Fact or Hypothesis?

Archaeological reconstructions based on 3D models created for documentation purposes by photogrammetry and CT scanning

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How can digital 3D models created for documentation purposes also be used as popular science reconstructions to clearly convey the difference between fact and hypothesis?

Initial situation

With the advent of new digital media such as laser scanning, photogrammetry and even CT scanning, the volumes of data and 3D models for documentation purposes are also increasing (Campana and Remondino, 2016). The main aim of this work was to ascertain if it is possible to make these 3D models, which might not be as detailed as they could be, more accessible to non-professionals and to use them to create accurate reconstructions.

Experience has shown that an unproven hypothesis can be mistaken for a proven fact if the reconstruction is too realistic in nature (Schurz, 1995). Another task was therefore to find suitable imagery that would allow viewers to distinguish immediately between scientific fact and scholarly hypothesis.

Case 1: Roman pottery kiln, a 3D model created by photogrammetric means

Several well-preserved Roman pottery kilns were discovered during an excavation at the site of the Vicus of *Tasgetium* on the south bank of Lower Lake Constance in 2000. The archaeologists decided to block-lift one of the more intact kilns for restauration in the laboratory and display at the museum.

The kiln was placed in a corner of the museum with two sides concealed, one by a wooden panel, the other by the wall.

In 2016 the decision was taken to record the exhibit by photogrammetric means in order to more accurately document it. The 3D model generated was incomplete on two sides due to the exhibition situation described.

Challenges posed by making the kiln and its workings accessible to the general public:

Since the 3D model of the kiln was incomplete and the model by itself, and particularly its original function, is not easily recognisable to a non-professional, some artistic adjustments had to be made. Knowing that a three-dimensional reconstruction could lead viewers to believe that the kiln's appearance was scientifically proven because it would look like a 3D scan of an intact kiln, the reconstructed parts in the 3D model were depicted in a completely different style and medium (Schurz, 1995). The medium that was eventually chosen was a short animation showing the bare rendering without any reconstructions followed by the reconstructed parts faded in as transparent pencil drawings. This resulted in an interesting mix of two diametrically opposed creative means of expression, photorealistic rendering and pencil drawing, which, it was hoped, would ensure that the distinction between documented fact and hypothetical reconstruction would immediately be made.

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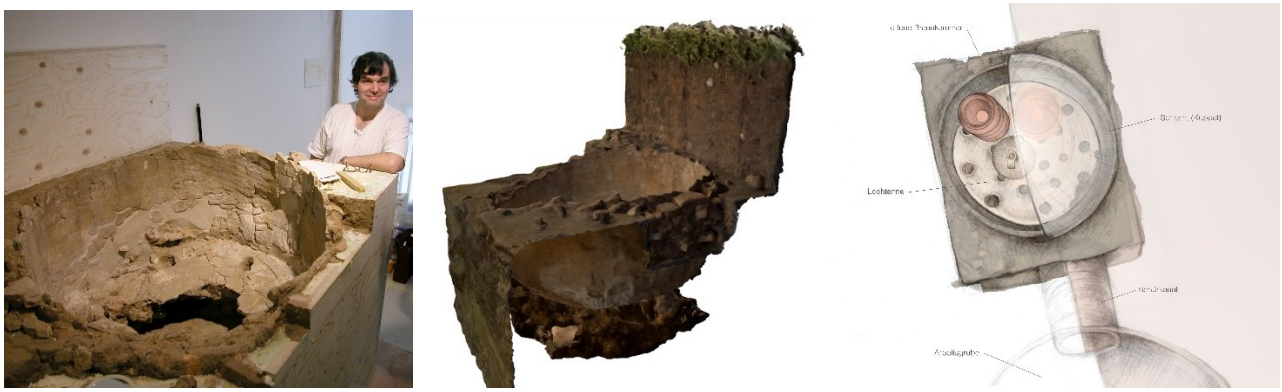

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Fig. 1. The different stages of the recovered pottery kiln a) during installation in the museum; b) the bare 3D scan, screenshot from the final animation; c) the reconstructed pottery kiln, screenshot from the final animation (© AATG).

Case 2: Block-lifted early medieval features, 3D models created from CT scans

In 2013 a Merovingian-period cemetery with over 130 graves was discovered on the outlet from Lower Lake Constance. Due to time constraints and difficult weather conditions the decision was made to block-lift the delicate features. Shortly after the recovery of the features, CT scans were taken of about 40 of the gypsum blocks.

In 2018 the CT scanning data were reprocessed in order to document the artefacts and their locations during excavation in the restoration laboratory.

Challenges posed by making a grave or traditional costume accessible to the general public:

Because the CT scans were taken in a hospital, the density settings of the scanner were adapted to record recent material (Frey et al., 2014). This raised additional problems in that the settings were not ideal for documenting corroded metal or partially decomposed material. The 2D sectional views, on the other hand, were sufficient as documentation aids during the excavation of the individual blocks. However, the 3D models that could be generated from the scans exhibited a low resolution.

The same reasons as cited for case 1 led us to decide that the depiction of the grave and the reconstruction of the Merovingian person in traditional costume should not be too realistic. The problem, however, was that a layperson would find it difficult to understand a 3D model generated from a CT scan. The arrangement of the objects and only partially preserved bones would cause confusion. Single sectional images of CT scans are even harder to decipher for the general public. It was therefore decided that the exhibit should first explain why and how CT scanning is used in archaeology, so that the 3D model generated would be easier to understand. Individual objects that could clearly be identified on the CT scan with the help of reference artefacts were selected and shown in juxtaposition with the hypothetical reconstruction. The blocks have largely been left intact and the objects have not yet been excavated. By juxtaposing the 3D models generated from the CT scans with their reconstructions, viewers are free to independently interpret them.

The resulting artwork (Fig. 3) was longlisted for the 2018 international *KANTAR Information is Beautiful* Award.[2]

[2] https://iibawards.herokuapp.com/showcase/3293-scanning-arnegund, (Accessed, 28 May 2019)

a b c

Fig. 2. The CT data at different stages; a) sectional view; b) 3D model of the metal artefacts generated from a CT scan; c) 3D model of the metal artefacts with a superimposed transparent 3D model of the entire gypsum block generated from a CT scan (© AATG).

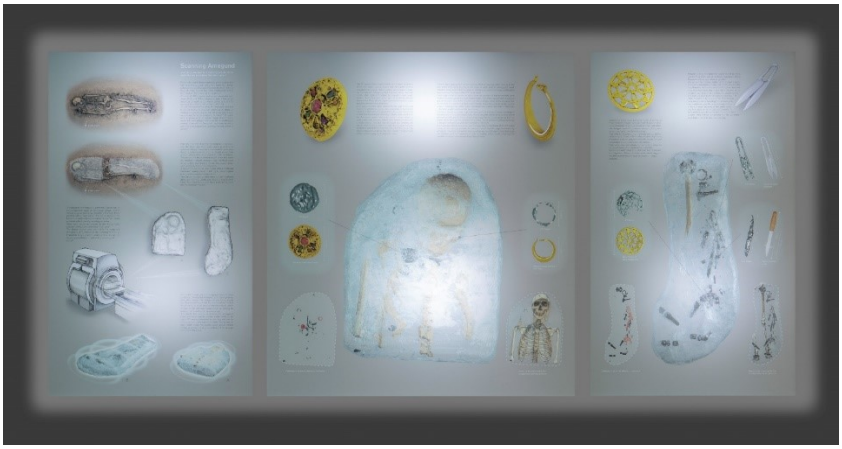

Fig. 3. The final layout of the artwork on three backlit acrylic glass plates. (© AATG).

Conclusion

When processing 3D data recorded for documentation purposes, the best prerequisites are given to distinguishing between fact and hypothesis in a popular science reconstruction, since the documentation should record the pure facts. For the reconstruction it is recommended to differentiate the design from the 3D model of the documentation, for example by choosing a different design medium. Furthermore, sequences of images can help to explain the exact facts and circumstances of the documentation or reconstruction and thus give the viewer scope for his or her own interpretations.

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