The subtle difference between knowledge and 3D knowledge

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THE SUBTLE DIFFERENCE BETWEEN KNOWLEDGE AND 3D KNOWLEDGE

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In spite of the relatively long history of the use of digital 3D technologies in archaeology and heritage contexts, specialists have begun only rather recently, after the introduction of affordable easy-to-use tools and their (relative) mass-adaption by archaeology and heritage (rather than technology) specialists, to unveil some of the more general outcomes and shape quotidian expectations of how the different methods of producing and using three-dimensional representations might influence the broad patterns of practices in archaeology and cultural heritage fields.[1] As, for instance, Reilly[2] and Huggett[3] have argued, there is a general lack of solid theoretical underpinnings not only for archaeological 3D applications but for digital or virtual archaeology in general. This could be seen as one possible reason why three-dimensional applications in archaeology »maintain a status of underdog«[4] as Lanjouw argues. There has been a discussion on what is meant with such terms as virtual archaeology, virtual reality or 3D in archaeology, but these theoretical ruminations have had relatively little impact on practice,[5] and vice versa. However, in addition to the possibility of beginning to understand explicit and planned implications, the wider adaption of these technologies has made it possible to begin to explicate the by-products and unplanned consequences of embracing the new means of representing the past and knowledge about it. Even if »world building«[6] has always been a central aspect of archaeological imagination, it takes time and effort to understand how it happens and evolves together with the change of theoretical and practical approaches and technologies.

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1   On the impact of digitisation on cultural practices, ref. *Daniela K. Rosner:* The Material Practices of Collaboration. In: Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work, CSCW'12 New York 2012, pp. 1155–1164. ACM Digital Library: http://dl.acm.org/citation.cfm?id=2145204 (date: 4.8.2017).

2   *Paul Reilly:* Palimpsests of Immaterial Assemblages Taken Out of Context: Tracing Pompeians from the Void into the Digital. In: Norwegian Archaeological Review 48 (2015), pp. 89–104.

3   *Jeremy Huggett:* A Manifesto for an Introspective Digital Archaeology. In: Open Archaeology 1 (2015), pp. 86–95.

4   *Tijm Lanjouw:* Discussing the Obvious or Defending the Contested: Why Are We Still Discussing the ›Scientific Value‹ of 3D Applications in Archaeology? In: Hans Kamermans et al. (eds.): The Three Dimensions of Archaeology. Proceedings of the XVII UISPP World Congress (1–7 September 2014, Burgos, Spain). Volume 7/Sessions A4b and A12. Oxford 2016, pp. 1–12.

5   E.g. *Reilly*, as fn. 2; *Lanjouw*, as fn. 4; *Isto Huvila:* The Ecology of Information Work – A Case Study of Bridging Archaeological Work and Virtual Reality Based Knowledge Organisation. Åbo 2006.

6   *Michael Shanks:* The Archaeological Imagination. Walnut Creek 2012.

This article makes some remarks on the implications of how attaching three-dimensional artefacts with a range of different labels such as visualisation, model or ›virtual form‹ have on the artefact itself, how it is produced and received, and in the end, how the artefact engages in knowledge production, and what kind of knowledge comes out of the process. Earlier studies have suggested that the engagement with two-dimensional representations leads to differences in how archaeologists perceive the past in comparison to when they are interacting with three-dimensional objects.[7] Similarly, there are differences in the perceived outcomes of using photogrammetry and manual drawing of features for archaeological documentation.[8] However, there is also evidence that the use of three-dimensional artefacts does not necessarily lead to a better or more comprehensive understanding of a phenomenon[9], and no real reason to believe that the difference between two and three dimensions would necessarily be a question of superiority or inferiority.[10] This article hypothesizes on the one hand that the choice of the approach of producing three-dimensional representations is related to distinct epistemic beliefs and planned outcomes, and on the other, that the use of a particular approach and decision to attach a specific label to an approach have epistemic consequences and outcomes that can be more or less aligned with premising beliefs and planned outcomes.

Theoretical premises

The theoretical underpinnings of questioning and interrogating the making and naming of three-dimensional artefacts and the implications of these different approaches are necessarily based on an assumption of their non-essentialistic nature. The present text builds on an assumption introduced by Alfred North Whitehead[11] and later elaborated by, for instance, Isabelle Stengers[12]: that technologies, their individual users and the context within which they exist are not separate but inherently connected and part of the same reality. Another premise of this text adopted from Whitehead is the focus on processes rather than essentialistic entities. This type of approach

7   *Fabrizio Galeazzi/Paola Di Giuseppantonio Di Franco/Justin L. Matthews:* Comparing 2D Pictures with 3D Replicas for the Digital Preservation and Analysis of Tangible Heritage. In: Museum Management and Curatorship 30 (2015), pp. 462–483.

8   *Anders Gutehall:* Hand Drawing vs Photogrammetry – A Comparative Case Study of Two Techniques for Archaeological Documentation. In: Nicolai Garhøj Larsen/Matteo Pilati (eds.): Why 3D? – Proceedings from the Why3D? Seminary. Faaborg 2016, pp. 51–62.

9   E.g. *Kyong Eun Oh* et al.: Blocked: When the Information is Hidden by the Visualization. In: Journal of the Association for Information Science and Technology 67 (2016), pp. 1033–1051; and therefore real reasons to ask what constitutes the added value of new technologies cf. *Shanks*, as fn. 6.

10 *Lanjouw*, as fn. 4.

11 *Alfred North Whitehead:* Process and Reality. An Essay in Cosmology. New York 1978.

12 *Isabelle Stengers:* Penser avec Whitehead. Une libre et sauvage création de concepts. Paris 2002.

leads to the three-dimensional artefacts, their makers, users, designations and referents being inseparable parts of the same process. They influence each other and cannot be separated. Further, it is the *process* that is the main point of our interest, how the artefacts and human actors become and unbecome, rather than what would be an assumed essence or nature of the artefact itself. This general position requires an approach that is close to what Jones[13] demands of a critical inquiry of discourses. Instead of examining them in relation to abstract entities, they need to be investigated in the specific situations within which they keep their links with other aspects of reality intact.

Modelling, capturing and algorithmic generation

The inherent connection between three-dimensional artefacts, their makers, users, designations and referents means that in order to understand the labels (or designations), it is necessary to understand artefacts (referents of the labels), their makers and the process of making. The different approaches to creating digital three-dimensional artefacts can be roughly divided into three kinds, even if in most cases, the actual procedures are based on combinations of these approaches.

Firstly, the most straightforward approach to literally *create* three-dimensional artefacts is to make them by *modelling*. Traditionally, modelling has been the most popular approach to generating digital three-dimensional objects and larger ›models‹ of sites, buildings and landscapes in archaeology and other disciplines in the field of digital humanities. The central aspect of modelling is that a human-actor is continuously engaged in the process of making a digital object, often to represent a physical object or site. Modelling relies on the technical skills, subject expertise and the vision of a human operator, and can be, to a certain extent, linked to the development of hypotheses in Peircean[14] cycle of reasoning (deduction leading from hypothesis to prediction, induction from prediction to observation, and abduction from observation to hypothesis).

Secondly, a digital object can be generated by *capturing* the geometry, and often also the visual texture, of a physical object. There are multiple techniques for capturing this information. The most popular ones at the time of writing are photography (combined with algorithm-based photogrammetry), laser scanning and various remote sensing techniques (which are often based on photography, laser-scanning and structured light systems). In addition to the technical accuracy of the capturing method i.e. how accurately the new digital artefact corresponds with the captured physical object, another crucial

13 *Peter E. Jones:* Why There Is No Such Thing as »Critical Discourse Analysis«. In: Language & Communication 27 (2007), pp. 337–368.

14 *Charles S. Peirce:* Philosophical Writings of Peirce. New York 1955; *Jan Svennevig:* Abduction as a Methodological Approach to the Study of Spoken Interaction. In: Norskrift 103 (2001), pp. 1–22.

factor is its resolution, i.e. the amount of detail in the produced model. The technical premise of capturing is to technically measure the dimensions, geometry and visual texture of a physical object and to present them (as far as possible) as-is in a digital space. There is no direct human interference in the act of capturing itself even if the choice of what is captured, when, and from which angle, is in most cases dependent on a human operator. In Peircean[15] terms, capturing comes close to the idea of observation that functions as a basis for working with hypotheses.

Thirdly, it is possible to generate three-dimensional digital objects *procedurally using an algorithm* to produce digital artefacts. To put it simply, the algorithmic generation of three-dimensional artefacts is based on the generation of a set of rules formulated as an algorithm and used to generate an object. The objects can be built entirely on the basis of formal rules (i.e. the algorithm itself incorporates all necessary information for producing an object) or by applying an algorithm to manipulate a dataset (e.g. a point-cloud captured using a laser scanner or a series of photographs used to create a solid model). In an algorithmic generation of three-dimensional artefacts, human involvement is restricted to the formulation of the algorithm and the decision to execute it. A central aspect of the algorithmic approach is the quality of the algorithm and its capability to generate digital objects that correspond with observed or assumed forms of reality. There are examples of the applications of procedural generation of three-dimensional artefacts in the context of agent-based modelling and procedural modelling of architectural features and landscapes,[16] but in general, the algorithmic approaches have not been as popular in archaeology as other approaches for producing three-dimensional artefacts. There are undoubtedly several reasons for this, from the occasional lack of baseline data for algorithmic processing to the conventional archaeological work processes that are acquisition (survey, excavation) rather than hypothesis or design based. In Peirce's cycle of reasoning,[17] the procedural generation of three-dimensional objects draws on the rationale of predicting on the basis of deductive inference.

Because of the overlap of the approaches, it can be difficult to make a clearcut distinction which technical procedure is used in an individual case and how it should be labelled. Photogrammetry is undoubtedly often characterised as a method of capturing geometry even if it is technically a procedural method of processing photographic information for the creation of a

15 Ibid.

16 E.g. *Eugene Ch'ng/Vincent Gaffney/Henry Chapman* (eds.): Visual Heritage in the Digital Age. London 2013; *S. J. Winterbottom/D. Long:* From Abstract Digital Models to Rich Virtual Environments: Landscape Contexts in Kilmartin Glen, Scotland. In: Journal of Archaeological Science 33 (2006), pp. 1356–1367; *Pascal Müller* et al.: Procedural 3D Reconstruction of Public Buildings in Xkipché. In: Marinos Ioannides et al. (eds.): The 7th International Symposium on Virtual Reality, Archaeology and Cultural Heritage (VAST). The Eurographics Association. Geneve 2006, pp. 139–146.

17 *Peirce*, as fn. 14; *Svennevig*, as fn. 14.

three-dimensional artefact. Similarly, modelling is almost always based on the use a set of algorithmic tools to create an (close) approximation of an existing or a conceivable object.

Knowledge production in three dimensions with three different names

Independent of the chosen approach, there are different opinions about what happens when a three-dimensional object is generated. To a certain extent there is a difference between capturing, modelling and creating three-dimensional artefacts procedurally; but even in a seemingly simple process of reproduction, the sameness of originals and reproductions is far from being self-evident. Many researchers and theoreticians are inclined to see the creation of three-dimensional objects *a priori* as a productive process. This becomes apparent upon a closer look at the process of how documents and visual representations come into being.[18] Even capturing or copying a physical object is not a simple act of reproduction but always an instance of making a new object, even if it closely resembles the original one. Garstki has posited that a closer look at photography as a parallel form of creating reproductions could inform archaeologists on how to fit three-dimensional artefacts and related digital tools into archaeological thinking.[19] Similarly, a look back at the practices of archaeological illustration and the use of plaster of Paris to create physical artefacts can provide useful parallels.[20] In practice, however, the generation of digital objects is often treated as an act of creating a surrogate that is essentially capable of functioning as a replacement of the original.[21]

Whereas the general question of whether the creation of a 3D object can be considered to be an act of reproduction, translation or production can be argued to have mainly academic relevance, the question of the functionality of the resulting artefact has more far-reaching consequences. Both a reproduction and a new object (with a certain resemblance to its predecessors) can be capable of functioning as a substitute for the original under certain conditions. Depending on its similarity with the original, the conditions of using the original compared to those of using the 3D object, and the specific characteristics or affordances of the 3D artefact falling behind and going

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18 In archaeology e.g. *Lesley Adkins/Roy Adkins:* Archaeological Illustration. (= Cambridge Manuals in Archaeology). Cambridge et al. 1989; *Peter G. Dorrell:* Photography in Archaeology and Conservation. (= Cambridge Manuals in Archaeology). 2. Aufl., Cambridge 1994; and beyond e.g. *Mark Monmonier:* Coast Lines: How Mapmakers Frame the World and Chart Environmental Change. Chicago/London 2008; *Nathan Ensmenger:* The Multiple Meanings of a Flowchart. In: Information & Culture 51 (2016), pp. 321–351.

19 *Kevin Garstki:* Virtual Representation: The Production of 3D Digital Artifacts. In: Journal of Archaeological Method and Theory 24 (2017), pp. 726–750.

20 *Huvila*, as fn. 5.

21 E.g. *Dominic Powlesland:* 3Di – Enhancing the Record, Extending the Returns, 3D Imaging from Free Range Photography and its Application During Excavation. In: Kamermans et al., as fn. 4, pp. 13–32.

beyond the original object, the original or the 3D object can end up being more or less useful.

So far, much of the discussion of the qualities and usefulness of various types of 3D objects have focused on their technical characteristics rather than on how they can aid and influence archaeological thinking.[22] There are exceptions and in the recent work of, for instance, dell'Unto, Landeschi, Forte, Berggren and colleagues, researchers have begun their enquiry into this issue.[23] What is also often said to be lacking is solid archaeological thinking behind the practical applications of using and producing three-dimensional artefacts in archaeological inquiry.[24] Also, the appropriateness of specific concepts has been the subject of a lively discussion.[25] What has received less explicit attention are the implications of how the making and using of a certain 3D artefact explicitly as a model, captured geometry or visualisation potentially alters the artefact itself. Assuming that the original objects, 3D artefacts, their makers (of the originals and 3D objects), tools for making objects and their 3D versions, the users of the objects and their names reside in the same reality, the naming of an artefact is inherently related to how it is perceived and acted upon. However, in contrast to suggesting that calling a 3D artefact a visualisation would mean *a priori* that it was made to represent or to be used as a different artefact than another object called a model, following Jones' suggestion, it is important to avoid essentialising the names, too. There can be many different reasons for calling a 3D object a model in a particular context, and the name itself can be related to the making and use of the object but also to contextual conventions of calling 3D artefacts models.

The different conditions of naming and conceptualising 3D artefacts can be illustrated by a brief consideration of three earlier projects I have been involved in. I am not suggesting that these projects would be the best examples of the discussed phenomena *per se*, but for this current article, they provide

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22 *Costis Dallas:* Archaeological Knowledge, Virtual Exhibitions and the Social Construction of Meaning. In: Archeologia e Calcolatori supplemento 1 (2007), pp. 31–63; *Jeremy Huggett:* Lost in Information? Ways of Knowing and Modes of Representation in e-Archaeology. In: World Archaeology 44 (2012), pp. 538–552 (= Issue 4: Mark Lake (ed.): Open Archaeology).

23 *Nicolò Dell'Unto* et al.: Experiencing Ancient Buildings from a 3D GIS Perspective: A Case Drawn from the Swedish Pompeii Project. In: Journal of Archaeological Method and Theory 23 (2015), pp. 73–94; *Giacomo Landeschi* et al.: 3D-GIS as a Platform for Visual Analysis: Investigating a Pompeian House. In: Journal of Archaeological Science 65 (2015), pp. 103–113; *Maurizio Forte* et al.: Interpretation Process at Çatalhöyük Using 3D. In: Ian Hodder/Arkadiusz Marciniak (eds.): Assembling Çatalhöyük. Leeds 2016, pp. 1–29; *Åsa Berggren* et al.: Revisiting Reflexive Archaeology at Çatalhöyük: Integrating Digital and 3D Technologies at the Trowel's Edge. In: Antiquity 89 (2015), pp. 433–448.

24 *Reilly,* as fn. 2.

25 E.g. at the 2016 ARIADNE Summer School, Athens, 12–17 June 2016: WP8 – Legacy data and dataset design. Digital curation of archaeological knowledge. New approaches to digital research, information management and communication in archaeology).

a useful context that allows a first exploration of some of the pertinent aspects of naming three-dimensional artefacts and the related consequences. The first example, described in detail in *Argumentation paths in Information Infrastructure of the Archaeological virtual realities*[26], focused on the question of the documentation of archaeological »virtual realities« or »virtual reality visualisations« i.e. three-dimensional artefacts representing archaeological entities and their related paradata (documenting how the artefact was made) for later use. The starting point of the project was the creation of a virtual approximation for a visual analysis of an ancient maritime landscape and a description of the procedure of making the three-dimensional artefact for the purpose of documenting and making transparent the analytical process. Even if the earlier publication does not explicitly discuss why the objects were called virtual realities in this particular case, it is safe to conclude even some years later that the reasons were largely contextual and related to the contemporary conventions of calling complex multi-dimensional representations of archaeological entities »virtual realities«. At the same time, however, the choice of name does have repercussions for how virtual realities were discussed in the project. Even if, according to the text, a virtual reality should not aim to be »a perfect spatio-temporal simulation of the past«, a virtual reality was suggested to »be seen as a virtual form of an essentially ›real‹ phenomenon«. The focus of the project was not on the production of three-dimensional artefacts, but the approach used in the experimental setting was based on a combination of using captured geometry as a basis for a landscape model, procedural creation of vegetation and incorporation of known archaeological features in the artefact by modelling them manually.

In another project conducted in collaboration with archaeologist Dr. Kari Uotila and described in a book chapter called *Virtual Landscape Modelling*[27], the focus of the project was on bringing together and presenting insights from a series of landscape studies based on the use of three-dimensional modelling as an approach to recreating historical and prehistorical landscapes. Our focus was on »models« and »modelling«. The text states that »[a]rchaeological landscape models are a form of archaeological perception and interpretation that present many theoretical and practical challenges«, they are »ideational constructs«[28]. Further, it is suggested that models can function as devices for communicating archaeology to researchers and

26 *Isto Vatanen:* Argumentation Paths in Information Infrastructure of the Archaeological Virtual Realities. In: Magistrat der Stadt Wien – Referat Kulturelles Erbe – Stadtarchäologie Wien (eds.): Enter the Past: The E-Way into the Four Dimensions of Cultural Heritage. CAA 2003. Computer Applications and Quantitative Methods in Archaeology. Proceedings of the 31st Conference, Vienna, Austria, April 2003 (on the accompanying CD-ROM). (= BAR International Series 1227). Oxford 2004.

27 *Kari Uotila/Isto Huvila:* Virtual Landscape Modelling. In: Marko Lamberg/Marko Hakanen/Janne Haikari (eds.): Physical and Cultural Space in Pre-industrial Europe: Methodological Approaches. Lund 2011, pp. 273–286.

28 *Uotila/Huvila*, as fn. 27, referring to *A. Bernard Knapp/Wendy Ashmore:* Archaeologies of Landscape. Contemporary Perspectives. Oxford 1999, pp. 1–32.

the general public, and as an »active participant« in archaeological scholarly work. »A model explicates that which has been done and that which is known, but it is also an instrument that constructs new knowledge.« Instead of being a form of a real phenomenon, a model is a construct with resemblance to the original. Whereas in the first example, the meaning of virtual reality as a virtual form or a visualisation remained somewhat unclear, in this second effort we were highly explicit about the artefact in question being a model. The models discussed in the text were generated using a combination of data capturing (modern height data) and modelling to add details that were known and expected to exist in the landscape.

The third example is a project which aimed at evaluating the possibilities of »visualising« captured three-dimensional archaeological documentation data in a virtual world and communicating archaeology online in an open non-dedicated virtual environment for the general public. Similarly to the second example, this project was a collaboration between the author and Dr. Kari Uotila. The central findings of the effort were reported in a conference presentation: *Taking excavation to a virtual world: importing archaeological spatial data to Second Life and OpenSim*[29]. The focus was on comparing Second Life and OpenSim environments for the presentation and communication of archaeological information. The central outcome of the effort was that the two evaluated environments had their respective advantages. In Second Life, the world itself and its relatively large user base provided opportunities to interact with users in their own environment (where they were already active). In contrast, OpenSim provided far better technical possibilities for importing and operating with authentic archaeological data, and for having more comprehensive control of the environment. From the perspective of how the three-dimensional objects were generated in the project, it was based on data capture although, due to the limitations of the tools used in the project, it became apparent that producing a useful artefact required manual modelling, especially in Second Life. In contrast to the two previous examples, the focus of the third effort was to visualise (i.e. literally make visible and show) existing archaeological data instead of creating a model or a virtual reality even if the activity itself was taking place in an existing three-dimensional environment. However, in order to produce a workable visualisation for the audience, it was necessary to recreate i.e. model a new artefact on the basis of the original digital three-dimensional data.

Some epistemological consequences

Even if the three short examples are not comprehensive enough to unfold the entire complexity of naming three-dimensional objects and the related premises and consequences, they give some glimpses into the potential epis-

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29 *Isto Huvila/Kari Uotila:* Taking Excavation to a Virtual World: Importing Archaeological Spatial Data to Second Life and OpenSim. In: Presentation at the CAA 2012 Conference, Southampton/UK 2012.

temological implications of naming and not naming digital artefacts in particular ways and how the act of naming relates to techniques and approaches used to produce the three-dimensional artefacts. Even if, to a certain extent, it could be plausible to argue that the three-dimensional artefacts discussed in the three projects did not necessarily differ from each other to a considerably extent, the names of the artefacts treated in each case were indicative of the aims of the projects and consequently of how they were treated and acted upon in each individual case. The first example aimed at a certain holism in producing a virtual form of the landscape for future visual analysis. The second one was closer to being a processual tool for negotiating and creating a version of the past landscape. Finally, the third one aimed at presenting captured visual data, thus, in very rough terms, resembling a photographic display. To a certain extent, the examples can be undoubtedly criticised for not being illustrative of the general state of affairs in how all of the three projects engaged in an explicit conceptual discussion of the nature of the three-dimensional artefacts. However, in spite of their shortcomings, a closer look at the projects reveals some issues that warrant further consideration.

Firstly, in all discussed cases the three-dimensional artefacts were expected to have an active role, or agency[30], to a certain degree, but as the examples show, this agency could be very different depending on what the objects were supposed to be from the perspective of their makers and users. In this sense, the making and naming of the artefacts as virtual forms, models and visualisations meant that they became different even when the methods of creating them were quite similar.[31] In all cases, the artefacts were intended to be used after they had been created, but the understanding of the use had perhaps somewhat subtle but still significant differences. The naming of artefacts and how they are made in practice are related, but as the examples show, for different reasons, the technical approach itself does not necessarily explain why artefacts are called models, visualisations or virtual forms. The fundamental question is the belief about the epistemic possibilities and limits of the artefact. The first case and it's admittedly somewhat awkward terminological exploration does also illustrate the fact that a name and its intended meaning can be far from being fixed, as was the case for the notion of virtual reality at the time of reporting that particular study.

It is apparent that a model that is modelled (instead of captured) could be expected to be more vulnerable to the bias of pre-existing mental images[32]

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30 Similarly to what has been discussed in the literature, e.g. *Anna Bentkowska-Kafel/Hugh Denard/Drew Baker* (eds.): Paradata and Transparency in Virtual Heritage. Farnham 2012; *Maurizio Forte:* 3D Archaeology. New Perspectives and Challenges – The Example of Çatalhöyük. In: Journal of Eastern Mediterranean Archaeology and Heritage Studies 2 (2014), pp. 1–27; *Huggett*, as fn. 3, pp. 22.

31 In practice, the naming lead to a certain type of multiple objectivity, e.g. *Ron Eglash:* Multiple Objectivity: An Anti–Relativist Approach to Situated Knowledge. In: Kybernetes 40 (2011), pp. 995–1003.

32 *Tim Ingold:* Being alive. Essays on Movement, Knowledge and Description. London 2011.

and pre-cognition of modeller, but as far as the model is treated as a participant (rather than as an authentic and/or objective source) in the modelling and interpretation process, it is also a prerequisite for the informed and conscious use of that particular conceptual-practical tool (of wayfaring as Ingold[33] suggests). Similarly, a problem with visualisations is the danger of falling into the fallacy of authenticity not only by the visual persuasiveness of the three-dimensional artefact[34], but also by suggesting that it is a visualisation of not only an interpretation, but of the past itself. In that respect notions like »reality-based virtual models«[35] sometimes used for captured digital objects are problematic both in suggesting that other models would not be based on reality, and that these would be somehow *a priori* more real than other types of three-dimensional objects.

Secondly, even if the three examples did not explicitly explore the question of how the produced artefacts were received[36], it is obvious that the naming of the artefacts is not a sole privilege of the maker of the model. The absence of an explicit user study calls into question whether the outspoken intentions of the efforts were fulfilled in the sense that their audiences would have called the produced three-dimensional artefacts by same names as their authors. Transparency of the process of producing an artefact undoubtedly helps and, as Brusaporci[37] notes, it is important to try to be honest in explicating the process. But there is still no way of making sure that the two interpretations of their makers and spectators would be the same. It is not only a (relatively) binary question of whether the audience would believe that photo-realistic representations are more authentic than they really are, or whether the artefact was capable of conveying a sharper picture of ›reality‹[38], but also of nuances: whether a three-dimensional artefact is intended to be looked upon as a visualisation, a model or a virtual form of an original, and how the spectators conceptualise what they see. To complicate the mat-

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33 Ibid.

34 *Hugh Denard:* A New Introduction to the London Charter. In: Bentkowska-Kafel/Denard/Baker, as fn. 30, pp. 57–71; *Sara Perry:* Fractured Media: Challenging the Dimensions of Archaeology's Typical Visual Modes of Engagement. In: Archaeologies 5 (2009), pp. 189–210.

35 E.g. *Armin Grün:* Reality-Based Virtual Models in Cultural Heritage. In: Michael Falser/Monica Juneja (eds.): ›Archaeologizing‹ Heritage? Transcultural Entanglements between Local Social Practices and Global Virtual Realities. Berlin 2013, pp. 109–126.

36 Which is the serious problem of archaeological 3D applications in general, ref. *Lanjouw*, as fn. 4.

37 *Stefano Brusaporci:* The Importance of Being Honest: Issues of Transparency in Digital Visualization of Architectural Heritage. In: Alfonso Ippolito (eds.): Handbook of Research on Emerging Technologies for Architectural and Archaeological Heritage. Hershey 2016, pp. 66–93.

38 Than artefacts produced using older technologies, cf. Shanks, as fn. 6, or by producing a circuit of exchange that helps the spectator to see better e.g. as in Monique Tschofen: The Denkbild (Thought-Image) in the Age of Digital Reproduction. In: Theory, Culture & Society 33 (2016), pp. 139–157.

ter even more, as Perry has compellingly shown[39], the collaborations during the production of the artefacts (e.g. between illustrators and archaeologists) add another layer of interpretation. Different participants may name artefacts using different words and understand the terms differently. In the three projects discussed in this article, the explicit conceptual discussion (during the project and/or in the report) did probably alleviate the potential problem of conceptual misunderstandings but it would be too daring to say that they were avoided altogether. In contrast, it would undoubtedly be useful to be more explicit about the need for such discussions in the future as the examples and, for instance, the study by Perry suggests. The usefulness of an on-going dialogue will be accentuated even more when the production of three-dimensional artefacts involves more and more diverse stakeholders such as amateurs and local community members, artists and designers and researchers from a broad range of relevant disciplines, from the sciences to cultural studies.[40]

Towards more reflexive practices of knowledge production in 3D

From the perspective of understanding the implications of knowing about archaeology versus knowing three-dimensionally about them, the efforts to promote the use of paradata[41], visual literacy[42], explorations of the auratic potential of digital objects[43], explorations of the general considerations of the qualities of immersive documents[44], classification of different types of three-dimensional artefacts[45], and a new language of virtual archaeology[46] are necessary steps in the direction of making three-dimensional knowledge visible (sic!) in archaeological information work and providing it with the solid theoretical basis it has been lacking since the emergence of the first

39 *Sara Perry:* Crafting Knowledge with (Digital) Visual Media in Archaeology. In: Robert Chapman/Alison Wylie (eds.): Material Evidence. Learning from Archaeological Practice. New York/London 2015, pp. 189–210.

40 Such efforts discussed e.g. by *Jeffrey Tait* et al.: (Re)presenting Heritage: Laser Scanning and 3D Visualisations for Cultural Resilience and Community Engagement. In: Journal of Information Science 42 (2016), pp. 189–210.

41 *Bentkowska-Kafel/Denard/Baker,* as fn. 30.

42 *Andrew Cochrane/Ian Russell:* Visualizing Archaeologies: A Manifesto. In: Cambridge Archaeological Journal 17 (2007), pp. 3–19.

43 *Stuart Jeffrey:* Challenging Heritage Visualisation: Beauty, Aura and Democratisation. In: Open Archaeology 1 (2015), pp. 144–152.

44 *Lyn Robinson:* Multisensory, Pervasive, Immersive: Towards a New Generation of Documents. In: Journal of the American Society for Information Science and Technology 66 (2015), pp. 1734–1737; *Lyn Robinson:* Immersive Information Behaviour: Using the Documents of the Future. In: New Library World 116 (2015), pp. 112–121.

45 E.g. *Barbara R. Barricelli/Davide Gadia/Alessandro Rizzi/DLR Marini:* Semiotics of Virtual Reality as a Communication Process. In: Behaviour & Information Technology 35 (2016), pp. 879–896.

46 *Huvila*, as fn. 5.

digital three-dimensional artefacts in archaeology.[47] However, what seems equally important is that these ruminations take into account the technical and especially epistemological diversity of these artefacts, while at the same time avoiding the obvious pitfalls of losing the connection between theory and practice aptly noted by Lanjouw.[48] It is highly relevant to ask whether a particular three-dimensional artefact is indeed a model, a visualisation or a substitute, whether it has been created as a hypothesis, a prediction, or whether is it meant to be an observation[49], and to what extent these different categories intersect and overlap in the produced artefact. There is more than one category of three-dimensional or immersive documents and the most pressing question is not about reality and unreality, or authenticity and inauthenticity.[50] A useful approach needs to avoid ending up being a merely theoretical exercise without any practical dimensions, a vision based on wishful thinking, or something that merely allows us to state the obvious. What would be necessary is a certain level of stability and consistency that would facilitate comparison and communication[51], without the risk of losing sight of the differences of three-dimensional artefacts. Different types of digital and digitised objects function differently, both as mediating boundary objects between adjacent communities of users and documents, as Björk has demonstrated.[52] There is no reason to believe that this would not apply to distinct types of three-dimensional objects. The requirement of authenticity or truthfulness may vary between different types of three-dimensional artefacts. A visualisation can be authentic in a different sense than a model. An artistic digital artefact could be allowed to be less authentic[53] (or not[54]) whereas scholarly ones are generally expected to be meticulously documented and their reliability made transparent[55] – even if this seldom happens in practice.[56] Similarly, the type of knowledge that is made in the

47 Ref. *Reilly*, as fn. 2.
48 *Lanjouw*, as fn. 4.
49 In terms of the Peircean cycle, see *Peirce*, as fn. 14; *Svennevig*, as fn. 14.
50 Ref. *Robinson*, as fn. 44; *Denard*, as fn. 34.
51 Similarly to how the normalisation of archaeological practices and documentation have provided stability before, ref. *Bjørnar Olsen* et al.: Archaeology. The Discipline of Things. Berkeley 2012.
52 *Lars Björk:* How Reproductive Is a Reproduction? Digital Transmission of Text – Based Documents. Ph. D thesis, University of Borås, Borås 2015.
53 *Sarah Colley:* Ethics and Digital Heritage. In: Tracy Ireland/John Schofield (eds.): The Ethics of Cultural Heritage. New York 2016, pp. 13–32; *Cornelius Holtorf:* Can You Hear Me at the Back? Archaeology, Communication and Society. In: European Journal of Archaeology 10 (2007), pp. 149–165.
54 *K. Anne Pyburn:* Archaeology, Indiana Jones, and Honesty. In: Archaeologies 4 (2008), pp. 201–204.
55 *Bentkowska-Kafel/Denard/Baker*, as fn. 30.
56 *Paul Reilly/Stephen Todd/Andy Walter:* Rediscovering and Modernising the Digital Old Minster of Winchester. In: Digital Applications in Archaeology and Cultural Heritage 3 (2016), pp. 33–41.

course of producing specific types of artefacts is bound to vary. There is not only a difference between knowledge, and two-dimensional and ›three-dimensional‹ knowledge[57] but also between knowledge derived from a model and that coming from socio-technical interactions with a visualisation or virtual replica. Taking these epistemological differences seriously and making them visible would allow everyone with an interest in interacting with them to work together. At the same time, however, it is necessary to acknowledge that it is a never-ending fight against an ever-changing cycle of defining and redefining what it means to visualise or model and what becomes knowable in engagements with these particular and many other types of artefacts. The three-dimensional artefacts are functioning, perhaps more than anything else, as intermediaries or boundary objects[58] between the past and the present, and the makers and users of these objects.

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57 Cf. *Galeazzi/Di Giuseppantonio Di Franco/Matthews*, as fn. 7.

58 On the naming and renaming of boundary objects, see *Dick Boland:* The Concept of Boundary Objects and the Reshaping of Research in Management and Organization Studies. In: Geoffrey C. Bowker et al. (eds.): Boundary Objects and Beyond: Working with Leigh Star. Cambridge/London 2015, pp. 229–237.