EXAMPLES OF GOOD PRACTICE IN 3D VISUALISATION IN PREVENTIVE ARCHAEOLOGY

Milan Horňák (Via Magna)

Archaeological visualisations focused on the analysis of results of field excavations have been considerably improved by development of digital and IT technologies. New technology did not provide faster, more accurate and efficient modes of data recording and processing, but instead opened a series of new conceptual questions regarding the study of past architectures and the possibilities of presentation of the results of archaeological excavation to the public. It should be emphasised that, 3D reconstructions help develop the protection of archaeological monuments, they help promote the work of archaeologists, and they directly influence cultural heritage awareness of a population, which is the most important aspect of the preventive protection of cultural heritage. From the perspective of preventive archaeology, it is also a very efficient tool that can add a significant scientific value to research results, as this aspect is almost absent in the process of rescue research.

One of the aims of the project EU FP7 MARIE CURIE ACTION IAPP "CONPRA – Contributing the preventive archaeology: Innovativeness, development and presentation", the results of which are presented in this monograph, was to introduce methods and possibilities of 3D visualisation, with emphasis on the education of variously qualified archaeologists active in the process of preventive archaeology. I here present examples of good practice in the application of 3D visualisation in archaeology.

Scientific principles of 3D virtual reconstructions

The input for 3D reconstructions created by our company consisted of data obtained from various rescue archaeological investigations (e.g. the northern terrace of the Bratislava Castle, Bratislava, the medieval monastery Skalka nad Váhom and the settlement from the Late Bronze Age in Rajec-Charubiná; Figure 47) in which the author of this article acted as the head of research and which were performed by the company Via Magna s.r.o. – a partner institution in the CONPRA project. The archaeological data were collected in said excavations by applying the methods of 3D photogrammetry so as to allow creation of the geo-referenced photograms in the program Agisoft software-Photo Scan Professional and Capture reality. The photograms subsequently served as the direct input for reconstruction, modelling and visualisation of the investigated masonry architecture from the La Tène culture (European Iron Age) and the Middle Ages, or archaeological structures from the Late Bronze Age. The programs SketchUpPro and Cinema 4D were used as the basic analytic tool for 3D models.

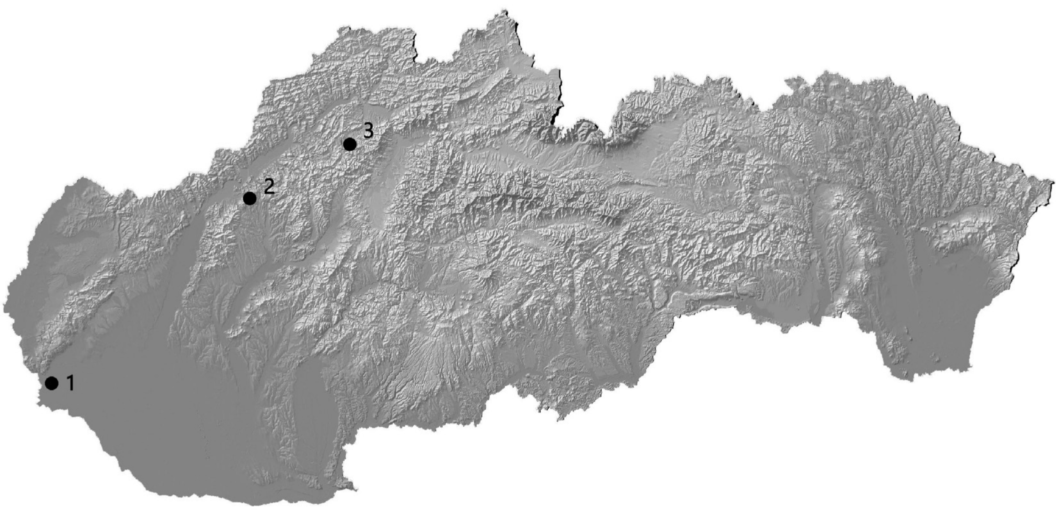


Figure 47. 3D visualisations of archaeological/architectural sites: 1. Bratislava; 2. Skalka nad Váhom, Trenčín; 3. Charubiná, Rajec

VR of a Celto-Roman building, Bratislava Castle, Bratislava, Slovakia

During the archaeological research of the northern terrace of the Bratislava Castle in 2013-2014, directed by the author of this article, a unique masonry building which was, according to the related finds, dated to the 1st century B.C., was reinvestigated. It was the best-preserved building of the acropolis of the Late La Tène (Celtic) oppidum. We named it “the building with eights pillars”. The name reflects the fact that this was the only structure with almost completely preserved ground floor and walls on each side.

However, the building was damaged, especially in the Early and High Middle Ages, with the Baroque period constructions. The damage includes quarrying of stone walls down to the foundation level, truncation of the original floor and dismantlement of one of the pillar stands. The walls were preserved up to the height of 50 cm. The pillars were placed on rectangular sandstone slabs the dimensions of which were 52x54 cm. Still discernible at the time of the excavation were central crosses; also, a circle of 43 cm in diameter was visible on two of the slabs. No complete, or parts of, worked stone pointing to the presence of some other architectural elements were found. We assume, on the grounds of the revealed layout, that this was an atrium building, similar to the ancient atriums in buildings of the Classical world in the Apennine Peninsula.

3D reconstruction was created using SketchUpPro software. The basis for the modelling was the 3D photogrammetric model made during the archaeological excavation (Fig. 48).

Figure 48. Ground plan of the Celto-Roman building II, the basis for the 3D reconstruction.

In creating this 3D reconstruction, we started from a theoretical hypothesis that emulation of Roman buildings in Celtic environment was a symbolic demonstration of the influence of Celtic rulers of the Bratislava oppidum. However, we were aware that the "replica" of a piece of Roman architecture located in the different climate likely had a different meaning and functional than in the country south of the Alps. We know from the literature that columns were used by the Romans only for atrium buildings. The reconstruction itself was performed by gradual layering of individual architectonic elements into the logical structure, and subsequent rendering of colours (Figure 49 a-e):

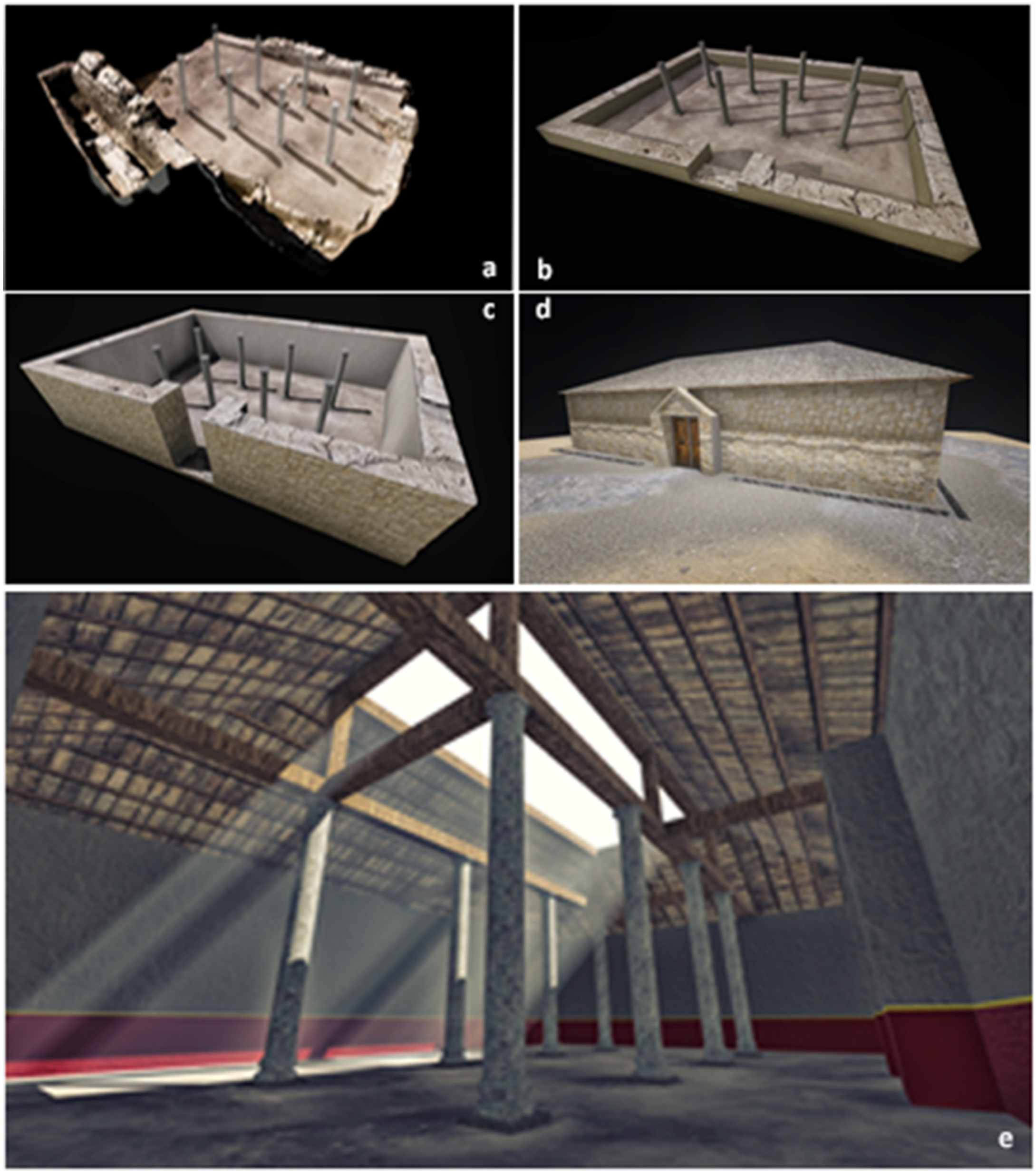


Figure 49 (A-E). Sequential modelling of the reconstruction of the Celto-Roman building II.

Medieval monastery Skalka nad Váhom, Trenčín, Slovakia

According to generally accepted interpretation, the Benedictine abbey was founded in the area of "Villa Scala" by the Nitra bishop Jacob I in 1224. This foundation allegedly happened at the cave popularly named "Skala" which, in the 11th century, was a place where, according to the Maurus legend, saints Andrej-Svorad and Benedict resided. The monastery was taken over by the order of Jesuits in 1644 who completely renovated the monastery in the period 1667-1669. Further building modifications were made in 1712-1713, when both the small church and the monastery were renovated in the aftermath of the Kuruc wars. A new kitchen was built then and a few rooms added. The large hall was turned into a refectory, which was paved with square stones and illuminated from three sides with large windows. New windows were also installed, new chimneys built and the tiled roof repaired. In 1768, all monastery buildings got new roofs. After the Jesuit order was disassembled, the abbey property was transferred to the state ownership. he property was received by the Study Fund in 1780 and the monastery administration was assigned to the Skalka parish. The overall appearance of the monastery in this period is captured in an important iconographic source, providing the general ground plan, the layout of individual floors, as well as views of the facades; this source served as a basis for our 3D reconstruction.

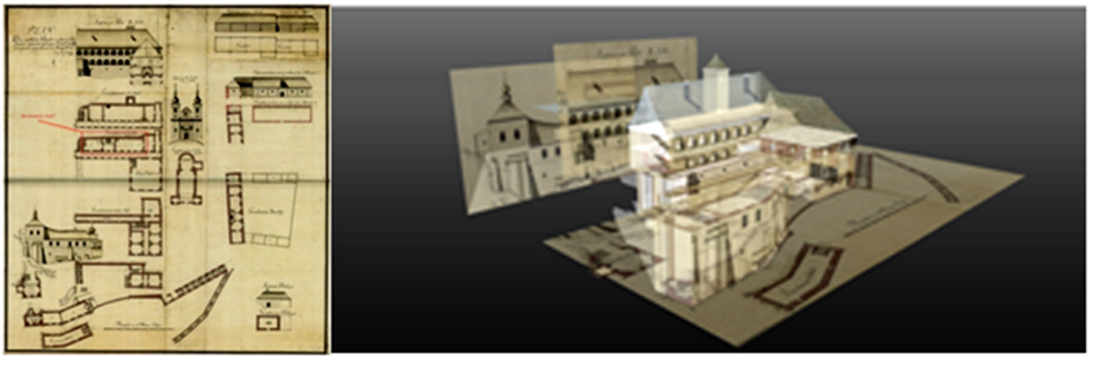


Figure 50: Baroque depiction of the monastery from 1783 (A), suggested model (B).

3D reconstruction was created using SketchUpPro software. The basis for the modelling was a historical depiction of the monastery in its baroque development phase (Figure 50) and the 3D photogrammetric model of its present condition (Figure 51). The process of the 3D reconstruction is shown in Figures 52 A-E).

Figure 51. View of the current state of virtual reconstruction.

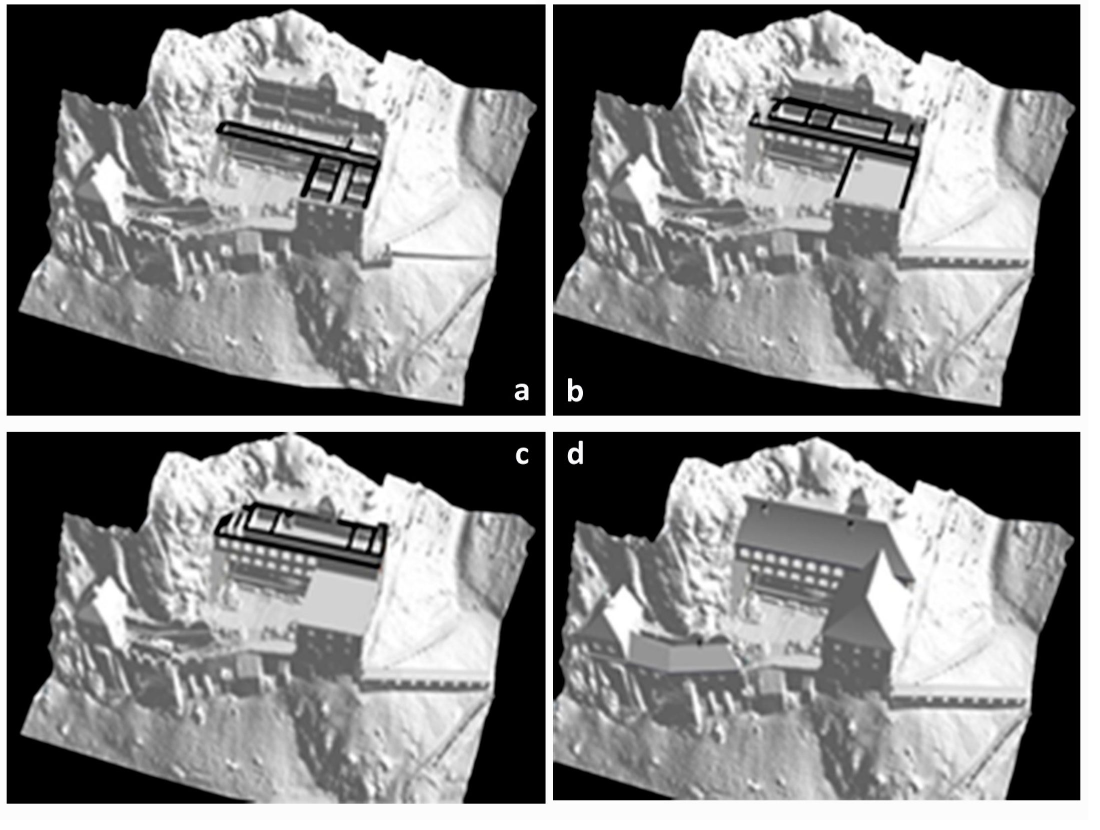


Figure 52. (A-E) step by step modelling of the baroque phase of the monastery.

The last step was colour rendering

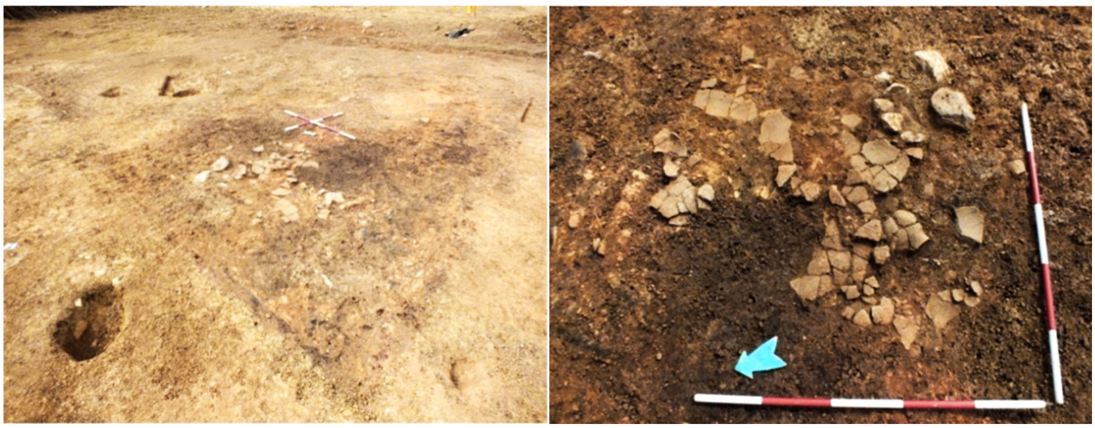
Figure 53. Final 3D reconstruction of the baroque phase of the monastery (M. Hornak).

Late Bronze Age settlement in Charubiná, Rajec, Slovakia

The archaeological research is currently associated mainly with building investment actions, and such research must be performed prior to the start of construction works in line with the relevant legislation. In compliance with the legislation, rescue investigation was performed in March 2016 in the area of planned expansion of the existing local golf courses. A settlement from the Late Bronze Age (1000-700 B.C.), built by Lusatian culture community, was excavated.

The dominant section of the examined location consisted of settlement structures. It was established that the structures were dug into clay subsoil. They were of irregular circular shape at the level at which they were identified. We here focus on those of the structures that allowed us to understand the life in this prehistoric settlement and that provided sufficient input data for 3D reconstructions.

Destruction of a prehistoric hut: After the removal of topsoil, partially preserved house foundations were recognized in the field (Figure 54 a) consisting of floors with distinctive layer of red colour containing high concentration of screed and ceramics (Figure 54 b). On the grounds of the interpretation of screed as a structural component of the building, we assumed that the remains represent a destroyed wall. Clay floor was preserved in the interior of the house; on top of it, a significant concentration of pottery fragments and traces of several fireplaces were found. A drainage gutter was probably dug around the house, of which parts were preserved to the south-east and north-west of the house foundations.



Figures 54 A, B. (A) Remains of the house – clay floor with the concentration of potshards. (B) Detail of the concentration of pottery fragments.

Cooking pit: The examined feature, which was interpreted as a cooking pit based on its contents and the appearance, was situated approximately 7 m southwards from the above-described house. The excavation area enclosed the destroyed house and its depth was subsequently extended to include the detected cooking area. The cooking area was filled with burnt stones, which were placed into the pit to provide sufficient heat whether for heating of water or for slow cooking of meat-based meals.

Structural complex No. 3: A group of settlement structures was situated in the lower western part of the examined area. It was interpreted as a “working area” of the described house. Its main axis overlaps with the drainage gutter, which probably started nearby the house. It could be established that all of the registered remains were preserved thanks to this drainage from the Late Bronze Age, as the drainage of the slope prevented erosion, which would have been caused by rain flow being retained on top of the impermeable clay subsoil. The gutter was filled with soil containing large quantities of pottery and house rubble. A distinctive accumulation of pottery was found around the gutter – remains of whole but broken pots. These deposits were most likely associated with the use of the house.

The data gathered by secondees A. Đuričić and N. Jončić during the rescue excavations using Cinema 4D software. We have relied on the available knowledge as a starting point, considered also the current problems when attempting a reconstruction of prehistoric dwellings.

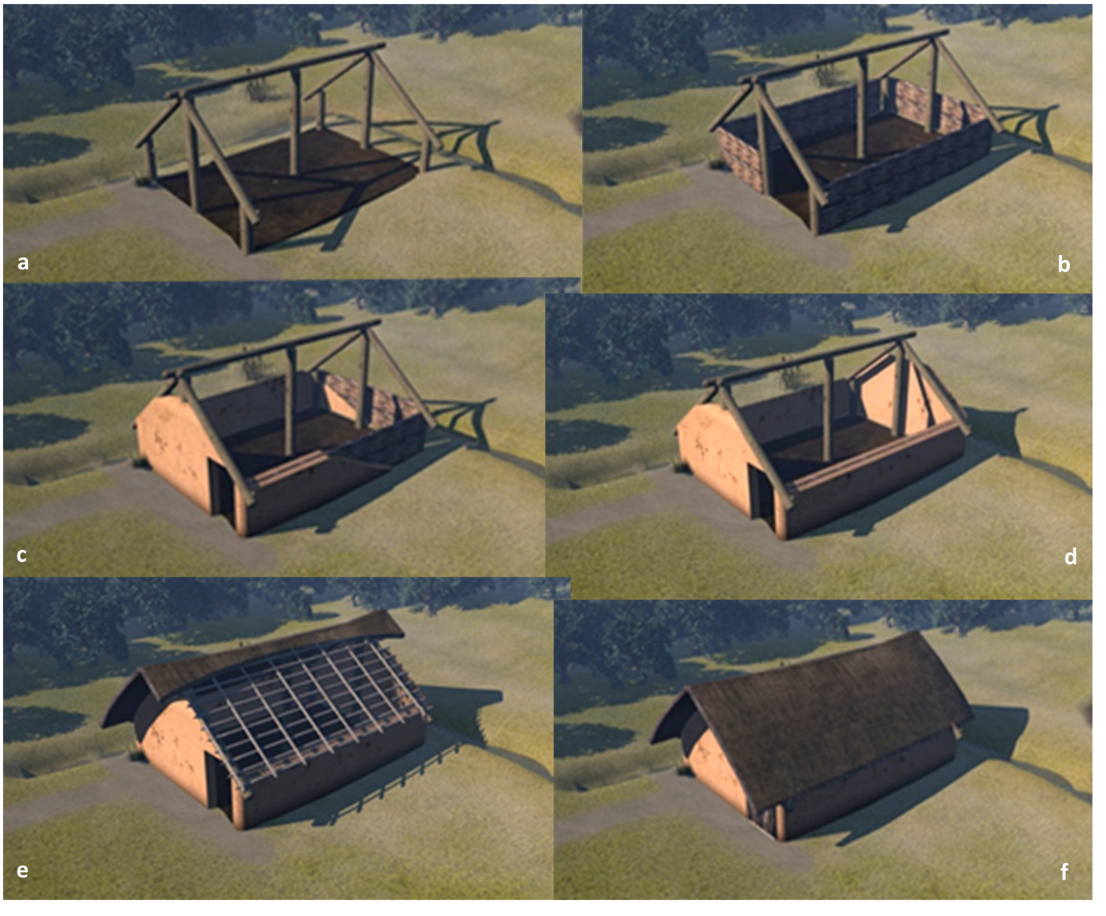


Figure 55. Stages in modelling of the reconstruction of the Late Bronze Age dwelling

Conclusion – Different ways of presenting 3D virtual reconstructions

In conclusion, we would like to present experiences gained during the creation of the described 3D models.

Quality of the input data: Data obtained through field and archive research must be selected prior to the 3D reconstruction itself. Such data should allow extracting specifically the descriptions of individual construction stages, structural elements and function(s) of the structure. Thanks to the fact that large quantities of data are accumulated during archaeological investigation, it is possible to use them for 3D reconstruction already during the research. If we wish to place the model in space, we need to work with geo-referenced data. For this purpose, geo-referenced photographs of the layout of architectural elements or distribution of artefacts appeared to be the best source.

Selection of software and cooperation with IT specialists: Selection of suitable software is an important aspect in 3D reconstruction in archaeology. The current market offers various fee-based or open-access programs. We decided to use programs SketchUp Pro and Cinema 4D, as those were part of the program portfolio of the Centre for Digital Archaeology, University of Belgrade. The user interface of both programs is generally user-friendly, but based on personal experience and the demands placed by software on the archaeologist working in preventive archaeology (e.g. the requirement to be able to work in graphic and geodetic programs), I would recommend cooperation with experienced IT experts, as the training in the use of new programs requires considerable time and previous knowledge.

Methods of presentation to the public: From the perspective of a common user, we can, in principle, display results of the 3D reconstructions in several open-source programs that allow various presentation properties. First, we used Adobe Reader interface (PDF). This format proved to be more-or-less adequate, but it has problems with imaging, it jams and can rotate the model only about one axis. We then tried SketchUp environment. The results were similar to those obtained in Adobe Reader. The third method was to create a classic video (in AVU or MP4 format). This method proved as very efficient because of its easy access, fast loading and granted complexity of the information that we want to pass on through 3D reconstructions. This last method was displayed by means of QR codes (various models); it is very impressive, but it requires additional time and cost for programming some specific applications.