McDONALD INSTITUTE CONVERSATIONS

Authenticity and cultural heritage in the age of 3D digital reproductions

Edited by Paola Di Giuseppantonio Di Franco, Fabrizio Galeazzi and Valentina Vassallo

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with contributions from
Nicola Amico, Frederick Baker, Gareth Beale, Eleni Bozia, Mark Elliott, Kevin Garstki, Sorin Hermon, Stuart Jeffrey, Peter Jensen, Jody Joy, Sarah Kenderdine, Nicoletta Miltiadous, Franco Niccolucci, Paola Ronzino and Lola Vico

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Figures

Chapter 5

Evaluating authenticity: the authenticity of 3D models in archaeological field documentation

Peter Jensen

The use of photorealistic and photogrammetric techniques to create 3D models of excavations is increasingly becoming an accepted approach to documentation practice in field archaeology. Whilst archaeologist seem happy to embrace new technologies for field documentation they tend to use them, either for traditional recording purposes (such as computer-aided drawing), or by letting technology dictate the documentation outcomes, for example, by creating interactive 3D models, which are incompatible with traditional means of documentation. Paradoxically, the use of 3D visualization in archaeology is neither a relatively recent or sudden phenomenon (Reilly 1992; 1988). The advent of 3D representations as archaeological documentation characterizes a departure from the conventional spatial abstraction of a 3-dimensional world to a 2-dimensional piece of paper. As a consequence, the basic epistemological foundations for archaeological recording are affected, calling for a revision of not only the general workflow of excavations, but a re-evaluation of those dichotomies inherent to field archaeology, such as that between observation and interpretation. With 3D documentation, we are increasingly dealing with photorealistic representations of archaeological excavations, and the time, place and basis for archaeological interpretation is changing. The far-reaching consequences touch upon core dichotomies of archaeological science, where particularly the polarization of objectivity and subjectivity has affected archaeological thinking for the better half of a century (Kristiansen & Rowlands 2005, Shanks & Tilley 1987). However, as stated by Shanks and Tilley (1987, 243): '*Archaeological theory and practice as labour in the present completely transcend this artificial division, labour which draws past and present into a fresh perspective, a perspective which serves to rearticulate their relationship.*' In this regard, accepting 3-dimensional photorealistic documentation also means accepting that it is not free of bias. To an extent, the ideal of objective truth through empirical falsification (Popper 1959), reproducibility, and testability set forth by the scientific method is hindered by the destructive nature of the archaeological excavation and the derivative nature of the archaeological documentation.

In this chapter, the term reality-proximate is used to describe the creation of photorealistic representations of the observation event, taking into account the limitations of detail, and distancing the visual replication from a notion of objective recording. Rather than focusing on objectivity and subjectivity, this chapter will discuss the dichotomy between observation and interpretation in archaeology in the light of the new paradigm of 3D photogrammetric documentation, and it proposes a way of managing 3D observation data alongside reconstructions and visualizations. The excavation of three archaeological sites in Denmark; Skelhøj, Jelling and Alken Enge, reflects the impact of technological developments on the archaeological workflow during the last 15 years, and show how a conceptualization of authenticity may be applied to address the evaluation of documentation quality.

It is proposed that the use of 3D documentation encourages us to adopt a new workflow with more 3-dimensional reasoning, allowing the utilization of 3D recording as a tool for the continuous monitoring of progress and evaluation of an excavation and its results. Just as in the general use of models to form hypotheses, it is possible to use 3D models as spatial hypotheses within an ongoing excavation. This allows us to visually realize or spatially conceptualize our hypothesis as a virtual reconstruction and to combine it with our observational data.Usually our interpretation is characterized by the delineation and characterization of features and finds, be it line drawing on paper or vectorizations in GIS or CAD, but in a 3D representation, this makes much less sense. We are actually able

to interpret and visualize through 3D modelling of a spatial hypothesis, rather than working with lines and sketches. This in turn requires strict guidelines, and regard for the separation of observation and spatial hypothesis, and assurance that the one is not mistaken for the other.

Finally, this chapter presents experiences gained from combining *reality data* with *model data* in the case of the Jelling excavations. The field-recording principles applied accentuate the necessity of continuous evaluation of the integrity and validity of empirical data, and illustrate how the concept of authenticity becomes paramount to assessing excavation documentation. This is particularly the case when documentation is combined with 3D models and reconstructions at the boundary between research and dissemination.

Observation and interpretation in archaeology

If there is one characteristic, more than any other, that permeates the discipline of field archaeology, it is dichotomy. As Carver (1990, 45) puts it: '*Archaeologists who work in the field suffer from split personality*.' Carver obviously refers to the conflicting traditions of field work, which diverged in the early youth of the discipline, in the nineteenth century. Briefly put, British archaeologists Pitt-Rivers (1887) and later Barker (1977) were among the most prominent proponents of the empiricist approach, based on an idea that every minute detail matters and should be recorded in the field, and that an archaeological site should be treated as a system of deposits and formations processes. This is related to the processualist approaches of New Archaeology (Binford & Binford 1968, Trigger 1989). On the opposing branch, Petrie (1904) and Wheeler (1954) saw that attempting to record every fact about everything was futile and useless without an overall goal or research motivation, which is what inspired the structuralist and contextualist approaches, focusing on the site as text to be read, rather than deposits to be described. These dichotomies exist to this day, albeit they are converging, perhaps not least due to developments in technology. Lucas (2001, 10) points to the fact that field archaeology by the 1870s was characterized by '*experience, presence in the field, as a critical guarantor of scientific validity*.' Incidentally, the advent of contract archaeology and the factor of competitive tendering based on price, favouring preservation by record, saw the growth of archaeologists specializing in fieldwork, meaning that fieldwork became more separated from the broader interpretative process. The archaeologist now took the role as a technician, whose job it is to retrieve data from the field, resulting from '*an ideology founded on the assumption that data collection is independent of interpretation*' (Lucas 2001, 12). In contract archaeology, the dichotomy stems from a matter of politics which separates fieldwork from interpretation, and where the empiricist seek to record as much as possible, while researchers and universities state that actual meaning is determined by posing relevant research questions – making data a research asset. The challenge or 'Archaeological Value' lies in combining the two (Carver 2009; 2003).

When dealing with archaeological excavation recording and documentation, using a seemingly arbitrary concept like authenticity may appear to make very little sense, especially if we claim to aim for 'objective' documentation. Nonetheless, one might argue that the dichotomy of the objective (Malmer 1980) vs. subjective (Shanks & Tilley 1987) lies at the heart of evaluating the authentic, but it tends towards an unproductive opposition between realism and constructivism (Madsen 2003, Madsen 1995). The processual or 'new' archaeology of the 1960s never questioned if we are able to describe anything objectively, but rather than the positivistic realism of measurements and observations, asserted that archaeological interpretation could come to objective conclusions via the ability to pose questions and formulate what we want to investigate (Binford 1964, 426). In particular, the ability to uncover the regularities of human cultural behaviour was in question. The post-processual archaeology of the 1980s, however, saw that every description requires interpretation and reflects the subjectivity and viewpoint of the archaeologist. By this notion, authenticity, which usually relates to a seemingly arbitrary level of 'trustworthiness' or 'related to fact', reflects the views, bias and possibly the social/political circumstances of archaeology and the archaeologist. The influence of society '*appears to remain one of archaeology's permanent features*' (Trigger 1989, 380), which is why it is necessary to account for context when evaluating authenticity in archaeological documentation. This in turn forces the archaeologist to explain, if not theory and method, at least the choices made during the excavation process, as well as the rationale behind them. It is considered a serious problem if an archaeologist is unable to '*look out beyond the individual context or unit they are excavating, [as they] will not be able to deal with interpretative issues that involve other contexts and other sets of data*' (Hodder 2003, 59). In particular, the interpretative and reflexive element is of interest to Hodder who pointed to the 'momentary, fluid and flexible' existence of excavation methodology by the late 1990s (Hodder 1997).

Advances in archaeological field documentation in the new millennium are a continuation of the development of computer applications in archaeology throughout the 1980s and 1990s focusing on the use

of quantitative methods in archaeology. In particular, photorealistic and photogrammetric techniques for creating 3D models of excavation situations are fast becoming a common approach to documentation practice, and call for a re-evaluation of the inherent dichotomy of interpretation and observation in archaeology (Berggren et al. 2015, Forte et al. 2015, De Reu et al. 2013, Forte 2014, Powlesland 2014). Compared to previous paradigm shifts, which were characterized by confronting ideas and ideals of how to do archaeology, the significant technological advances have only just recently become identified as a prelude to a paradigm shift in a scientific revolution (Kristiansen 2014, Huggett 2004). This inevitably raises questions and concerns whether archaeology is at risk of abandoning the interpretative and reflexive incentive, for the sake of a form of documentation that appears to correspond more closely to the observed 'truth'. Drawing in particular, is often seen as essential to archaeology and '*part of a hermeneutic system that acts to both initiate and reinforce the knowledge-creation structures of the discipline*' (Bateman 2006, 74), but it may also be considered a remnant of analogue documentation traditions, which becomes challenged by the need for the ability to handle and integrate digital representations of both reality and interpretation. Evidently, Hodder's fluid archaeology is becoming even more pronounced, as the clear distinction between observation and interpretation turns increasingly fluid and traditional concepts become entangled. By direct consequence, evaluation of authenticity gains new relevance as the documentation itself, rather than the object or artefact, attains authenticity. Generally speaking, archaeologists who share a goal of measuring the past as accurately as possible are also the ones who are most interested in pursuing authentic archaeology.

Photogrammetric documentation

One technological advancement stands out more than any other as '*a tool that underpins our notion of the objectivity of the recording process*' (Bateman 2005, 192). In the last decade, archaeologists have overwhelmingly adopted digital photography (Morgan 2014, Morgan & Wright 2018). At the same time, digital photos have increasingly become one of the primary sources of archaeological documentation, in addition to – or as basis for – digital delineation of the interpreted features and contexts. Digital photos have become an easy, quick and affordable way of documenting an excavation. The documentation process at the excavation of the Bronze Age barrow Skelhøj (2002–2004) in Southern Denmark exemplifies one such early application of digital photography in excavation documentation (Holst & Rasmussen 2013). It also illustrates how the archaeological community, fairly early on, realized that digital photography had to be treated differently, as it is not directly equivalent to analogue hand drawing. First of all, digital photos must be manipulated to become usable for documentation: rectified (Scollar 1998, Johansen 2003) and embedded with geographic information. This clearly leads to some concerns as to the validity and derivative nature of what would otherwise be considered very objective documentation. On the other hand, it evidently offers new possibilities of a different level of detail, quality and authenticity. In the case of Skelhøj, documentation workflows were deliberately adapted to combat the risk that photos could potentially shift the archaeological focus away from interpretation, towards the mere descriptive, and basically undermine the value of documentation. To accommodate concerns of losing the interpretative incentive and whenever possible, parallel series of photos were taken – an observation series with the prepared archaeological features, and an interpretation series where an archaeologist's interpretation would be scratched or sketched into to soil (Fig. 5.1). This of course only works for soil-archaeology, as opposed to building recording, but was based on a notion that the observational photos are somehow a more objective form of documentation that would allow us to revisit or re-examine our archaeological data, and therefore represent a set of data, which was less 'disturbed' by interpretational bias.

As claimed regarding the reflexive archaeology at Çatalhöyük: '*The goal is to make the excavation process virtually reversible in a simulated environment at levels ranging from laptop computers to virtual immersive systems*' (Berggren et al. 2015, 437). Being well aware that the collected data – the photos – are never more objective than the archaeological process as a whole (Bateman 2005), the archaeologist still has to choose and prepare the different surfaces and objects for documentation. It is an encounter, not just observation, albeit active or interpretive observation (Lucas 2001). On many levels, digital photos represent different resolutions of evidence, and 3D photogrammetric techniques such as Structure from Motion represents a further extension of the inherent properties of digital photos. This is due to their ability to provide visualizations and representations, which appear as photorealistic and geometrically authentic representations of real-world objects and scenes, which consequently is evolving to become an ideal of documentation. The key point here is that 3D photogrammetric techniques *represent* rather than accurately *reproduce* some aspect of reality. The documentation is still as subjective as ever but, perhaps worryingly, disguised as unbiased by its photorealistic appearance.

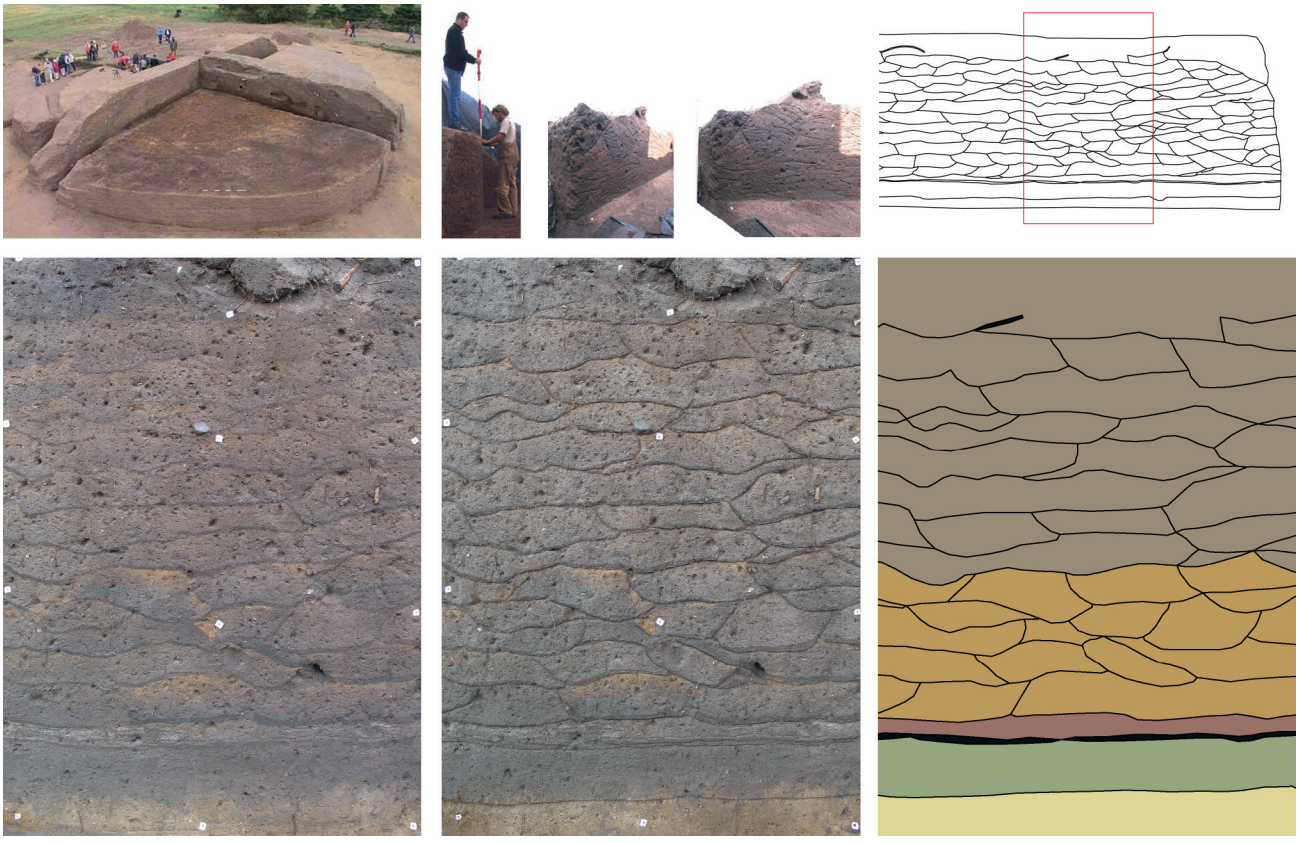

Figure 5.1. *Skelhøj. Documentation of turf structures in a Bronze Age barrow, using observation photos and interpretation photos as basis for rectification, mosaicking and vectorization. Photo: Peter Jensen.*

If, for the sake of argument, we state that the level of authenticity is in direct correlation with the amount of interpretation and assumption in its representation of reality, photographic evidence must clearly be more authentic than a delineated interpretation. But more authentic in this case does not necessarily mean that it makes the greatest contribution to knowledge. One would think that a 3D model or a photo is easily understood and requires fewer preconditions, but rather it lacks explanation and interpretation to fully extract the embedded information. What a 3D model does provide, however, is an immediate representation of reality. Instead of knowledge and skills of abstracting from the 2-dimensional drawing or photo, we see a malleable canvas, which we can interactively explore in a non-predetermined way.

Maybe the biggest Achilles heel of post-processual archaeology is our inability to agree on even the most trivial factors, such as classifications or the description of fill and colour of a context or layer in a section. As Madsen (2003, 14–15) illustrates, the descriptions are so dependent on prior experience and knowledge, that two people with the same basic understanding, but different experience, will rarely reach the same conclusions. The work of the less experienced archaeologist may appear as the most authentic, as the lack of prior knowledge prevents differentiation between the important and the less significant; they tend to describe 'what they see'. It is, however, difficult to integrate as common fact into our documentation, and emphasizes the dichotomy between rationalism and pragmatism – if knowledge comes before experience or if experience precedes knowledge. Even implementing something as objective as colour-codes is still limited by various factors, ranging from different lighting condition to the individuals' perception of colour. Post-processual archaeology inherently necessitates an evaluation of the authenticity of the classification and description according to the 'human factor'. One of the postmodern traits of post-processual archaeology is the disappearance of the limits between disciplines, and the disappearance of faith in knowing the one truth (Johnson 1999, 166), leading archaeologists to accept all understandings of the past as equally valid and equally authentic, but not necessarily equally objective.

'New-objectivity'

In 2003 Madsen pointed to the discrepancies between the geologist's and the archaeologist's approach to the interpretation of a soil section, and how different professional backgrounds and perspectives shape the documentation outcome. Naturally, an archaeologist will focus on traces of human activity, while the geologist is looking for geological processes. In either case, the issue is not how to draw or describe, but the act of identifying the abstract notion of something, which is not a physical entity like an object or artefact, but a context of some previous human or natural action. 10 years later, in addition to the philosophical implications of a new paradigm of 3D photorealistic documentation, this 'new-objectivity' has arguably a profound methodological impact on several aspects of field recording. It offers a new conceptual interface or structure of visual representation, which forces us to construe how an object in a 3D representation relates to a feature in the reality of the past. The new tools affect the interpretation flow and how we perceive and identify the relation between objects, and redefine the interdisciplinary preconditions of archaeology such as collaboration with geologists.

The archaeological investigations in the wetlands of Alken Enge between 2012 and 2014 revealed thousands of scattered human bones, dated to the Early Iron Age, lying beneath approximately 2 m of peat on an old lake bed (Hertz & Holst 2015; Holst et al. in press). This set the stage for an interdisciplinary collaboration involving, amongst others, the Department of Geoscience at Aarhus University (Søe et al. 2017).

The excavation conditions were challenging; excavating a bog 2 m below the water table of the neighbouring Lake Mossø. From the onset, a workflow and documentation pipeline was set up, consistently based on photogrammetry and Structure from Motion using VisualSFM and Agisoft Photoscan (Wu 2011, Agisoft 2016). This way, every documentation unit, context, and arbitrary plan or section was photo documented, 3D modelled, ortho-rectified, printed, drawn, classified and vectorized. Beyond the collaboration with osteoarchaeologists and anthropologists, the presence of geologists and their very different approach to the research questions came to be of great value in explaining the prehistoric events (Fig. 5.2).

Furthermore, the challenge of combining the archaeological and the geological interpretation of

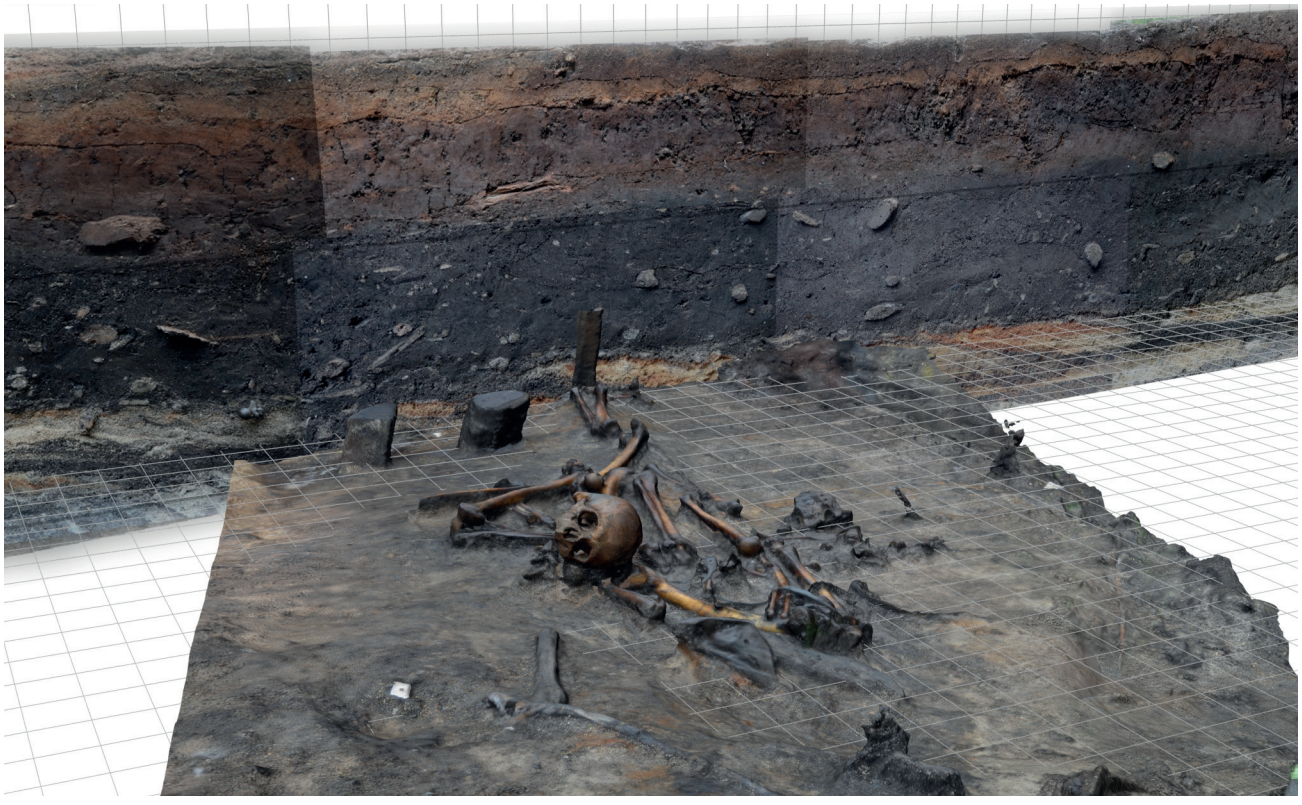

Figure 5.2. *Composite of 3D Structure from Motion documentation of human bones, alongside geological section in Alken Enge. Photo: Peter Jensen.*

the same reality demonstrated, how 3D models and photorealistic documentation may act as a common language in this discourse. The excavation saw the development of a common language, exchange of terms across disciplines and illustrated how interpretations were not necessarily linked to one profession alone. The boundary between geology and archaeology became fluid, and at a general level a method development took place where datamining and comparison of data became key to understanding the facts. Most importantly, this cross-discipline exchange of knowledge was not limited to or hindered by different interpretations of the same reality, because the issue was no longer a disagreement of classifications, as Madsen (2003) implied. The premise for the 'new-objectivity' of 3D photogrammetric documentation is not one of classification, but accounting for the level of authenticity and validity. How open to interpretation are our observations and what is the quality of our documentation?

Derivative and generalized: para- and meta-data

One of the keys to integrating 3D photogrammetric documentation in archaeology lies with the realization that 3D models are part of a process, much like the formation processes which create the archaeological record in the first place. The premise for this type of documentation is that our so-called primary data is derivative in nature, and its validity depends entirely on our ability to account for how data was created and evolves over time. We all work from assumptions that are rarely well described or even questioned. The formation process of our 3D documentation, or rather the para- and meta-data does exactly this. By estimating and evaluating claims of certainty or documentation quality, it may be possible to augment the scientific quality of data – and use authenticity both as a concept and as a tool in the archaeological documentation workflow. In this way, we are in fact equalizing evidential value and testing hypotheses – rather than engaging in a truth-seeking quest.

The most enticing promise of archaeological 3D documentation is that, in theory, we should be able to create a reality-proximate visual representation of reality. And in fact, we should be able to 're-excavate' on the computer at a later point in time, and potentially engage other colleagues in the interpretation process. This breaks with the traditional premise or paradox of archaeological excavations – that it is a destructive discipline that cannot be redone and which destroys the original source material. The fact that this approach actually enables and encourages us to correct or revise both the observation and the interpretation data, facilitates a more dynamic approach to documentation, instead of delivering that one interpretation – the synthesized and condensed report of an excavation.

We know that all visual data is derived – a generalization of something more detailed to begin with, and must undergo some process to get from the real world into our digital representation. First of all, we must account for multiple parameters related to the excavation process; how was the excavation planned and executed, and what where the documentation events that make up our bulk raw data (Jensen 2012). Secondly, the data processing needed to get from photographs to 3D models must be documented. The increasingly complex calculations needed, perhaps even by proprietary closed-source software, poses an issue in this regard. It makes the documentation process much less transparent, and any inaccuracies and systematic errors may potentially sneak into our primary documentation when we trust a 'black box' and its invisible algorithms to process data.

Arguably, it is by conceptualizing levels of generalization and authenticity of these steps of the digital documentation that we are able to more coherently integrate new levels of documentation detail into our excavations. If we develop procedures for measuring the authenticity of 3D photogrammetric documentation through an evaluation process, we may break with the objective realist stance commonly applied to 3D models. This is, however, not to assume that the authentic is a utopianism to be achieved. The concept of *objective documentation* is far less important than *authentic documentation*, and in this regard, authenticity equals the quality and detail of representing the observed. To express it more explicitly; the level of authenticity may be expressed as an equation of approximation, which includes all available para- and metadata related to the documentation events. The level of generalization is in direct relation to the required resolution (level of detail) of the documentation, and the amount of interpretations and assumptions are in direct correlation with authenticity.

Conceptualized authenticity in archaeological documentation

In the case of the Skelhøj and Alken Enge excavations, the realization of authenticity as a concept and tool in the excavation practice happened gradually and as an iterative process, reflecting technological developments since the turn of the millennium.

First of all, an evaluative authenticity-concept was implemented at the lowest level of the documentation ladder; in fact, authenticity was printed on context and find sheets in order to allow for an assessment of the observation/interpretation dichotomy. This gave the

archaeologist the incentive to evaluate the documentation quality at a very early stage in the process, and impose the reflexive question: 'how certain am I?' and 'how well does this/my documentation reflect reality?'

Secondly, concepts of documentation units, documentation events and data collections were introduced to address the derivative nature of digital data, and record the historic dimension of the documentation process (Jensen 2012). This way, para and meta-data are explicitly contained within the documentation, and it is known how interpretations and representations evolve over time, as new data and new knowledge become available. Authenticity of the documentation has nothing to do with what is original, but simply how what we have now, the visual representation, relates to what was in the past; knowing that everything is derived. The combined parameters are what help ascertain the authenticity of the documentation, and becomes part of the hermeneutics of the documentation process, where the interpretation is not exclusively an end product of the documentation.

Thirdly, 3D models were increasingly used to visualize the spatial hypotheses of the ongoing excavation.

3D models and spatial hypotheses

Far from being limited to archaeology, it is easy to see how the 3D paradigm is currently trending in countless branches of computing. In particular, archaeology's most beloved tools: Geographic Information Systems (GIS) and Computer Aided Design (CAD) are merging and evolving into doing things which used to be limited to dedicated 3D software (Wheatley & Gillings 2002; Breunig & Zlatanova 2011). Consequently, this also means dealing with different levels of abstractions, ranging from the reality-proximate and photorealistic via the delineative and generalized to the artistic and stylized representation.

In addition, 3D representation supports the combination of the observed with interpretation, following a more 3-dimensional reasoning, where we may apply 3D documentation as a tool for continuous monitoring and evaluation of an excavation and its results. Just like the general use of models to form hypotheses, it is possible to use 3D models as spatial hypotheses of an ongoing excavation. This allows us to visually realize or spatially conceptualize our hypothesis as a virtual reconstruction and to combine it with our observational data. The inherent issues of using photorealistic and high quality hypothetical visualizations as part of the documentation, and discerning which is which and accounting for level of certainty, was already touched upon more than 20 years ago by Eiteljorg and others (Eiteljorg 1998; 2000; Eiteljorg & Limp 2008). One of the main concerns was that visualization tools are rarely capable of displaying uncertainty or fuzzy data, or levels of probability when it comes to reconstructions (Eiteljorg 2000; Miller & Richards 1995). '*As disseminators of information to a data-naïve public, we must find techniques for displaying areas of fudged data within our models, and attempt to educate people in the skills of visual data analysis: an awareness of scale, an understanding of the fact that lines on maps often represent fuzzy boundaries, and a perception of the limitations inherent in our data*' (Miller & Richards 1995, 21). One such way of displaying uncertainty is by the use of colour, texture or opacity (Fig. 5.3). This, however, trails back to the issues of relying on prior knowledge or an individual's intuitive ability to read and understand such visual information.

Additionally, there is a whole array of visual elements, which may not rely solely on archaeological

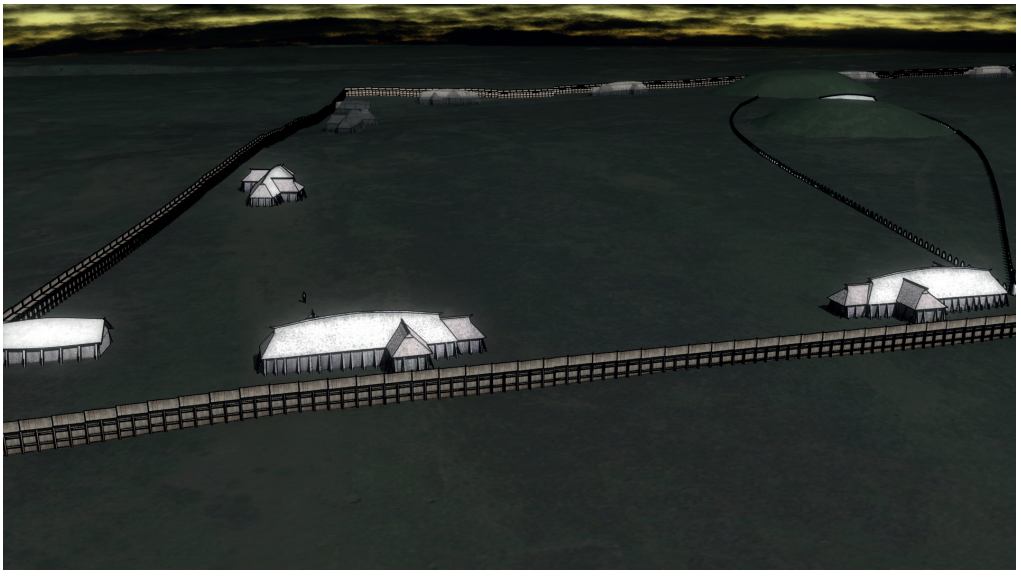

Figure 5.3. *The Jelling Complex visualized as 3D animation for the VIKING exhibition at the Danish National Museum. The style is non-photorealistic, and levels of uncertainty or hypothesis are indicated by varying transparency of elements.*

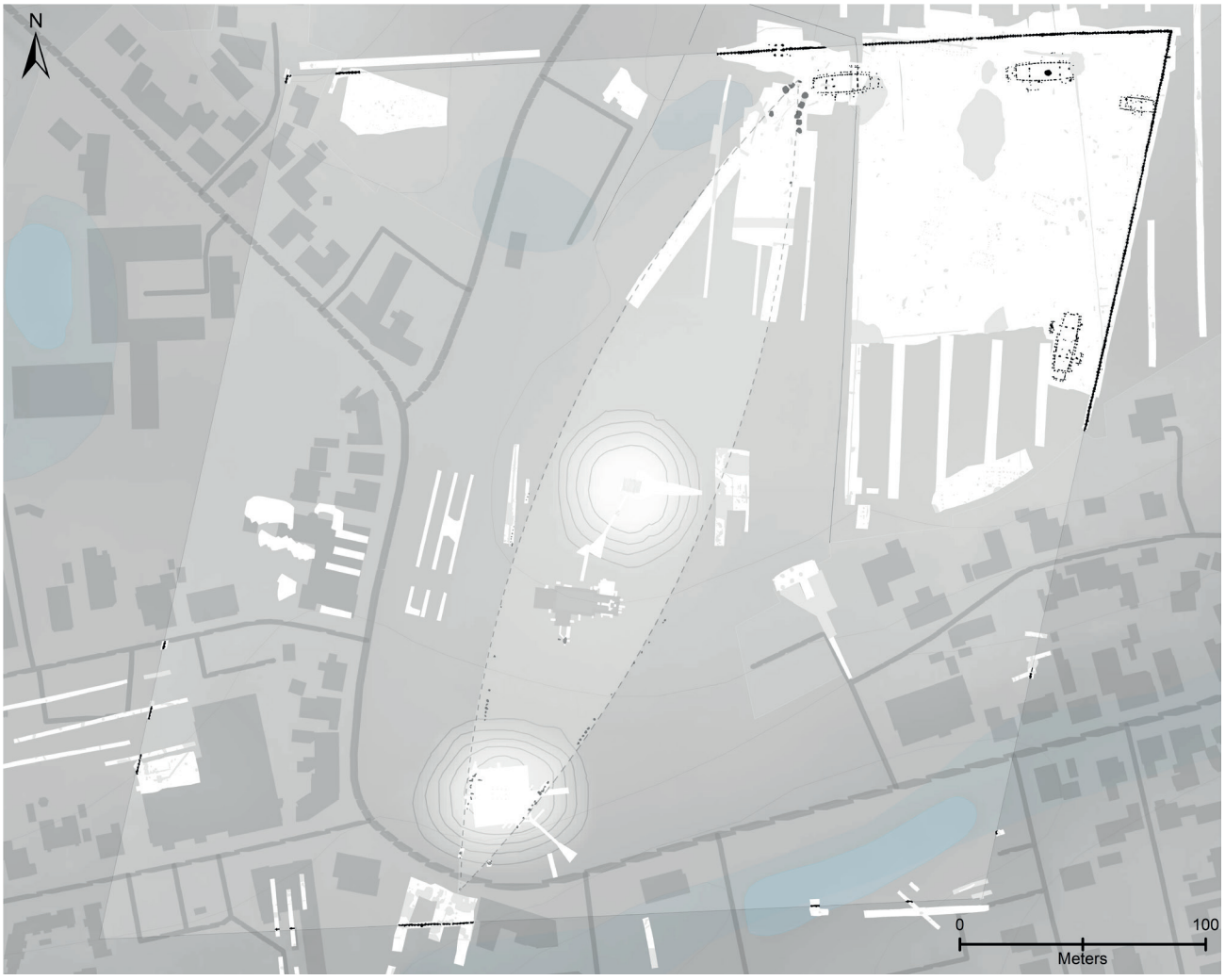

Figure 5.4. *The Jelling Complex: A central complex with a church and two burial mounds, rune stones and stone ship setting. A palisade surrounds the monuments and buildings are placed along the inside at fixed intervals and orientation. Excavated areas shown in white.*

evidence, and where the level of certainty is highly questionable. These may include, for example, written sources like *Beowulf*, which describes the appearance of the great hall building, ethnographic analogies, as well as the inherent assumptions governed by current trends and social/political circumstances. This is however part of a literary and societal discussion, rather than one of visual archaeological representation.

The concerns about scientific certainty in visualizations, among other, have led to the ratification of London Charter for the Computer-Based Visualisation of Cultural Heritage (Hermon et al. 2007; Denard 2012) – see Hermon & Niccolucci chapter 3. The London Charter highlights the major pitfalls of navigating the border zone between research hypotheses and public dissemination, but also hints at practices for combining *reality data* with *model data*. In this case, evaluating the level of authenticity, or uncertainty, is paramount to express the quality of excavation documentation, but as previously stated, authenticity may arguably also be integrated as a measurement tool that allows for evaluation of the empirical data and the excavation process.

The Viking Age royal complex in Jelling

As with Alken Enge, the excavations of the Viking Age royal monument complex in Jelling were to a very large extend based on digital photogrammetric documentation (Jessen et al. 2011; Holst et al. 2013). The 2010 campaign was targeted upon the large palisade structure, which encloses the mounds and the church, as well as the north-eastern quadrant (Fig. 5.4). The

excavations revealed postholes belonging to buildings, which in their pattern strongly resembled the architecture from known Viking Age houses, usually assigned to King Harald Bluetooth and the circular fortresses at Trelleborg, Fyrkat and Aggersborg (Holst et al. 2013; Jessen 2015; Roesdahl et al. 2014). In this case, it is of course important to note, that prehistoric architecture in Northern Europe is very seldom a matter of filling in missing pieces of a ruin of known design like Classical and Romanesque architecture (Miller & Richards 1995; Huggett & Guo-Yuan 2000). We are talking about the excavation of sub-surface ephemeral features associated with organic evidence of postholes with very little else evidence. This is a factor which should somehow accompany any visualization of such features.

Given that the houses at the circular fortresses tend to adhere to very strict geometric rules for placement, scale and orientation, meant that this was something which could be easily visualized and used to generate a working hypothesis of where to look for more houses, and estimate their architectural appearance – if indeed the similarities were substantiated. Key features of the Trelleborg-type houses are the unique entranceways and the double row of wall posts, presently interpreted as a combined wall and external supporting structure, following cruck construction. Neither the function of the external posts nor the entryways were initially identified by the early excavations of Trelleborg in the 1930s and 40s, but later excavations allowed archaeologists to reinterpret and physically reconstruct houses using these hypotheses (Schmidt 1981; Schmidt 1985; Olsen 1977) (Fig. 5.5). This is itself an excellent example of how reconstructions, as well as archaeology as a whole, are a product of time and society (Trigger 1989), as the first reconstruction shows Roman-derived traits, know from porticoes around Roman villas and Romano-Celtic temples, compared to the later, more Germanic reconstruction with cleaner lines.

By almost direct comparison, the excavations at Cowdery's Down (Millett & James 1983) also deal with the identification and interpretation of slanting posts, and quite interestingly present not just one, but several alternative reconstructions based on the same archaeological evidence.

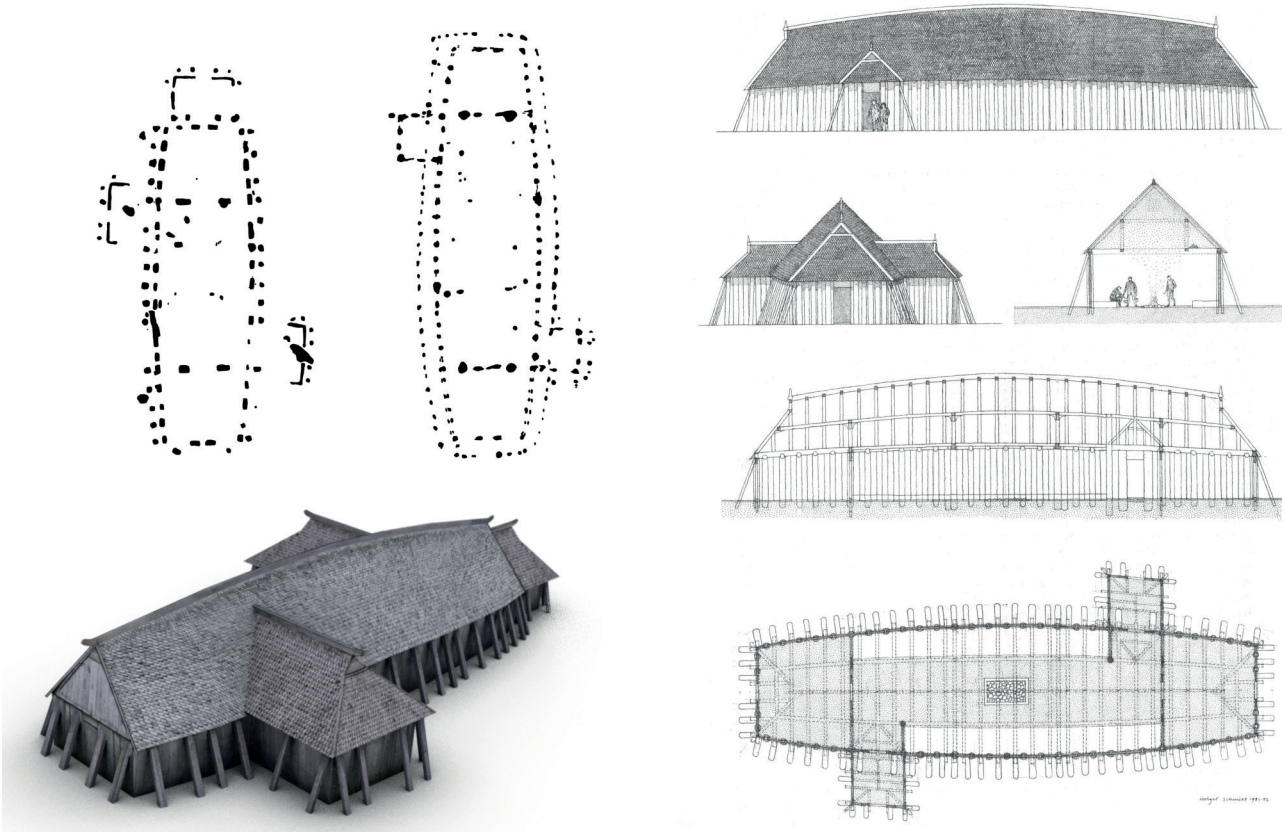

Figure 5.5. *Plan drawings of postholes show the architectural similarities between a Jelling House on the left and a Fyrkat House on the right (Olsen 1977). Holger Schmidt's architectural drawings for the Fyrkat reconstruction are on the far right (Schmidt 1985).*

The initial excavations in Jelling, revealed one house with an entranceway on one side. It was however known from the reconstructions of Trelleborg-type houses at Fyrkat that the entranceways are placed on both sides, and displaced to either end (Fig. 5.6). Combined with the observed systematic mirroring of the house orientation in the fortresses, this helped to guide the excavation into where to look for more entranceways, among the otherwise poorly preserved postholes. In addition, the Jelling houses turned out to have a very unique feature, as the gable ends would have an extension in either end. The Jelling-house, however, still adhered to the strict geometry and rules of mirroring and symmetry. The natural response was to try to 3D visualize this special structural feature on the basis of the architecture of the physical reconstruction at Fyrkat (Schmidt 1985) and apply it as a working spatial hypothesis for the excavation.

The visualizations were done in a combination of software: Agisoft Photoscan, ESRI ArcMap and ArcScene and 3D Studio Max. Acknowledging that archaeological interpretation is a dynamic and iterative process, different snapshots or documentation events account for the thought processes and expectations of the archaeological source material. This way, *when* these snapshots were made, by *whom* and based on *what* criteria, became the basis for evaluating the authenticity of the development of the spatial models, and the rationale for replacing one model with another revised model. The experiences gained in Jelling demonstrate how abstractions shape the basis for the archaeological process, and how 3D visualization functions as a tool of reflection – combining what we know with what we expect.

The excavations at Jelling, and not least the intensified use of 3D models as spatial hypotheses, exposed the need for a framework to manage the iteration of interpretations. By including an evaluation of authenticity at all levels of the documentation pipeline, the system should be able to fill in the void of meta- and para-data, left by the break-down of the clear distinction between observation and interpretation, itself caused by the introduction of photorealistic 3D representations.

The evaluative process of the empirical data collected would generally follow a predetermined chain of events:

Figure 5.6. *Photos of the reconstructed houses at Trelleborg (top) and Fyrkat (bottom). Photo: Anne Pedersen (top), Peter Jensen (bottom).*

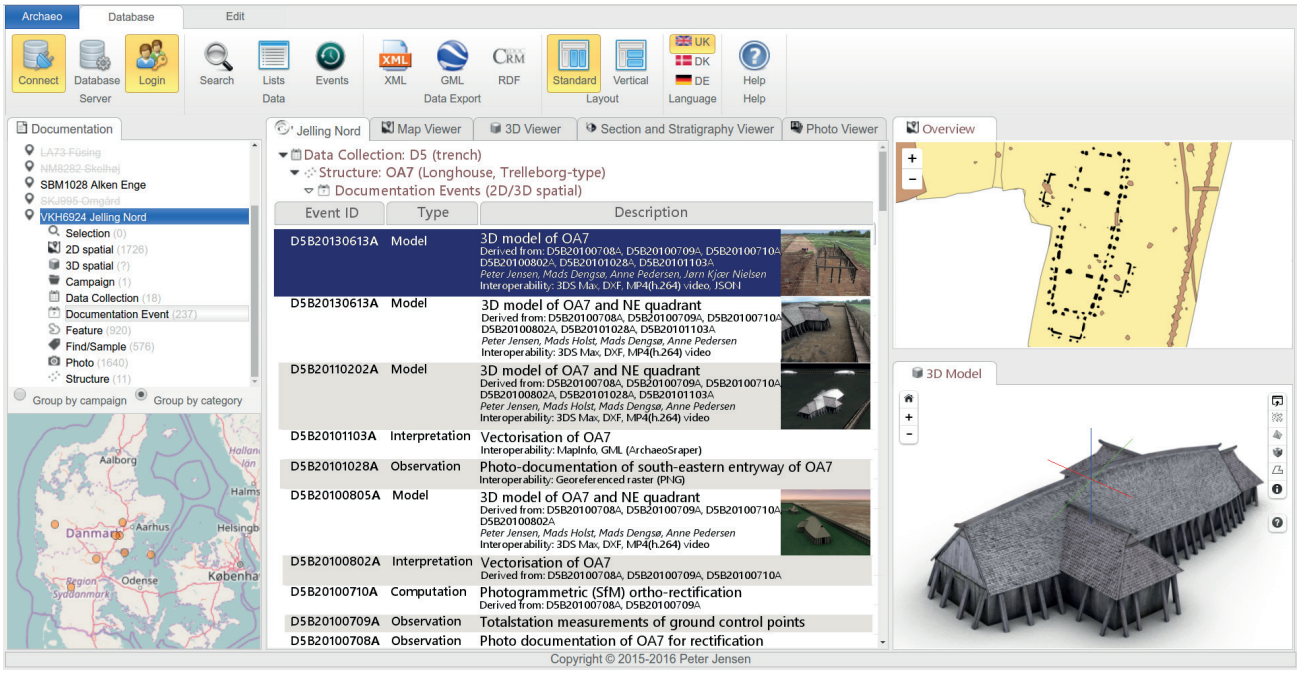

Figure 5.7. *Screenshot of the Archaeo online database, currently under development. Displaying the chain of Documentation Events and iterations of spatial hypotheses while excavating the house OA7 in Jelling.*

1. An opening strategy of excavation methodology and definition of Data Collections (Jensen 2012). The Data Collections were used as constructs, which served to collect all related primary data within well-defined physical boundaries. I.e. all descriptions, photos and measurements within a given area, which would tentatively be used to synthesize an illustration. In practice, each trench would act as a Data Collection.

2. Each consecutive Documentation Event would refer to a Data Collection in a one-to-many relationship, and provide primary data as well as derived data. Authenticity would be assessed through aggregated para- and meta-data.

3. Following a Documentation Event, results would be re-interpreted and synthesized into a separate Documentation Event containing a spatial hypothesis: GIS-plan or 3D model (see Fig. 5.7). In this case, authenticity was expressed as levels of certainty and evaluated through the use of colour-coded visual elements. Each element would refer to back to the Documentation Event from which the interpretation derived.

4. The excavation strategy is reassessed and retargeted according to the revised hypothesis defined by the last Documentation Event. New Data Collections are defined, or new Documentation Events take place within existing Data Collections, such as documentation at a deeper level.

Finally, we should consider whether we need to quantify levels of authenticity, to tie our documentation to standards of processual archaeology, or if we should focus more on the separation of research vs. dissemination or hypothesis vs. fact in 3D visualization to accommodate a different type of audience.

Unintended consequences; Research tool or public dissemination?

Visual models have a tendency to cement an interpretation as fact, rather than fiction or hypothesis, and even with proper precautions and disclaimers they easily evolve into a 'truth', recognized as such by non-professionals. As already noted, this is also one of the main motivations behind the London Charter (Hermon et al. 2007; Denard 2012). This happens as archaeological research flows into public dissemination, where 3D graphics provide a marvellous tool to convey a story about the past. The use of models or reconstructions to convey a story, or even serve as experiments to test a hypothesis is nothing new, as already illustrated by the example of the physical reconstruction attempts of Viking Age Trelleborg houses in Denmark by Holger Schmidt (Schmidt 1981). These reconstructions have,

however, become representative of how the houses looked, even though we actually had two very different reconstruction attempts and therefore two conflicting architectural hypotheses. Paradoxically, this is the whole idea behind hypotheses or experiments; we learn from them and adapt our theories, which in this case, and in combination with subsequent research, has led to other or better interpretations of the architectural characteristics of the Trelleborg-type houses (Schmidt 1985; Jessen et al. 2011; Holst et al. 2013; Jessen 2013; Jessen et al. 2014; Jessen 2015). The challenge is how we convey this to the public in terms of authenticity. Compared to previous generations, what has changed is that 3D models and visualizations now reach the public much faster and through different media, and potentially without the necessary scientific discussion. Computer models tend to carry more authority than paper images and '*Large audiences are being exposed to visualizations in circumstances, where the pictures or animations are divorced from the academic discussion…*' (Miller & Richards 1995, 20).

When the excavations at Jelling encountered postholes of Viking Age buildings, which in their outline showed similar characteristics, the natural thing was to use the same architectural idea in 3D models, which helped the archaeologists get an impression of the site as it was excavated. Inadvertently, due to the high demand of something to show the public, these models were shared at a very early stage, and soon ended up in newspapers, information posters and even went into the new museum exhibitions. Fortunately, the Visitor and Experience Centre at Kongernes Jelling – Home of the Viking Kings, were very aware of the academic discussions and the reservations about visualizing ongoing research. They often brought in the archaeological team to re-evaluate the architectural basis for the interpretations in the light of the new excavations and archaeological evidence. It, however, still became a struggle between scientific integrity and the public demand for visualizations.

One key feature of the 'old' reconstructed houses were the hipped roofs which were part of Schmidt's

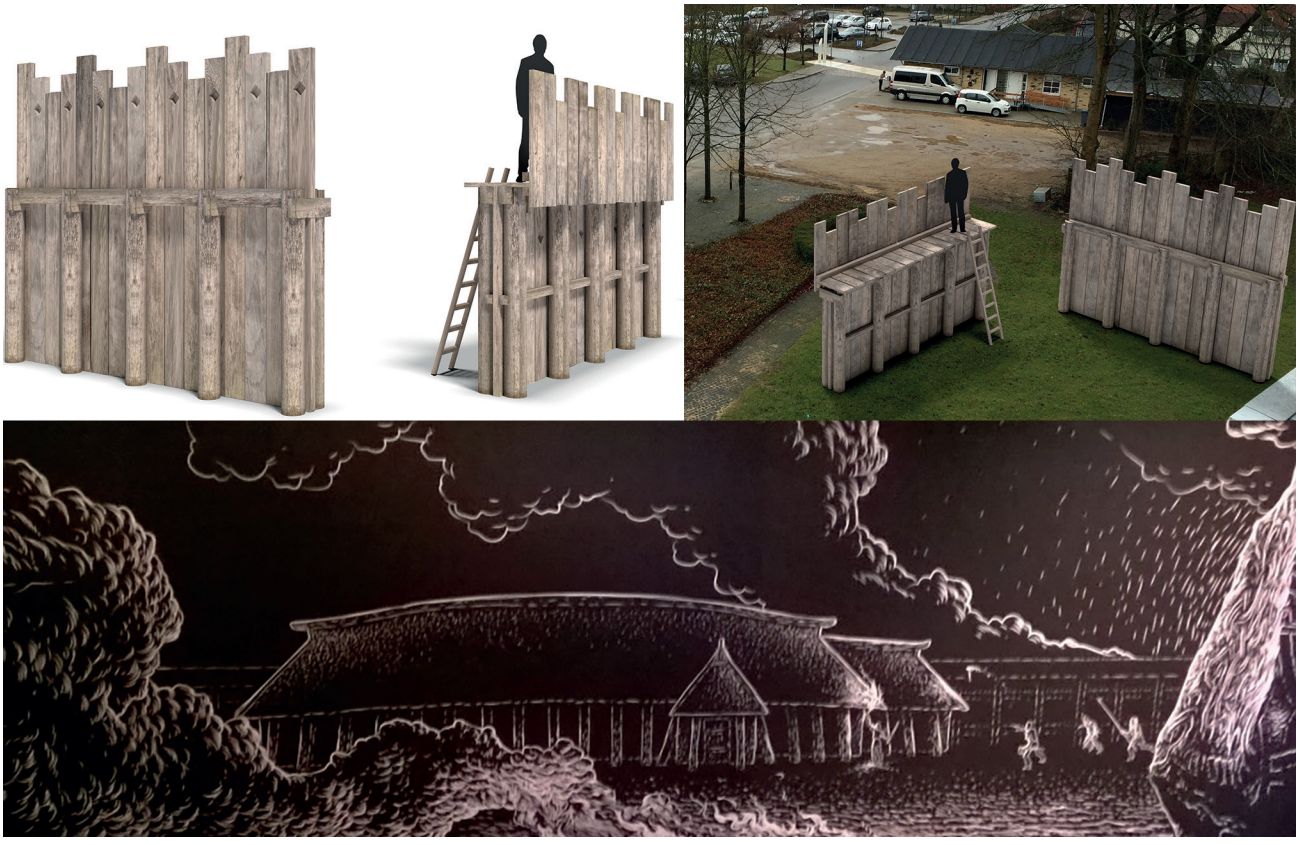

Figure 5.8. *3D model of the planned physical palisade reconstruction (top left and right). Photo: Peter Jensen. The exhibition wall backdrop at the Visitor and Experience Centre at Kongernes Jelling – Home of the Viking Kings, showing an artistic rendering of an outdated spatial hypothesis (bottom). Painting: Sebastian Bausdorph, photo: Adam Bak, Kongernes Jelling.*

original reconstruction at Fyrkat. The process meant that this feature was inherited by the visualizations of the Jelling houses, despite the fact that current interpretations of the postholes suggest gabled roofs were more likely. Stepping into a brand new exhibition and seeing visualizations based on a, now outdated, excavation hypothesis naturally causes concerns that an inauthentic or unsubstantiated account of the past is being conveyed to the public (fig. 8). The museum has addressed these challenges by actively introducing several interpretations of different architectural elements. An example of this is the Viking Age palisade, which went through several iterations in the archaeological spatial hypotheses. For 2017 a physical reconstruction of a section of the palisade is planned for the museum gardens, which will include several elements from the various interpretations regarding, height, paint, carvings and general architecture (Fig. 5.8).

Another example is the recent discovery of the Viking Age ring fortress Borgring, south of Copenhagen (Holm & Sindbæk 2014). Even though the preliminary excavations only revealed ramparts, gates and ditches, it was expected that it would be similar to the other Viking Age fortresses, in having 16 buildings inside (Fig. 5.9). Current excavations so far have however not found any evidence of buildings, which strongly conflicts with the 3D model, which was made to illustrate a hypothesis about what kind of feature had been discovered to the public (Persson 2016).

As the producer of these models, one realizes first-hand the importance of the London Charter (Denard 2012; Hermon et al. 2007) and the challenges of navigating the grey zone between archaeological documentation, hypotheses and public dissemination.

Despite all possible disclaimers, there is a demand from the public and exhibitions to visualize archaeology, not just as postholes, but to reveal *what the archaeologists are thinking* and to offer an informed opinion of what features might have looked like. One instrument to accommodate both is to refrain from photorealistic models altogether (Fig. 5.3). Yet is it safe to assume that the audience most likely already realize it is a model, but trust the authority when we present a model or claim? We should not underestimate the capacity of the audience to deal with uncertainty. What really matters is the ability to account for or justify the visualization, and in doing so, facilitate access to raw data as well.

The London Charter clearly states: '*Sufficient information should be documented and disseminated to allow computer-based visualisation methods and outcomes to be understood and evaluated in relation to the contexts and purposes for which they are deployed*' and '*Documentation of the evaluative, analytical, deductive, interpretative and creative decisions made in the course of computer-based visualisation should be disseminated in such a way that the relationship between research sources, implicit knowledge, explicit reasoning, and visualisation-based outcomes can be understood*' (Denard 2012, 8). This is not an easy task to accomplish, but evidently transparency of what the model is based on is what defines its authenticity. As Eiteljorg (1998, 3) put it: '*If we only present a simplified and sanitized view of the past, especially one that seems real and is visually compelling, we will have failed those who want truly to understand, both as scholars and as users of the technology*'.

Figure 5.9. *DR News online (www.dr.dk) depicting the Borgring visualization next to queen Margrethe II at the day she inaugurated the new excavations.*

On the other hand, the chances are that we are overly concerned with muddling the border between reality and model. Arguably many post-processual archaeologists could be accused of being overly obsessed with measuring and recording the past in as detailed a fashion as possible – perhaps forgetting that '*not everyone even wants authentic archaeologies – whether scientific or not – and understand what this fact means for professionals who work in the public sphere*' (Lovata 2007, 21). While the use of 3D-'replica', -models or -visualizations in archaeology is susceptible to being criticized for overstepping the bounds of scientific ethics, other disciplines do not appear to have the same reservations. Take, for example, the visualizations which accompany space exploration by organizations like NASA and ESA which also have public dissemination as a top priority. The use of computer-generated imagery has grown substantially in this field during the last 20 years. In order to accommodate the audience, data from deep

space, which like archaeological 3D data is based on sensor-input and calculations, is often post-processed to an extent where it has very little to do with reality, and rarely do the authors bother to write 'an artist's impression', when it surely is. In these disciplines, public dissemination and 'raw' research data appear very disassociated, which is in striking contrast to how we currently pursue archaeology, where public engagement and immediate publication of research data tend to be vital. On the other hand, some would argue that archaeology is hardly 'rocket science'.

Conclusion

Does authenticity qualify as a conceptualization of documentation quality in a world of reality-proximate, photorealistic and geometrically accurate digital representations and visualizations? At first glance, it might appear somewhat ambiguous. In particular, because the most common use of authenticity in archaeology refers to individual objects and artefacts of the past, rather than the replication of an event of the (near) present, which the photogrammetric field documentation represents. On the other hand, what such conceptualization portrays is a very conventional notion of authenticity; as one that is achievable through its representation of reality. But why do we not just call it documentation quality? This all points back to the dichotomies of archaeological science, and mainly the dichotomy of *observational reproduction* and *interpretational reconstruction*. Whereas the first might very well be addressed through a quantitative evaluation of the derivative nature of data processing through the recording of para- and meta-data, it does not account for the interpretive and reflexive element of utilizing 3D models as representations, which are more or less reliant on the subjectivities of archaeologists. Furthermore, the concept of quality does not describe the spatial hypotheses which the latter represents, and the varying certainty of the reconstructed elements within.

Authenticity remains, in part, a subjective notion concerning the trustworthiness of a visual representation, but the experiences from the cases presented in this chapter also demonstrate how authenticity may be integrated as a concept and a tool in a spatial database. The immediate accessibility and transparency of data is a key issue, and the documentation events in the database reflect the iteration of spatial hypotheses, facilitating a less deterministic approach to archaeological visualizations in documentation as well as dissemination.

What remains are the unintended consequences of multiple versions of interpretations reaching the public audience. But as much as technology is to blame for rapid distribution of tentative reconstructions, it may also hold the key to solving the issue. As more and more museums apply digital and interactive elements to exhibitions, it is only natural to make use of less static exhibitions, which traditionally could be on display for years if not decades. An interactive 3D model in an exhibition is easily and inexpensively replaced with an updated hypothesis, while returning visitors increasingly expect exhibitions to reflect the latest research. In turn, the public may grow accustomed to this kind beta-exhibitions, which are always improving – and in the process become more aware of the iterative process and nature of archaeological interpretation.

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