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DIGITAL 3D RECONSTRUCTED MODELS IN THE MUSEUM CONTEXT – ARE THEY AUTHENTIC?

Giving a vivid picture of the past, digital 3D reconstructed models[1] as visualisations of historical buildings or objects are a popular medium in the context of museums. As a medium for the dissemination of knowledge, these 3D reconstructed models are able to clarify complex spatial and object-related relationships. They thus also make it possible to represent large-scale cultural regions such as the imperial tomb at Zhaoling (Shaanxi province, China), in an easy-to-understand manner, and to place cultural heritage objects in a spatial context (figs 1-3).

But what is authentic about these 3D reconstructed models? How would it be possible to situate these digital 3D reconstructed models in the current scholarly discussion about historical authenticity? This is not an easy question to answer, because the subject is made highly complex by various parameters. This paper provides an overview of the current discussion and of the complexity of the issue – in other words, a consideration of these digital 3D reconstructed models on a metalevel.

ASPECTS OF AUTHENTICITY

Currently there is no clear definition of authenticity related to these 3D reconstructed models; research is still in the early stages here. This article is based on a definition of authenticity in terms of the scientific validity and credibility of these 3D reconstructed models. There is therefore no easy answer to the question of the authenticity of these models, for example, in terms of their being a suitable form of presentation; rather it is necessary to consider all aspects of these models.

Fig. 1 Area of the tomb at Zhaoling (Shaanxi province, China), North Part. – (Photo M. Pfarr-Harfst).

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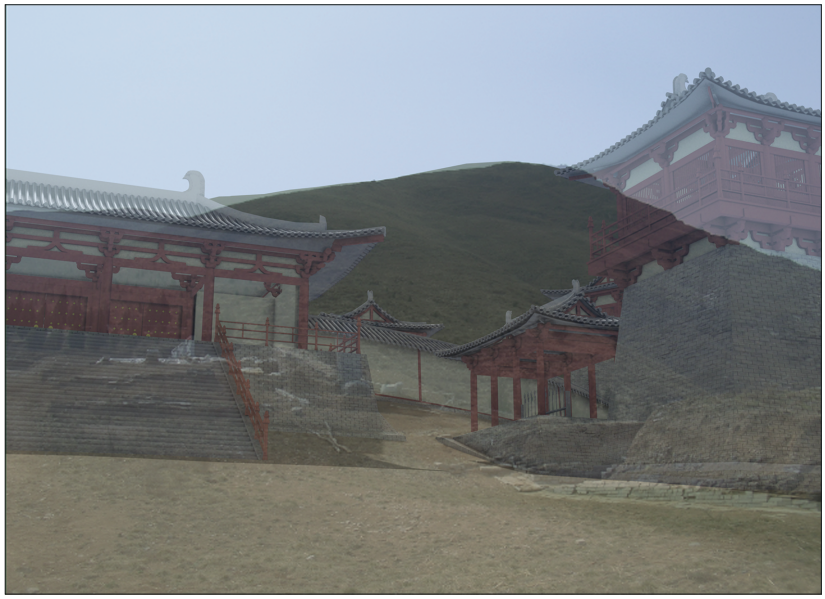

Fig. 2 Digital 3D reconstructed model of the tomb at Zhaoling (Shaanxi province, China), North Part. – (© Fachgebiet Digitales Gestalten, Technische Universität Darmstadt 2006).

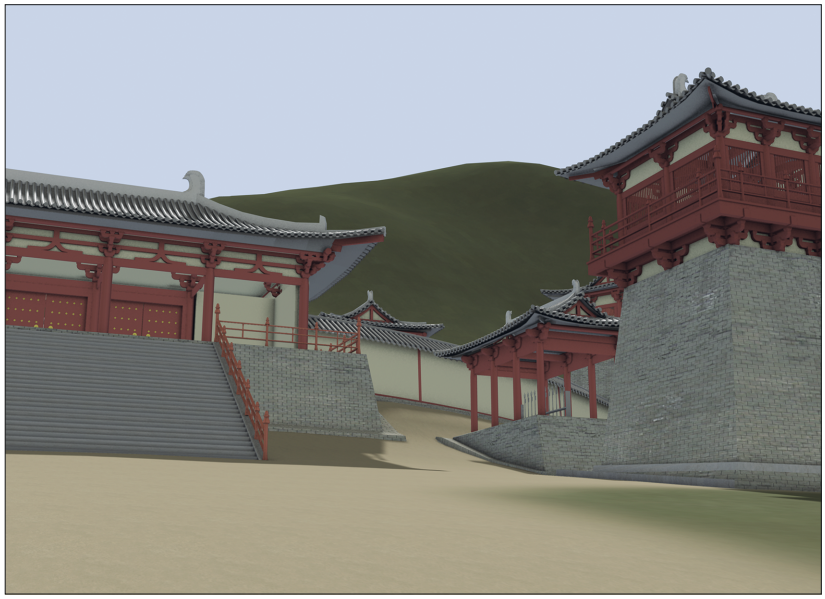

Fig. 3 Digital 3D reconstructed model of the tomb at Zhaoling (Shaanxi province, China), North Part. – (© Fachgebiet Digitales Gestalten, Technische Universität Darmstadt 2006).

Different typologies of visualisations and their definitions

A first aspect is the question of the typology of these digital 3D reconstructed models in combination with a binding definition of the term. Currently there is a wide range of different typologies of 2D or 3D visualisations in the context of cultural heritage[2]. Digital 3D reconstructed models are a subcategory of these visualisations and they are the most frequent form of visualisation in the museum context (**fig. 4**).
These 3D models could be characterised as digital-born objects and as the result of a complex hand-modelling process. Based on this, digital 3D reconstructed models could be further defined as a kind of digital 3D knowledge model, because they are computer-based models of buildings, building structures or structural elements in which object-based knowledge is gathered, consolidated, condensed and visualised. The consequence of this process is the regeneration of knowledge, and so these models effectively become mirrors

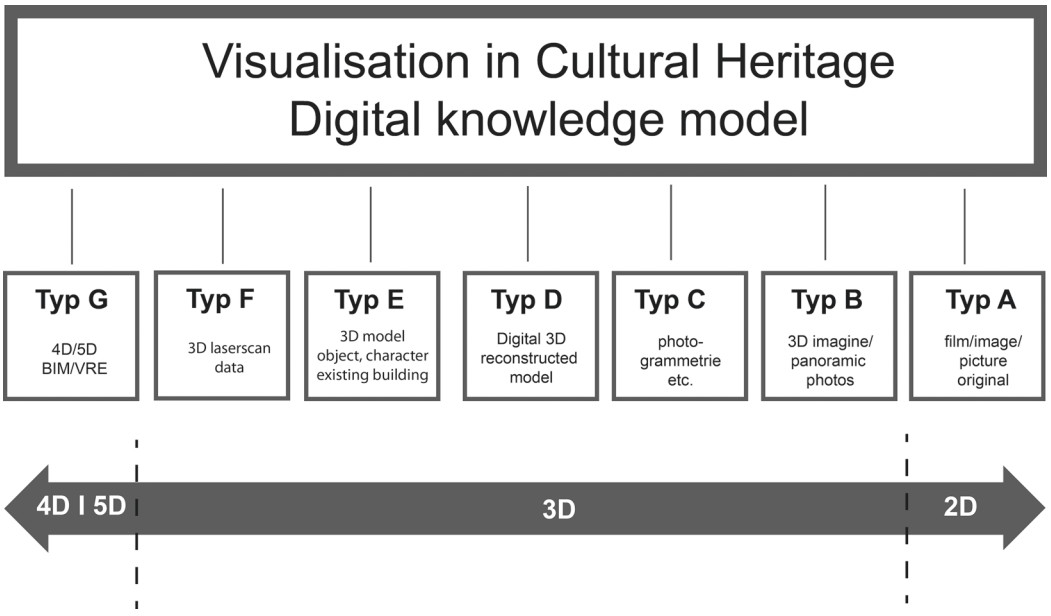

Fig. 4 Different typologies of visualisation in context of cultural heritage. – (Illustration M. Pfarr-Harfst).

of current research and objects of future research; as such, they are an innovative and future-oriented tool in the researching, dissemination and preservation of building culture[3].

WORKING PROCESSES AND METHODOLOGY

The working and creation process of these digital 3D reconstructed models is highly complex, so in relation to questions of authenticity it is necessary to consider the process of genesis and the methodology of these models. They are a synthesis of sources, the historical and cultural context, project backgrounds (*zeitgeist*) and the reconstruction process. In them, information is gathered, consolidated, filtered and compiled in a digital data set. The result is always a digital data set, which can then be further processed for various areas of application[4].

As mentioned above, they are usually the result of a non-automatic modelling process, which means that these models are conditioned by the person processing them and his or her technical and specialist expertise.

Today, there are projects in a scholarly context in a number of disciplines, with participation in the process of creating a 3D model being dependent on other influential factors such as the idea, occasion, and aim of the project, project partners, and so on[5]. There are two basic types of participation:

– content-related participation by disciplines such as archaeology, the history of art and architecture, and architecture;
– technical participation (model creation) by disciplines such as computer science, digital media design, architecture, and various engineering sciences.

However, the boundaries between these two basic types are often somewhat blurred. The consequence of the participation of such a wide range of disciplines is the use and integration of various initial data or typologies in the three-dimensional data set and the further processing of the same. The participation of various disciplines, the non-automatic creation process and the use of differing initial data are directly linked to the

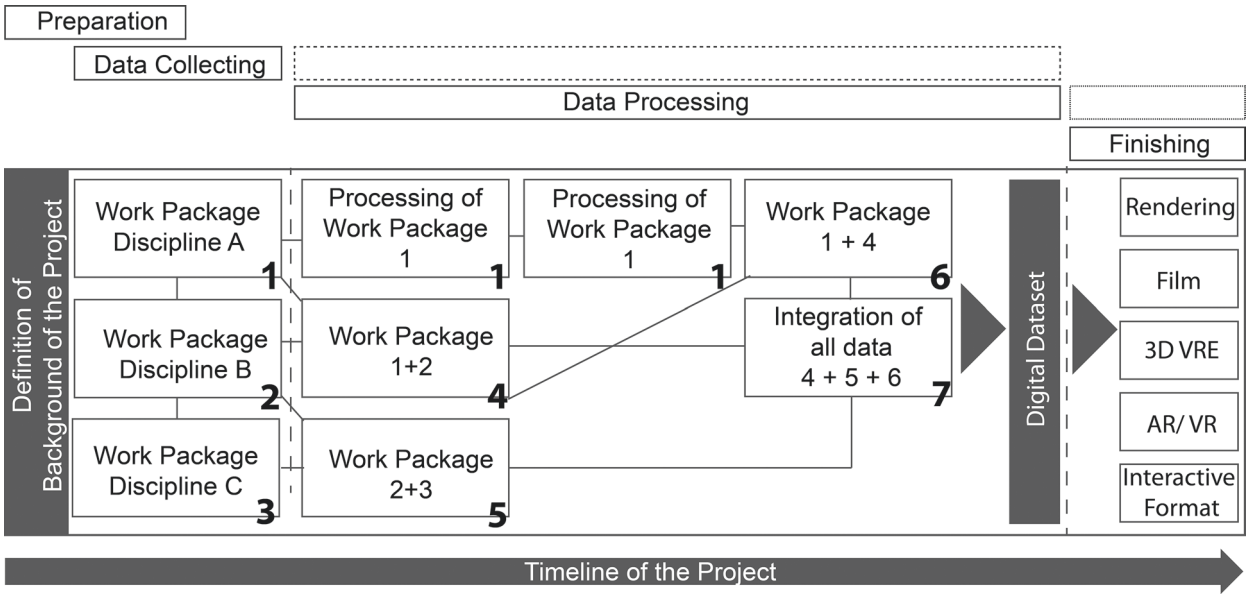

Fig. 5 Schema of a typical working process with different work packages. – (Illustration M. Pfarr-Harfst).

question of quality assurance in terms of authenticity. For this, a study of various 3D reconstruction projects[6] was carried out to investigate and compare such working and creation processes in order to examine the question of similaities among the different processes and, in connection with this, the definition of guidelines and strategies for quality assurance. As a result, it has been possible to define a typical working process consisting of four main stages: preparation, data collection, data processing and completion (**fig. 5**).
The different work stages are connected by a circulating process. However, it is already evident that various typologies of 3D models were incorporated into the end product. Furthermore, it was possible to identify an input-output principle between the different milestones of the project. At the end of this four-step working process, a digital data set is generated that determines the input for the end phase of the project, namely the type of presentation or the output formats. The phases are anchored in a project framework. The project background – the intention, underlying technology, and disciplines involved – should be defined at the outset and provide the framework for the entire project. This is absolutely crucial. There must always be a milestone, a quality check at the important points in the process where the output from one phase generates the input of the next one. This needs to be considered, and any necessary adjustments made[7].
So, what is authentic about such a complex data set? This question is not an easy one, and cannot really be answered completely at the moment, because the actual complexity of the task, the generation and processing of sources, information and, ultimately, knowledge, lies in the phase of data processing. A first step could be to establish some common guidelines based on the defined four-step working process and regular milestones as well as binding structures of such a process.

Repository of knowledge

The current source and processes reveal that these models are repositories of knowledge or so-called digital 3D knowledge models. They are even a fusion of various types of knowledge that can be called primary and secondary sources.

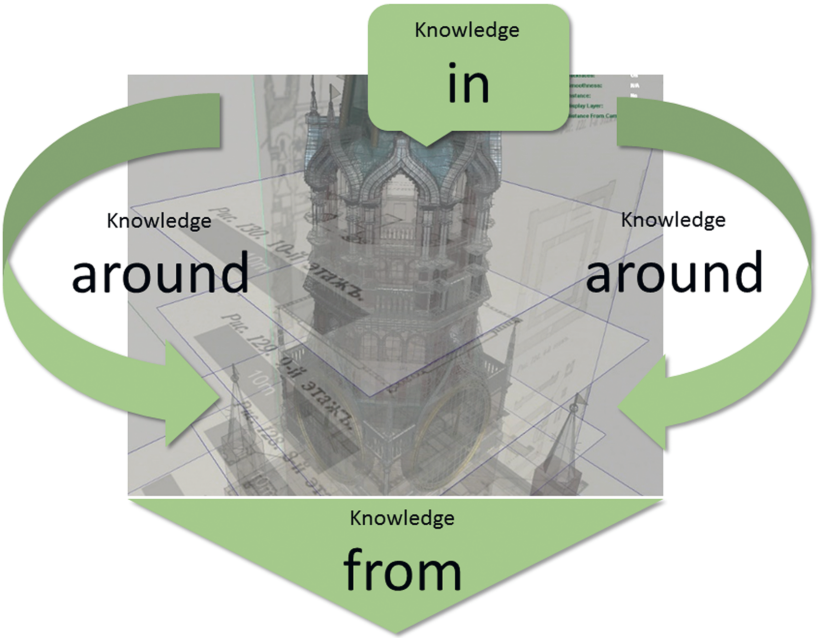

Fig. 6 Digital knowledge models – different kind of knowledge. – (Illustration M. Pfarr-Harfst).

The primary sources of digital 3D reconstructed models are excavation results, knowledge gained from research, extracts from literature, surveys, and plans. Secondary sources may include sketches, comparable structures and, above all, personal knowledge. This personal knowledge is often essential for the construction of the models, and is in turn the result of the complex creation process.
Ideally, during such a complex working and creation process new knowledge related to the historical building or building structure in question is generated. It is possible to define three categories of knowledge in the field of digital 3D reconstructed models (**fig. 6**):

– knowledge in the model, which is stored knowledge from the various sources that is transferred into three-dimensionality;
– knowledge around the model, which is knowledge that contains the context of the model, important background information on the project, project partners, technical systems, intention and objectives (all of the factors that directly influence the model and the end result);
– knowledge from the model, which is knowledge that is regenerated from the transfer into three-dimensionality and the fusing of the sources.

Form of presentation

All knowledge needs a form of presentation, a medium in or by which it can be presented[8]. This also applies to 3D models, which are a product of different geometric forms and of the process and resources. This is an area where technology offers a high level of variety in the forms of presentation, output and presentation formats, and poses tremendous challenges for authenticity. Every presentation format is an »image« of the 3D data set and every 3D data set is in turn an image of the knowledge contained therein. Today, the presentation methods in a museum context range from hyperrealism to scheme models and feature models. Aesthetics and appeal are just as important as the *zeitgeist* of the presentation.

The spectrum of digital output formats for the transfer of knowledge is also increasing at a tremendous rate as the result of technical development. We have at our disposal the following formats:
– rendering,
– film,
– augmented reality / virtual reality,
– projections,
– holo projections,
– interactive formats, and
– 3D print.

These formats can also be combined with each other. This already clearly shows that the type of representation and presentation, and the combination of the various output data, complicate the question of authenticity[9]. This could be clarified by asking a few questions:
– What is a finding that is rooted in a 3D model, what is a hypothesis?
– How can a 3D computer model be presented? Using colour coding or transparency?
– Or is it the idea of a white, i. e. a colourless presentation, that follows a certain aesthetic and that could be a suitable solution for the clarification of authenticity?
– How, then, should we evaluate hyperrealism? Is this even a serious kind of presentation in a scientific museum context?
– And how do we handle the presentation of finds?
– Can we codify the models and their presentation so they produce a recognition effect in users and visitors?

These questions illustrate the challenges and the need for research associated with the forms of representation and the presentation related to the question of authenticity[10].

Characteristics, potential, application and the challenges they entail

This is underscored once again looking at the links between characteristics, potential, application options and fields of application. Some of the potential of the digital 3D knowledge models is illustrated in particular by the types of representation and presentation formats. These digital 3D reconstructed models offer potential for three fields of application: research, preservation and transfer of knowledge. These fields of application are usually closely linked, merging with one another, since a digital model or data set will, ideally, permit various applications and output formats. There is a complex association between characteristics, potential, application option and field of application. The characteristics generate potential, which in turn produces the application options that are then transferred to the fields of application. The characteristics of the 3D models are:
– digitalisation,
– three-dimensionality, and
– imagery.

This results in the following potential for research, transfer and preservation:
– variety of output forms,
– clarification of complex content and spatial associations,
– presentation of variants,
– concentration, generation, verification and transfer of knowledge,
– communication, and
– virtuality.

This potential in turn generates further application options, i. e. opportunities for the above fields of application. The boundaries of the application options resulting from this potential are often loose, so again clear rules for authenticity need to be found. The range of potential and application options is huge, but how can quality possibly be assured?

Documentation – a first step?

To do justice to the claim for authenticity, it is necessary to consider the issue of the evidence of knowledge, of documentation and of archiving. It is important to maintain a balance between the scholarly claim and the transfer of knowledge using these digital 3D reconstructed models, especially in the museum context. So what could this kind of documentation look like, and what is the least it must contain in order to present the knowledge in, around and from the models?
In 2010 a documentation system was developed that is known as a »four-level system« and which documents every level of knowledge[11].

- Level 1 is the background to the project – that is, the knowledge around the models: project partners, intention, technology, results, etc.
- Level 2 contains the project context – the knowledge in the models and also around the models. This includes the cultural, historical and architectural backgrounds.
- Level 3 defines the classification of the documentation. This should be done individually, since every project has its own preconditions and rules.
- Level 4 is the main focus and is known as the level of evidence, where the origins and the creation process as well as the main decisions/milestones are documented. For this, in what is known as a sources catalogue, the source is assigned directly to the project, and, in the method catalogue, the project to the sources and the process.

This kind of scholarly documentation is very complex and the question arises of the minimum measure for transferring knowledge in a museum. So, how could the authenticity, the scholarly character of a digital 3D reconstructed model be made visible to visitors without swamping them and without boring them?
Based on this four-level system, in 2016 a new simple method of documentation, the reconstruction-argumentation method, was generated at the Technische Universität Darmstadt. Here a simple 2D image of a reconstructed building is directly linked with the decisions taken during the process of reconstruction and the scientific sources of reconstruction[12]. This system is suitable for all forms of reconstruction models (digital or analogue) and could be suitable for use in various disciplines.

DISCUSSION

So how could the authenticity of digital 3D reconstructed models be summed up? Digital 3D reconstructed models, in their capacity as knowledge repositories, are a fascinating, innovative and future-oriented medium in research and knowledge presentation whose potential facilitates a paradigm change in the transfer of knowledge. However, there are no strategies or standards for their authenticity, for the plausibility of the knowledge contained in the models, or for quality assurance[13]. Therefore, the question regarding authenticity needs to be asked on three levels:

- How authentic is the knowledge that is generated from the process and sources?
- How authentic is the 3D computer model and its geometry?
- How authentic is the presentation of the 3D computer model and the knowledge it portrays?

In the long term, it is necessary to find binding guidelines or strategies for each of these levels – or at least ones that are clear and easy to understand.

– At the level of knowledge: on the one hand, a practicable documentation strategy, and on the other thorough guidelines for the process as quality assurance
– At the level of geometry: technical exchange formats that facilitate editing and archiving
– At the level of presentation: a kind of code for plausibility and authenticity that users and visitors are able to decode

This is the only way that we can continue to do justice to the claim for »scholarliness« in the museum landscape and to the potential of imagery in educating with respect to authenticity.

Notes

1) Pfarr-Harfst/Wefers 2016.
2) Pfarr-Harfst/Wefers 2016.
3) Pfarr-Harfst/Wefers 2016.
4) Pfarr-Harfst 2015.
5) Münster 2011.
6) Pfarr-Harfst 2015.
7) Pfarr-Harfst/Wefers 2016.
8) Mahr 2004, 6
9) Grellert/Haas 2016.
10) Münster et al. 2015.
11) Pfarr 2010.
12) Pfarr-Harfst/Grellert 2016.
13) Münster et al. 2015.

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Zusammenfassung / Summary

Digitale 3D-Rekonstruktionen im musealen Kontext – Gibt es eine Art von Authentizität?
Digitale 3D-Rekonstruktionen sind mittlerweile vor allem im musealen Kontext als Medium der Wissensvermittlung etabliert. Obwohl sich die technischen Systeme und Applikationen stetig weiterentwickeln und sich so neue Potenziale und Anwendungsmöglichkeiten für digitale 3D-Rekonstruktionen eröffnen, ist beispielsweise die Frage nach ihrer Authentizität bisher nicht ausreichend beantwortet. Digitale 3D-Rekonstruktionen im Kontext des Kulturerbes können längst als eigenständige Typologie, als digitale Wissensmodelle betrachtet werden, die aufgrund ihres Geneseprozesses zum Wissensträger werden. Als solche sind sie neben Sprache und Schrift eine neue Ausdrucksform, ein neues Medium der Wissensdarstellung. Der vorliegende Artikel beleuchtet dieses breit gefächerte Feld der digitalen 3D-Rekonstruktionen als Wissensmodelle und ihrer Authentizität. Potenziale, Herausforderungen, die enge Verzahnung der aktuellen Forschungsthemen sowie die offenen Fragestellungen werden beleuchtet. Mit Blick auf die Authentizität liegt der Schwerpunkt vor allem im Bereich des Wissensnachweises, der Wissenssicherung, der Methodologie und der adäquaten Darstellung in der Wissensvermittlung.

Digital 3D Reconstructed Models in the Museum Context – Are they Authentic?
Digital 3D reconstructed models have become established as a medium for dissemination of knowledge, especially within the museum context. Although the technical systems and application possibilities have evolved steadily and new potentials as well as challenges for these models have opened up, the question of authenticity has not yet been adequately answered. Digital 3D reconstructed models within the cultural heritage context can already be seen as a new independent typology, a kind of digital knowledge model that becomes a repository of knowledge because of its genesis process. As such, they are a new form of expression in addition to language and writing, a new medium of dissemination. The main topic of this article is this broad field of digital 3D reconstructed models and their authenticity. Potentials, challenges, the close interlinking of the current research topics as well as the open questions are highlighted. With regard to authenticity, the main focus is on knowledge, methodology and adequate forms of dissemination.