УДК 39.572

The Technique of Virtual Archaeological Reconstructions on the Example of a Medieval Fort in the Yenisei Taiga

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The article discusses the basic principles of virtual reconstruction in archaeological research. The introduction states that the virtual reconstruction is an important and popular resource for research, as well as a means of preserving and maintaining the cultural heritage.
Materials and methods section considers an example of the virtual reconstruction of the fort Lesosibirsk-1 drawn under the grant of Institute of Humanities at Siberian Federal University.
General method for the virtual reconstruction of archaeological research is explained through the reconstruction of a particular architectural object.

Keywords: history, archeology, ethnography, virtual reconstruction, heritage and culture.

Introduction

The need for virtual reconstructions of already destroyed, as well as or partly destroyed monuments, various artifacts, historical events, etc. appeared once UNESCO adopted the Convention Concerning the Protection of World Cultural and Natural Heritage in 1972.

Following one of the definitions, a virtual reconstruction is the reconstruction of historical and archaeological objects or processes, with the use of various computer technologies and software.

Virtual reconstruction has become popular for at least two important reasons:

1. Cultural heritage objects trapped in zones of modern economic development (construction of hydropower station, mining, etc.) are needed to be virtually reconstructed in order to preserve the "historic memory" of the culture of a destroyed region.

2. The ability to use virtual reconstructions for research purposes, as well as for various educational resources.

One of the most striking examples of the virtual reconstruction is Google Earth allowing not only to see three-dimensional architectural monuments, but in some cases, chronologically trace the development of a cultural heritage site (Fig. 1).

Materials and methods

A serious research project carrying out a virtual reconstruction of an object or event is not possible without a multidisciplinary

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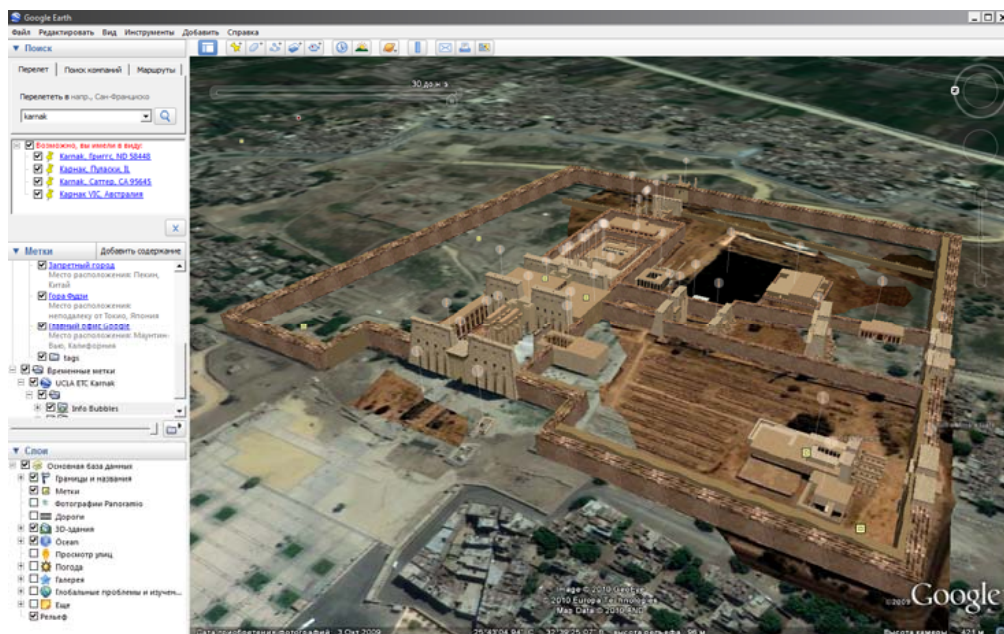*   Corresponding author E-mail address: artikus@inbox.ru

Fig. 1. Reconstruction pharaons' tombs at Karnak. University of California, Los Angeles (UCLA)

approach. Depending on the current project creators team includes academicians, architects, IT-specialists, artists, specialists in PR, actors, etc.

The cooperation of the Department «Information technologies in creative and cultural industries» and laboratories of archeology, ethnography and history of Siberia at Siberian Federal University resulted in creation of the virtual reconstruction of the medieval fort Lesosobirskoe-1 located on the riversides of the Yenisei.

Artifacts of archaeological excavations at the Krasnoyarsk Territory in 1998-2002 make up the base of source materials for the reconstruction.

Hillfort Lesosibirsk-1 is located on the 16-meter right-bank terrace of the Yenisei river near Lesosibirsk city. This cape-shaped terrace smoothly declines to 1-meter height to the north, on the west the terrace faces the Yenisei river, and on the east side it goes down into the ravine of dried stream.

An dirt road goes over the terrace. 8.2 km to the north is village Gorodishche, 3.2 km to the south is village Rudikovka. A part of the monument was destroyed during the construction of the road, as well as through the collection of floating wood.

The hillfort was discovered in 1998 and being studied with two excavations during 3 years. Total square of them was 390 m2. Inside part and defensive constructions consisted of three lines of half-ring safety fortifications were investigated. Found on the excavations iron melting furnaces, fragments of ceramic with comb ornament, iron loopy knives and other implements allow referring the hillfort to culture of autochthonic population who had lived at the beginning of the 2nd millennium AD (Mandryka, 2003).

Hillfort Lesosibirsk-1 was constructed by the following algorithm:

1. Deforestation and stubbing of the area. Trunks of the trees were used for building, and branches and stumps were burned. The total area amounted to the area of the future village,
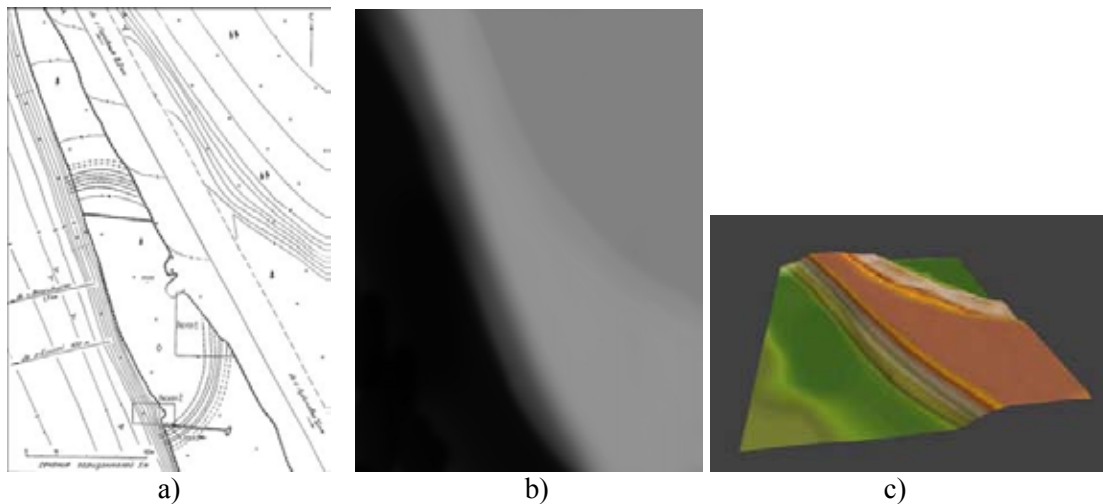
Fig. 2. Reconstruction of an authentic area of the right bank of the Yenisei: a) the topographical plan of the monument; b) The Mask c) three-dimensional model of the landscape

1840 square meters, and additional space, calculated for the flight of the arrow from the outer turn of the fortifications.

2. Creating a semiring protective moat adjacent to the steep slope of the Yenisei terrace. Blade from the moat was put on the inner side of the platform, thereby heightening it. Isthmuses were made in moats for the future passes in the defensive wall. Simultaneously, residential area was being built.

3. Construction of the first (internal) system of fortifications. Each line of defense was equipped with a with log wall, which is proved by concentrations of charcoal and the remains of burnt wood in the moans found during excavations. Log wall were formed from the horizontal logs laid down in vertical columns. The distance of each bay ranged from 1.6 to 1.8 m.

4. Construction of the second (middle) system of fortifications. The average line of fortifications was held parallel to the inner, three meters away from it.

5. Construction of the third (external) system of fortifications. The outer boundary had the lowest height of the log walls.

The Virtual reconstruction of the archaeological object required use of two-dimensional (Adobe Photoshop) and three-dimensional (3D Studio Max) graphics image editing programs.

Two-dimensional graphics editors were used for creation and texture processing, as well as for subsequent processing of the images (post processing).

To create the territory on which the fort located, as well as for modeling of various objects three-dimensional image editors were used.

The first step of creation of the virtual reconstruction of the fort Lesosibirsk-1 was the simulation of the authentic territory where archaeological excavations were carried out.

There are at least two ways to create three-dimensional model of the necessary territory.

The first method is a polygonal modeling or use of specialized software such as Autodesk MapGuide, etc.

The second way is to use a special mask, which is a bitmap image in grayscale, and with which, there is a "bumping" of the territory on the plane.

Fig. 3. Virtual reconstruction of the fort, a shot from an educational video

Since the results of this reconstruction will be used in educational activities, we had to create the territory of the right bank of the Yenisei river using the second method, which gives acceptable results for the final image.

Using the topographic plan of the monument fort Lesosibirsk-1 (Fig. 2, a) in a mask was created in Adobe Photoshop editor (Fig. 2, b), use of this mask in three-dimensional graphics editor allowed to "bump" the require territory (Fig. 2, c).

After that appropriate textures and landscape elements were added: the texture of land, water surface, the model trees and bushes.

The final result of the virtual reconstruction is the sequence of images demonstrating the algorithm of construction of fortifications of Lesosibirsk-1.

In addition to the sequence of images a three-minute educational video in which guest actor tells about the construction process was created by (Fig. 3).

Besides, some of the artifacts found during excavations were modeled.

The originals inhabitants living in this area were the keepers of traditions of comb pottery making. Thanks to use of the technology of three-dimensional «skulping» the original shape of the object with the appropriate ornamentation was recreated (Fig. 4).

One of the objects found was the remains of a loopy knife. A loopy knife and a leather sheath was reconstruction virtually (Fig. 5).

The algorithm for constructing dwellings (a tent (of skins or bark)) consisting of the following stages was reconstructed (Fig. 6):

1. Fixing carrying poles;
2. Creating main frame;
3. The construction of the hearth;
4. Imposition of birch bark cover;
5. Fixing of the coating.

Using the experience gained we put forward the main stages in the virtual reconstruction of an archaeological research:

1. Analysis of materials from excavation: artifacts, topographic maps, etc. followed by the simulation.
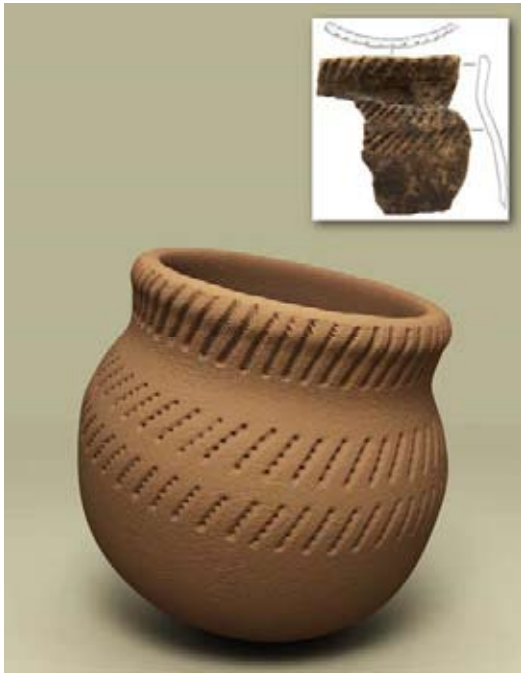
Fig. 4. Reconstruction of pottery with a "comb" ornament

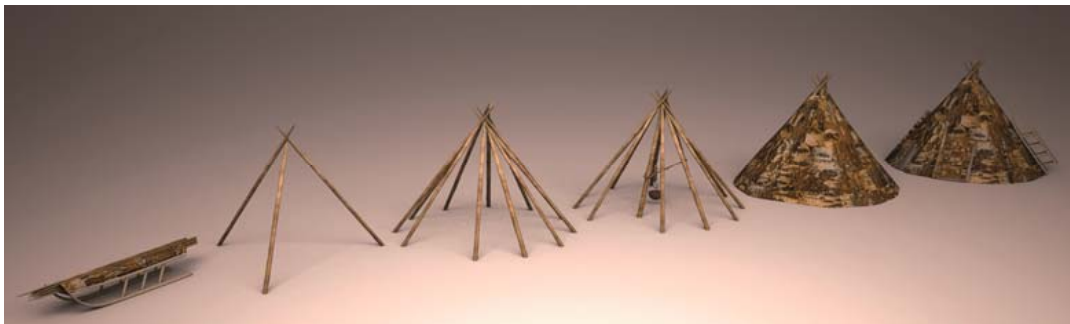Fig. 5. Reconstruction of loopy knife

Fig. 6. Reconstruction of the building plague

2. Creating a model of the landscape in which the excavations were carried out using various technologies:

2.1. Polygonal modeling in various graphic editors, based on available data;

2.2. Using specialized equipment to obtain a more accurate model: ground-based laser scanning, digital photogrammetric survey, etc.

3. Creating a two- or three-dimensional virtual reconstruction of scientific research and educational aspects.

Conclusions

For the results of scientific research accuracy and reliability are of high importance, while educational resources require high image quality aimed at attracting as many Internet users as possible.

In spite of an offered method, any virtual reconstruction of historical and archaeological research is a particular case requiring from designers new approaches, methods and different outcomes depending on the goal.

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Методика виртуальных реконструкций в археологии на примере средневекового городища в Енисейской тайге

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В данной статье рассмотрены основные принципы виртуальной реконструкции в археологических исследованиях. Во введении приводятся доводы в пользу того, что виртуальная реконструкция является важным и востребованным ресурсом в научных исследованиях, а так же как средство по сохранению и актуализации культурного наследия.В разделе материалы и методы рассматривается пример виртуальной реконструкции городища Лесосибирское-1