

# The methods and approaches of the visualization of 3D reconstructions

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**Abstract:** Two key points of scientific computer-based 3D reconstructions are the methods of their making and the principles of its visualisation. The discussion about the latter ones is the main aim of the paper. The attention is paid to the modelling methods, aesthetic and didactic demands of such reconstructions. These methods are strongly connected with monuments' features, typology of the reconstructions and their purposes. For example, it could be a reconstruction from specific point of view, a visualisation showing the difference between building stages, a presentation of the important architectural peculiarities of the monument or the type of an architectural object, a visualization of some typical urban or rural environment and so on. The two main points are the selection of view types (from main axonometric or orthographic to particular points of view) and the options of visualization (from hyper realistic renders to schematic views). On the one hand the axonometric view could be the best way to presented main features of a monument by one view. On the other hand the particular point of view could be important to demonstrate the specific peculiarities of a monument and show the real viewpoints seen by the people of that time. The choice between natural, schematic or stylized renders is also connected with the purposes of reconstruction. Furthermore they could give the opportunity to make the graphical visualisation of the reconstruction's argumentation and the degree of its hypothetical character. It enables to use the reconstruction in scientific discussions and as an instrument of verification. The special attention should be paid to the tendency of using the unreal viewpoints unconnected with the architectural peculiarities of the monument as well as in hyperrealism and concentration of the entourage unimportant for presentation of the features of chosen architectural objects.

**Keywords:** 3D-reconstructions, architecture, methodology, visualisation, presentation.

## Introduction

Two key points of scientific computer-based 3D reconstructions are the methods of their making and the principles of their visualization. The discussion about the latter ones is the main aim of the paper. We would like to draw attention only on criteria for the images which usually are one of the possibly results of any reconstruction. Renders or other kinds of pictures could be orthogonal or perspective, realistic or schematic. Let us point out that representation of the connection between reconstruction and its sources has already been examined in the talk by F.I. Apollonio<sup>1</sup> and it isn't the aim of our paper.

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<sup>1</sup> We mean a talk which was done by F.I. Apollonio in the Round Table "Digital 3D Reconstruction – Methods, Strategies and Challenges" held in Vienna on 3rd November 2015: <http://www.chnt.at/classification-schemes-and-model-validation-of-3d-digital-reconstruction-process/>

We think that the methods of visualization mainly depend on the aim of reconstructions and images which we create. We need to understand for what purposes we make an image of a model. There are two main aims:

- The first one is to show the architectural features of an object (planning, structure, constructional peculiarities or type of structural organization and building phases). In this case we are going to show the objective view of a reconstructed building both for professionals (archeologists, architects, historians etc.) and for non-specialists. The axonometric views, orthogonal projections and perspectives from the high viewpoints are the best way to do it.

- The second one is to show peculiar architectural features of the monument, if any, or to show some viewpoints, which could be important. Moreover we could just want to show the impression which the building could make on spectators<sup>2</sup>. The very important point is that this impression couldn't actually be reconstructed and it will always be controversial. These pictures are intended first of all for non-specialists. One could suppose that the perspective views from a real viewpoint with real light and so on is the best way to do it.

### **Objective views**

The first point could be supported by cutting of some parts of a monument in order to show its inner structure and its connection with the exterior. For example there is a possibility to clearly show the inner structure of a complex building - the gate with the portcullis, arrow slits etc. and its constructional features - the peculiarities of the stonework. At the picture (Fig. 1) one can see southern gate of Babylon fortress in Egypt<sup>3</sup>. The view of Nag el-Hagar fortress gate<sup>4</sup> is the same as the previous example (Fig. 2).

In the reconstruction (KARELIN 2014, 2015) of the Roman imperial cult temple at Luxor (Fig. 3,4) there can also be a possibility to show the connection between the interior (the baldachin, the apse and the paintings with the four tetrarchic figures in the apse and on the wall) and the exterior part - the hypostyle hall of Amenhetep III with the tetrarchic statues (Fig 4). The four figures outside the building are connected with the paintings inside and were extend of the interior composition.

Both these pictures show the connection between these objects (the four statues in the court, the statues between columns and the figures in the apse and on the wall). It is important because this connection had a sacral meaning.

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<sup>2</sup> One could say, that there is "...very little attention has been given to aspects of perception and cognitive theory. However, the fear of misleaing the observer with technically perferct images is great" (WITTUR 2013, 47).

<sup>3</sup> Details about the fortress see (SHEEHAN 2010).

<sup>4</sup> About the gate reconstruction see (KARELIN 2011, 11-12, Fig. 8).

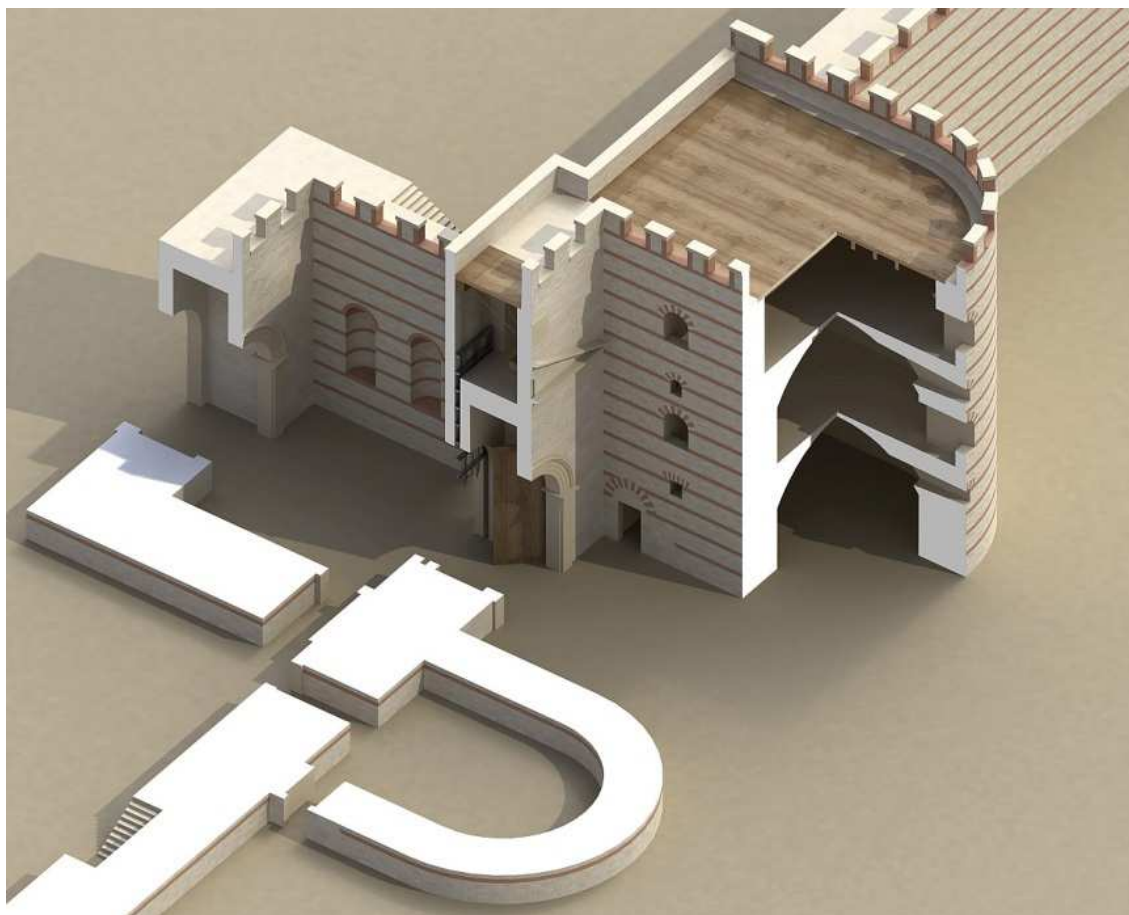


Fig. 1 – Southern gate of the fortress of Babylon in Egypt (reconstruction by D. Karelin, M. Karelina, T. Zhitpeleva, from KARELIN ET AL., 2015, Fig. 6)

In our opinion such views could be realistic but first of all they are schematic<sup>5</sup>. In this case we can also use the light from any direction without considering the trajectory of the sun. The main aim of lighting is to underline the form and planning of a monument. But first of all it has to give an "objective view". It is interesting that for this very reason the studies of Boris Rauschenbach show the ancient Egyptian art with its incorrect geometry and images "like children's pictures", as a very complicated system (RAUSCHENBACH 1980, 15-41; 2002, 181-219). The main feature of Egyptian art is to show the most objective and characteristic view of any object (legs - view from the side, body - front, face - profile) and to combine in one picture the different ways of representation - plan, facade, side view. However the Egyptians knew how to draw correct geometric projection of any object - for example they could draw the front view of the head.

We also think it is possible to combine different projections in the reconstructions visualization if there is such need.

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<sup>5</sup> For the discussion about the possibility of photo-realism or non-photorealistic visualisation see (WITTUR 2013, 48-49).



Fig. 2 – Gate of the fortress at Nag el-Hagar in Egypt (reconstruction by D. Karelin, from KARELIN, 2011, Fig. 8)



Fig. 3 – The temple of the Roman imperial cult at Luxor. Axonometric view (reconstruction by D. Karelin, from KARELIN, 2014, Fig. 5)

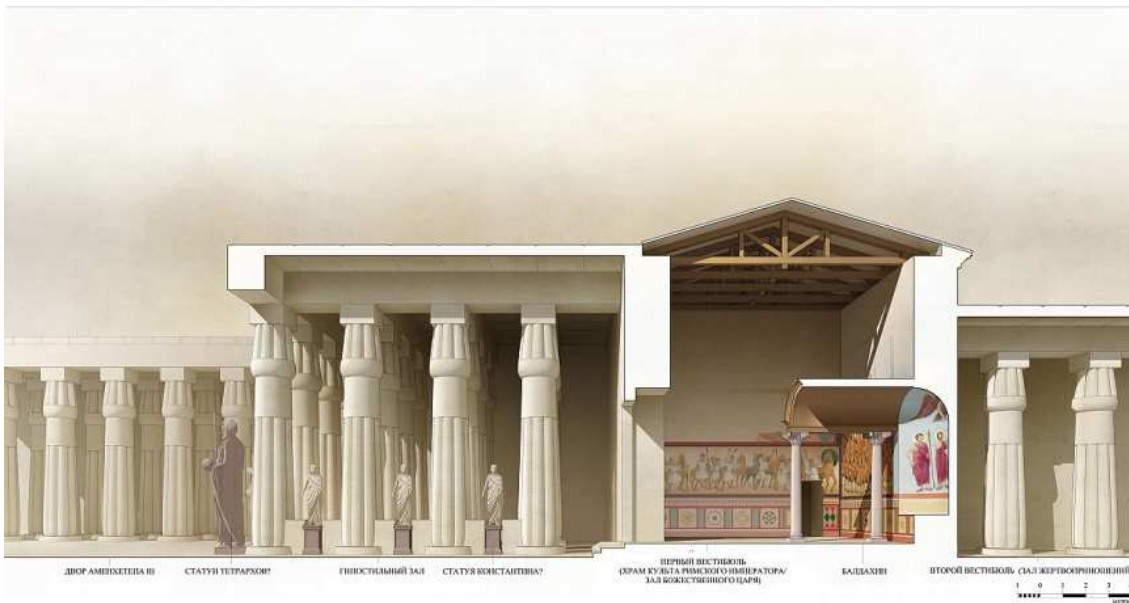


Fig. 4 – The temple of the Roman imperial cult at Luxor. Longitudinal section (reconstruction by D. Karelin, from KARELIN, 2014, Fig. 6)

### Views from real view points

When we use the views from the real viewpoints we have to take into account the followings:

- peculiarities of the human vision,
- the comfort angle for perception,
- the difference between geometrical perspective and peculiarities of human vision,
- the different ways of representation: from a printed picture to google glasses, for example<sup>6</sup>,
- the correct using of entourage (people, trees and so on),
- the picture composition which could show what is important and what is of less importance.

In these pictures (Fig. 5) we can see that wide angles aren't comfortable for perception of the object because the foreground seems bigger and the background seems smaller than they really are and the distortion of the borders of the view is too significant. However, a narrow angle is approaching to the orthogonal view and makes the foreground smaller and background bigger. According to the studies by Boris Rauschenbach (RAUSCHENBACH 1986, 9-88, 127-213; RAUSCHENBACH 2002, 13-81) the most comfortable angle for the human vision is around 30 degrees. But the problem is that in interiors or complex ensembles the angle of 30 degrees could not be enough. We think that for interiors and complex ensembles the most comfortable angle is between 50-60 degrees. This problem is very complicated, for example the specialists in photography discuss it for many years. It depends on the dimensions of the picture, the distance at which we see it and so on.

<sup>6</sup> In our paper we draw attention only to "flat pictures" or static images.

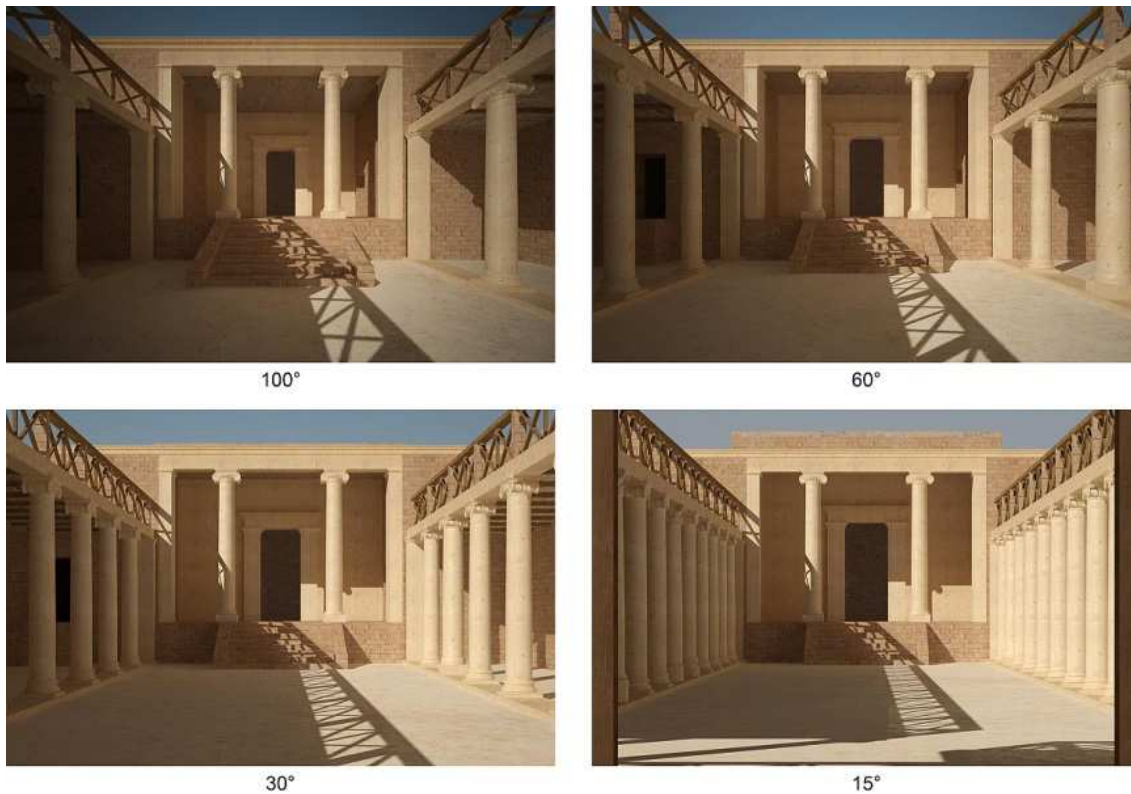


Fig. 5 – The example of difference in perception at the different angles of view (100, 60, 30, 15). Perspective views of *Via Praetoria* at Dionysias fortress (reconstruction by D. Karelin, T. Zhitpeleva, M. Karelina)

But we think that if the angle is too wide, it isn't good for the perception of the object either, and we think that it is possible to correct to narrow the angle by ignoring some objects of the scene. For example this is the real and geometrically correct view from this viewpoint (Fig. 6a,b), and because of a wider angle there are very significant distortions at the borders of the frame. Also the spectator could perceive the proportions incorrectly. If we move the viewpoint back and ignore the wall we create a geometrical incorrect view (Fig. 6c,d), but it is more comfortable for the viewer. It is important that our eyes perceive the picture not by the rules of geometrical perspective, but differently. Usually we turn our head and then our brain corrects all these distortions. Thus the second frame must be closer to picture which our brain creates.

To show the characteristics of real or artificial light also could be the aim of visualization. For example we can see that since around 11 a.m. the main dining room at Nag el-Hagar palace was in shadow (Fig. 7). That is why the room and the part of the court were protected from the Egyptian sun already at the stage of planning the palace. Such design created the nice and fresh microclimate, which is important in Egypt. In this case it is correct to show the pediment facade in shadow, because mainly it remained in shadow. The most authentic images of Russian architecture should be shown in ambient light, because 300 days of 365 we have ambient light in Russia. Such an approach is one of the ways to show the real impression of architectural monument upon the viewer and make the image more historical.

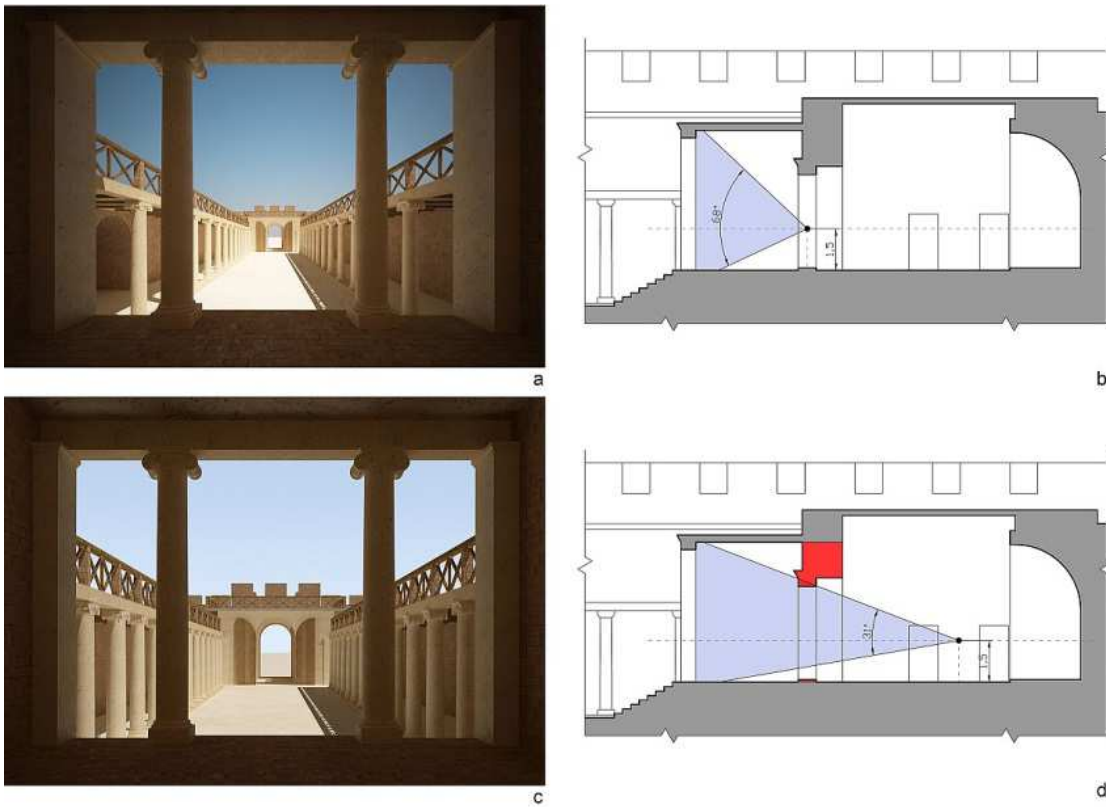


Fig. 6a-d – The possibility of narrowing the angle of the view along with ignoring of some elements of the building in order to create more comfortable view for human vision. Views of *Via Praetoria* at Dionysias fortress from the chapel (reconstruction by D. Karelin, T. Zhitpeleva, M. Karelina)



Fig. 7 – View of the peristyle court of Nag el-Hagar palace, afternoon (reconstruction by D. Karelin, from KARELIN, 2011, Fig. 11)

The peculiarities of artificial light could be the problem, because it is necessary to study the features of ancient lights and windows glazing (ELLIS 2007). Also it is necessary to note, that now it is possible to use a lot of free software, which could help to depict the condition of real, or artificial light and depict the realistic sky<sup>7</sup>. The careful attention to depiction of really restored colors is also very important<sup>8</sup>.

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<sup>7</sup> The good example is the Stellarium project (<http://www.stellarium.org/>) (FRISCHER and FILLWALK 2016:) and possibility to operate in many programs (3D Studio MAX and the others) with real features of light (exact position of sun due to the time of year and day, color temperature and the others).

<sup>8</sup> For example, B. Frischer and P. Stinson recommended to use in digital visualisation the colours in the range of 70-75% of the original intensity (FRISCHER and STINSON 2007, 67).



The using of entourage is also important. We think that it should be neutral and shouldn't prevent to spectator to percept the whole picture and the reconstructed monument. This example the view of western wall of Nag el-Hagar fortress from the river (Fig. 8) isn't good because the author took a great interest in entourage and added too much of it. But let us note that it was a long time ago.



Fig. 8 – The western wall of Nag el-Hagar fortress, view from the north, winter sunset (reconstruction by D. Karelin, from KARELIN, 2011, Fig. 5)

This example (Fig. 9) seems better. Here one can see the reconstruction of mansion in the estate of Nikita Trubetskoy (architect Dmitry Ukhtomsky). Here the entourage (park) is secondary, whereas the object is more important. Nevertheless it is a characteristic environment for architecture of this kind. This example also shows that the composition could make the object the dominant point of the picture and also demonstrates the important space in front of it.

We think that all the above mentioned proves that in this kind of representation of reconstructions we need to draw attention to:

- the choice of the correct angle of view,
- the peculiarities of human vision,
- the creation of real light,
- the correct using of entourage,
- the picture composition which can show what is important and what is less important.



Fig. 9 – The estate of Nikita Trubetskoy. Mansion. Architect Dmitry Ukhtomsky (reconstruction by K. Bilyan, D. Alexeeva, T. Danielan, A. Pogosyan, E. Biytynaya. Supervisers: S. Klimenko, Ju. Klimenko)

## Conclusion

Every small aspect of the construction of images, for example, an angle of view, entourage, some details, composition, viewpoints etc. could be very important. If the specialist making the reconstruction forgets about it the images will be much less impressive.

It means that such criteria as ones used in photography or art can be used for the reconstructions either. It is true that the wish to use these criteria for reconstructions and desire to make "beautiful pictures" could conflict with the main aim of any reconstruction - to create its reconstruction and to represent it as authentic as possible. However if one does it accurately it could help to reach this aim. Moreover, in good examples of realistic art and photography these methods only help to express the main idea. In modern studies on historical reconstructions the main idea is to show the authentic features of a building (details, materials and architecture) and to express the impression which the monument could produce upon the viewer using realistic light, comfort angle of view and it is of no less importance that we understand which visual methods should help us.

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