PHYSICAL VS. VIRTUAL RECONSTRUCTION

Stevan Đuričić (University of Belgrade)

Conservation and restoration entail treatments of structures or objects of material culture from the past in order to preserve and present them. The principles upon which experts in these fields conduct their work have to fulfil ethical, aesthetical and technical regulations which are very strict; thus, the rules which they must obey are, in most cases, rigid (e.g. The Venetian Declaration, The Burra Charter). The ideas leading to different versions of the final product, developed during the process of conventional reconstruction, often remain unrealized. The option that is usually picked as the final choice is the one which is considered to have the smallest window of error probability. Contrary to the physical, three-dimensional digital reconstructions allow for more freedom in the interpretation of the gathered data and do not bear risk of making an irreversible mistake. Virtual reconstructions are possible even in cases where physical reconstruction is not an option (either the objects and structures are poorly preserved, or there are not enough resources or time for physical reconstruction). Due to the fact that archaeological excavations are often destructive, and a lot of important data are preserved only in archaeological documentation, detailed graphic, photo- and video recording is necessary in order to preserve information about investigated structures and contexts. Three-dimensional scanning and photogrammetric recording can be considered as the optimal methods of visual documentation. Using these methods, all shapes are measured and recorded, and photographs are used as textures, so that detailed geo-referenced record is easily obtained. The end product is a three-dimensional model which can be upgraded in some 3D modelling and animation program.

Conservation guidelines for virtual reconstruction

One of the most important conservation guidelines is that the reconstruction has to preserve the authenticity of the original. At the beginning of the 20th century, Benedetto Croce developed a theoretical framework for this field (Croce 1990) and his work has become a cornerstone of Italian conservation philosophy. Also, his influence in defining basic principles of conservation should be pointed out. Further, Giulio Carlo Argan and Cesare Brandi, two notable conservation theorists, proposed the basic principles of theory of conservation (Jokhileto1994).

Main aspects of the authenticity principle are:

- Authenticity in design;
- Authenticity in manufacture;
- Authenticity in harmonization with the surroundings;

For some elements of the reconstruction, especially when buildings are concerned, analogies with other contemporaneous structures of the same type and function are used. That said, one should have in mind the selection of only unambiguous and secure examples. This is especially important when working with buildings from the historical periods which are constructed from hard materials. In some cases, although rare, original construction plans have been preserved. This is then not a reconstruction, but a restoration. When there is not enough of information for a reliable reconstruction, the problem should be approached with extreme caution. Due to the fact that the degree of reversibility is low when restoring structures made of hard materials, any correction of errors made during the reconstruction process is hardly feasible. The rule that must be followed is to clearly separate the original parts from the ones added during the reconstruction, which applies to both movable (i.e. objects) and immovable (i.e. structures) features (The Venetian Declaration, Article 12).

Respecting reversibility is the next important criterion that should be met when selecting the method and the degree of restoration. The risk of error which occurs when restoring objects or structures made of delicate and friable materials is far greater than the one present when dealing with object/structures made of hard and durable materials. In the first case, the process of structural stabilization can be performed. We can consolidate unstable materials, but even then, there is the risk of picking a wrong consolidating agent. Consolidation is one of the high-risk procedures, especially when applied to large structures, due to the fact that the degree of reversibility is extremely low, and it is virtually impossible to repeat the process. In some situations, it is best not to attempt physical reconstruction at all and instead do graphic reconstruction, which is one of the ways to present ideas for the subsequent virtual reconstruction. Virtual reconstruction is a very good solution, as it provides visualization of the reconstruction ideas without any physical interference with the actual archaeological feature.

Virtual reconstructions based on detailed documentation allow us to test different ideas and assumptions, without violating the basic principles of conservation and restoration. When archaeological sites are investigated systematically, data from more recent investigations tend to change previously developed ideas and reconstructions of the excavated

structures. When structures are physically reconstructed, it is often hard or even impossible to make any necessary modifications suggested by newly conducted analysis and fresh results, which is not the case when the reconstruction is carried out in virtual reality.

Even though 3D reconstructions offer a lot of possibilities and many advantages in comparison to physical restoration, this does not mean that the two methods exclude each other. On the contrary, physical reconstruction will probably never be replaced, because of the value of the actual archaeological finds. The excitement these provoke when they are presented can only partly be substituted by exhibiting replicas or virtual reconstructions. Also, beside restoration of the original appearance of archaeological objects, the basic purpose of standard conservation and restoration is the preservation and consolidation of structures and objects, and their protection from further decay, and this requires treatments of the original finds.

Three-dimensional models can be considered as one of the methods of preventive protection, first of all because they aim to produce a genuine image of the original which can the replace the original in some aspects of research and in some analysis, mostly the ones using visual methods or determining the volume of a structure and so on. In this way, the need for physical contact with the original structure or object is avoided. This is highly relevant to movable objects, because every time they are removed from the controlled environment they are under the risks of disintegration.

The production of replicas is a traditional method of archaeological conservation, which, in the preventive protection sense, has the same function as a 3D model, but can additionally serve as souvenirs, and this makes them profitable and suitable for promotion of cultural heritage. The problem occurs when a print has to be taken in order to make a mould, in which case the original object comes into direct contact with physical, chemical and biological (if the materials are organic) agency of the materials, that at certain point can have negative effects. The development of three-dimensional printing now enables printing of the replica of an object, based on the 3D model, and the original object stays safe in a museum.

In the case of physical reconstruction, the restoration relies on the remains of the original structure or object, following all the principles of conservation and restoration. One of the first tasks in virtual reconstruction is to create a 3D reconstruction of the excavation area and the archaeological remains. Regardless of whether a 3D scanner, LIDAR, drone, or photogrammetry is used, the end result is a “wire frame” and the texture that can be imported into software suitable for three-dimensional modelling and animation.

After making a 3D model of the preserved parts, all available data on the original structure or object are collected and technically prepared for a 3D upgrade. It is of vital importance to obtain all visual (graphic and photo) recordings, and it is often necessary to consult excavation dairies, geodetic data and specialists’ reports. If the structure/object being reconstructed has been published, it is recommended to gather all the relevant literature. If the data are insufficient, but the structure/object is available for observation, it is advisable to gather additional data, first of all through observation, photography and geodetic measuring.

The next step is the analysis of the data and the development of the reconstruction plan. If the reconstruction of large complexes is planned, the expert team consisting of

an archaeologist-excavator or an archaeologist-museum curator, a 3D modelling specialist and a conservator should be formed. When reconstructing urban units, an architect must be included on the team as well. They make the core of the team and they should closely cooperate during the process of reconstruction; if needed, the team can also include other specialists.

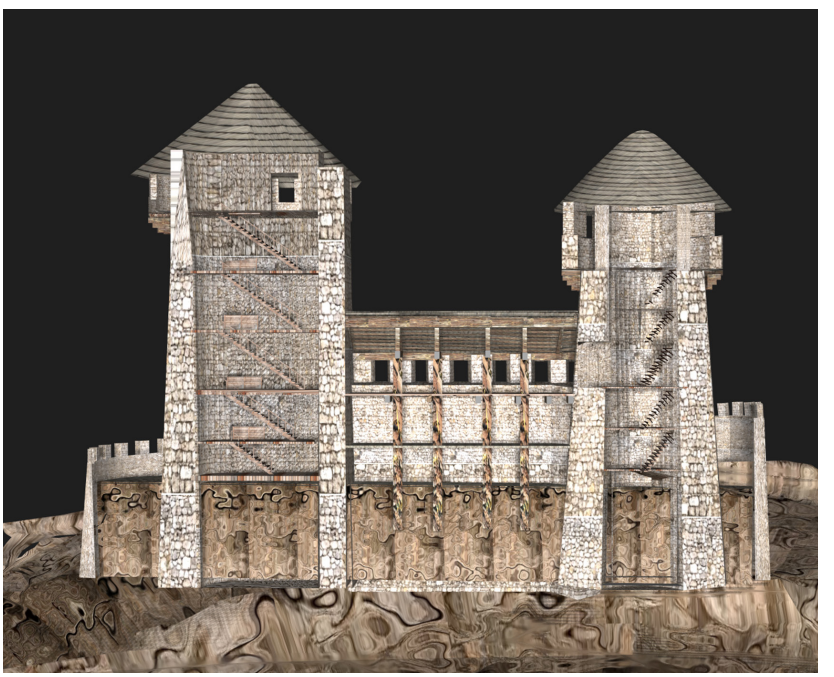

Figure 5. A Cross section of a medieval fortress.

Figure 6. Reconstruction of a kiln from Neolithic village of Stubline, Serbia.