

Knowledge representations of digital reconstruction in 3D models

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1 Introduction

Source-based 3D reconstruction is a field of the digital humanities dealing with the hypothetical recreation of lost heritage of architecture, cities and landscapes. The creation of visual messages in the form of illustrations or animations shows a hypothetical vision of an object or space at a specific time. However, from a scientific point of view, it is also important to show the process, appropriate documentation, used source materials and the level of the hypothesis (Pfarr-Harfst, 2016). It is difficult to determine how this information should be adapted in the projects. Researchers have a large variety of possible publication options in the form of articles, images, videos, or 3D models themselves and all of those forms require a different approach. This work will deal with the possibilities of knowledge representation in the 3D model and challenges associated with this approach of presentation of digital reconstructions.

2 Web-based 3D-viewers

Publication of 3D models on the web with the use of 3D viewers gives additional opportunities to enrich the model with additional knowledge. One of the options is adding annotations, in the form of comments or descriptions that are permanently associated with a specific place in the model (Fig. 1). One of the platforms that offer this type of solution is a free repository of 3D models, Sketchfab, which is quite popular in the scientific community (Champion, Rahaman, 2020).



Fig. 1: Annotation system performed in Sketchfab¹

The other solution is the open-source framework for the creation of interactive Web presentations of high-resolution 3D models, oriented to the Cultural Heritage field called 3DHOP. It allows to extend the annotation system from single points to hotspots, which can take the form of a specific plane, sphere or fragment of the model (Potenziani, Callieri, Dellepiane, Corsini, Ponchio, Scopigno, 2015). It gives a possibility to recreate model

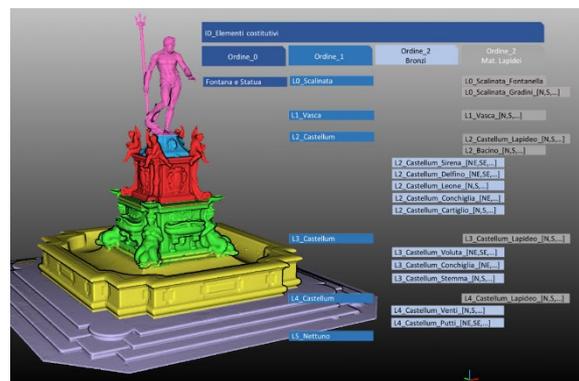


Fig. 2: Segmentation of the reconstruction model in 3DHOP²

¹<https://sketchfab.com/3d-models/bar-hill-fort-reconstruction-antonine-wall-6d04c19858b8421ebd034ba13abf4831>, last accessed 09.02.2022

² Apollonio F.I. (2019). Conceptual modelling and cognitive process in 3D virtual reconstruction In:

Kuroczyński, P., Pfarr-Harfst, M. and Münster, S. (eds) Der Modelle Tugend 2.0: Digitale 3D-Rekonstruktion als virtueller Raum der architekturhistorischen Forschung, p.420, arthistoricum.net, Heidelberg.

41 segmentation, which was used during data creation
 42 and apply it in the viewer (Fig. 2). In this case, the
 43 included knowledge is not limited to texts only.
 44 Hotspots could also contain images or other media.
 45 However, a certain difficulty may be the
 46 necessity to saturate the model with knowledge
 47 during the publication process. The information
 48 obtained during the creation must be documented
 49 independently and manually added on the model.
 50 This may result in the loss of some data that could
 51 be retained by the knowledge application during
 52 model production.

53 3 Modelling programs

54 One of the most important aspects of
 55 reconstruction from a scientific point of view is the
 56 level of uncertainty. General rules for graphical
 57 representation of it have already been undertaken
 58 by researchers (Grellert, Apollonio, Martens, and
 59 Nußbaum, 2019). Even though these
 60 considerations include online publication, there is
 61 no explanation of how to apply this knowledge to
 62 the model.³ It seems important to prepare an
 63 appropriate segmentation in advance, based on
 64 architectural knowledge and available sources.
 65 This would indicate that the object-oriented
 66 approach seems to be the best in the case of
 67 knowledge representations of digital
 68 reconstruction models (Apollonio, 2019). This
 69 approach allows the assignment of parameters with
 70 different values to individual elements of the 3D
 71 model. As default, the parameters are related
 72 mainly to the technical aspects of the building
 73 (Bruno, Roncella (2019).

74 Described methods can only be applied to the
 75 3D models during the production process. It means
 76 that to store all information it is necessary to save
 77 the file in native format of the software. That makes
 78 the data readable only for the users of the specific
 79 software. Most 3D data exchange formats store
 80 mainly information about the geometry and
 81 textures. Data export may cause the loss of the all
 82 collected knowledge may.

83 The project of reconstruction the New
 84 Synagogue in Wrocław⁴, conducted by researchers
 85 from Institute of Architecture at Mainz University
 86 of Applied Sciences, has made an attempt to link
 87 the model with the additional reconstruction data.

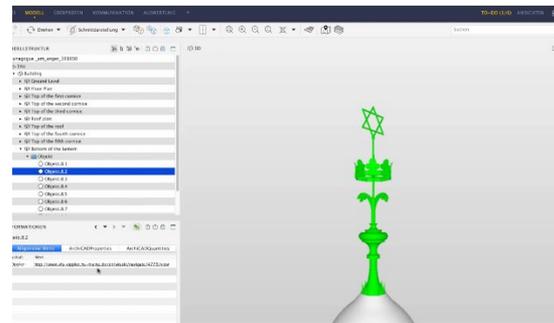


Fig. 3: Parameter with link to the VRE site with documentation of reconstruction of selected object in IFC viewer³

88 The division of the model into objects was carried
 89 out with a modeling program supporting Historic
 90 Building Information Modeling (HBIM) approach.
 91 This made it possible to assign each object a
 92 parameter with a link to an entry in an online
 93 database containing data about that object. Then,
 94 thanks to the export to Industry Foundation
 95 Classes (IFC), which is a standard for the building
 96 industry, it was possible to display the model in an
 97 external viewer and preserve the link between the
 98 objects and the database based on the CIDOC-
 99 CRM ontology (Fig. 3) creating a network in the
 100 Linked Data web.⁵ However, lack of storage of
 101 textures in this format makes it impossible to
 102 capture the entire atmosphere of the building in a
 103 single data exchange format (Kuroczyński, Bajena,
 104 Große, Jara, Wnęk, 2020).

105 4 Conclusions

106 Knowledge representation in the case of digital
 107 reconstitution aims at the possibility of applying
 108 information directly to the specific elements of the
 109 model. This would suggest an advantage of object-
 110 oriented modeling techniques in this field.
 111 Attempts to link the model to external sources of
 112 knowledge bring new opportunities for the
 113 integration of knowledge in the 3D model and its
 114 publication. Author's further research focuses on
 115 the knowledge implementation to the models,
 116 information preservation in different data exchange
 117 formats. The results will be presented during the
 118 workshop to determine a possible loss of
 119 information to determine further direction of the
 120 work on knowledge representation in 3D models.

³ <http://www.sciedoc.org/>, last accessed 07.02.2022

⁴ <https://www.new-synagogue-breslau-3d.hs-mainz.de/>, last accessed 10.02.2022

⁵ <https://www.w3.org/DesignIssues/LinkedData>, last accessed 10.02.2022

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