurbin "Methodology and technology of geophysical research in conservation and museumification of the archeological monuments" *Circle of ideas: algorithms and technologies of historical science: Proceedings of the IX Conference of the Association "History and the computer".* M., Barnaul, 2005. pp. 223 – 240, in Russian.

Виртуальная историческая реконструкция Троицкой церкви г. Енисейск

Р.А. Барышев

Сибирский федеральный университет,
Россия 660041, Красноярск, пр. Свободный, 79

В статье изложен опыт создания виртуальной исторической реконструкции Троицкой церкви, находящейся в старейшем городе Средней Сибири Енисейске. Представлена история храма и описание.

Одной из особенностей статьи является описание современных тенденций при проведении виртуальных исторических реконструкций. Одна из них – производство виртуальных реконструкций, приближенных к реальным, настолько, насколько этого требуют задачи проекта. Такой подход нужен, например, в индустрии документальных кинофильмов, исторических программах и др.

Другая тенденция, заключается в производстве максимально приближенных к реальности виртуальных копий объектов. Такой подход, позволяющий показать всю историческую достоверность объекта, востребован во всем научном мире.

В статье изложен авторский подход, в основе которого лежит синтез двух данных тенденций. Таким образом, представленная в статье технология виртуальной реконструкции Троицкой церкви является комбинированной, когда богатая источниковая база и точное воссоздание всех деталей экстерьера в объемных полигонах определяют историческую достоверность архитектурного объекта, а постоянный контроль за количеством полигонов (вершин) и применение наиболее эффективного инструментария позволяют создать реконструкцию небольшого объема. Это дает возможность в дальнейшем использовать полученный материал в качестве основы для дальнейших визуализаций и исследований. Например, данный подход позволяет применять полученные модели в интерактивных приложениях с визуализацией в реальном времени.

Виртуальная реконструкция Троицкой церкви доступна на сайте Гуманитарного института Сибирского федерального университета по адресу: sfu-kras.ru.

Ключевые слова: виртуальная реконструкция, виртуальная историческая реконструкция, история Средней Сибири, виртуализация, трехмерное моделирование, православная архитектура.