Visualisation of Uncertainty in Archaeological Reconstructions

(Transcript of Lecture)

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The Visualisation of Uncertainty is a method to explicitly demonstrate the hypothetic character of archaeological reconstructions. It combines sketches with abstract models and assumes that both, perception and meaning, will be adopted. By this, the Visualisation of Uncertainty, too, would be read intuitively. Both, sketches and abstract models, have in common their share of the undefined. The degree of the undefined is variable and adjustable. Furthermore, the lack of definition does not have to be a lack of information. On the contrary, the lack as such can carry the most important information: the need for further decisions or the existence of a multitude of possible completions.

The project started as an individual experiment initiating a cooperation with the chair for building history. On the basis of the first results we joined the Sculpture Network Berlin and became financed by the Excellence Cluster TOPOI 'The Formation and Transformation of Space and Knowledge in Ancient Civilizations', financed itself by the German Research Foundation DFG in order to project the whole city of Pergamon. The network provides us with knowledge and information about the current hypotheses. The German Archaeological Institute's office in Istanbul, official excavator in Pergamon, is working with us in close relationship particularly in city layout and in modeling detailed architectural parts.

We will attempt to explain our approach with a recourse to the basis of visual architectural representations: sketches are suggestions. While the depictive sketch works out the essences, the design sketch materializes a thought. If sketches look unsharp, the ideas that they represent are also unsharp, and therefore uncertain. In design sketches this uncertainty is intended, so sketching in the design processes is actually visualizing uncertainty. And this uncertainty is the link between architectural design and archaeological research. While the designer may leave decisions to be made in

a later state, the archaeologist's knowledge may be incomplete or ambiguous. In short form: design does not want yet, archaeology does not know yet (to determine further details).

Fig. 1 Pergamon 200 AD, temple of Zeus. (Virtual photography of digital 3D model, 2011).

In archaeology, reconstructions reflect the state of research (fig. 1). In some cases though, the information is not sufficient at all for a reconstruction. It depends on the state of the ruins, if you can reliably reconstruct in three dimensions. In some cases it is only sufficient for an outline. A complete antic city's appearance can therefore only be partly based on scientific research. In this case, a reconstruction is based on analogies or hypotheses. The aim of the Visualisation of Uncertainty is to establish methods of representing uncertainty and its degrees – and to visually emphasize the existence of uncertainty.

In the field of archaeology two dimensional methods for representing uncertainty have already been established. Perspectives look from selected points of view or hide those areas that are uncertain. Physical, haptic models on the other hand cannot fulfill this demand, since you can freely look around. By contrast virtual computer models can. But the idea of a model has to be considered different from a physical model. In general, a model is a theoretical construction, far more than bare geometry. A model may contain a multitude of geometries, several states, links, constraints or any other kind of information. This means that the representation of the model changes and varies in any aspect. The main focus within the Visualisation of Uncertainty is this differentiation.

Obviously visualized uncertainty will rarely look realistic. The reason for this is that most hypotheses leave many things undefined. If the hypothesis is extremely vague there is little to be

represented. But more precise information by the archaeologists may not be available. So there must be something in between. A certain formal and visual constraint to get convincing images, that show the hypothesis itself as well as its degree of uncertainty. This lead us to a set of methods:

Geometric Simplification turned out to be the most intuitive way to represent uncertainty. In circumstances other than archaeology this might be misinterpreted as contemporary design (fig. 2). Geometric contrasts furthermore clearly show the different degrees of certainty. Again, it is the context of archaeology that excludes an interpretation as a design sketch (fig. 3).

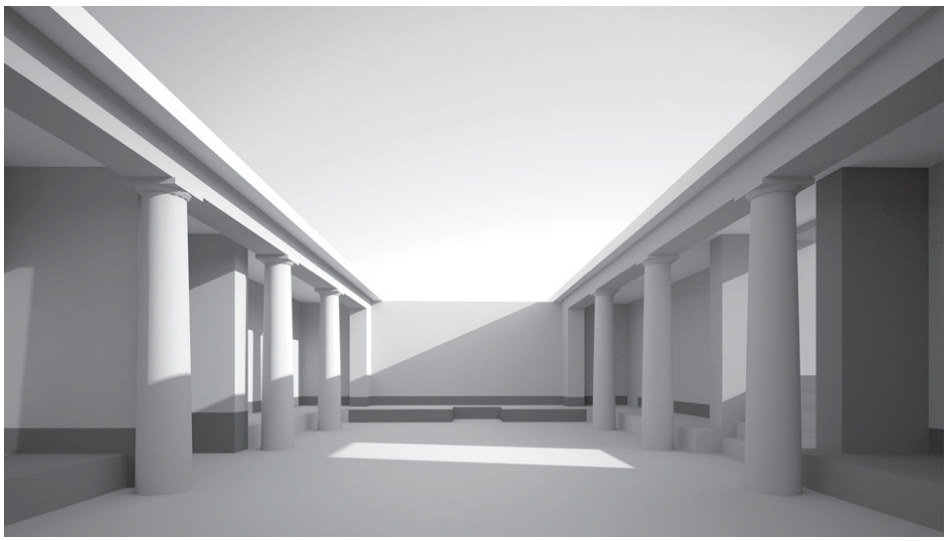

Fig. 2 Pergamon 200 AD, temple of Hestia. (Virtual photography of digital 3D model, 2008).

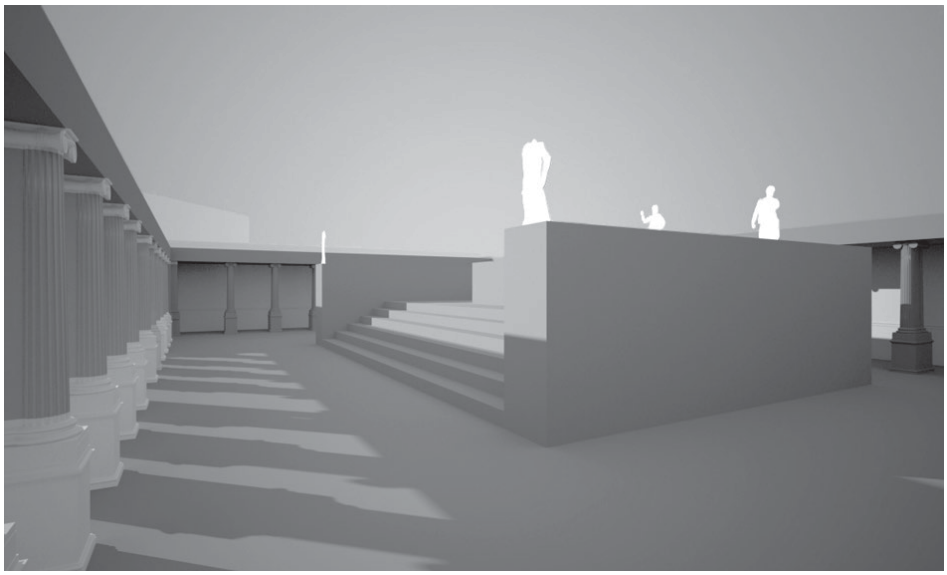

Fig. 3 Pergamon 200 AD, court of Great Altar. (Virtual photography of digital 3D model, 2008).

Transparency only pretends to convince. Indeed, transparency is disturbing, since it suppresses and distorts the natural spatial impression. Transparent objects neither represent a spatial situation with nor without them. Instead of visualizing two options, transparency visualizes none of them, but informs about this uncertainty in a non-spatial, rather theoretic way. The spatial representation therefore does not focus on spatial perception, but on abstract information, just as the verbal hypothesis does. This is why we apply transparency only in axonometries that match the diagrammatic meaning of transparency (fig. 4).

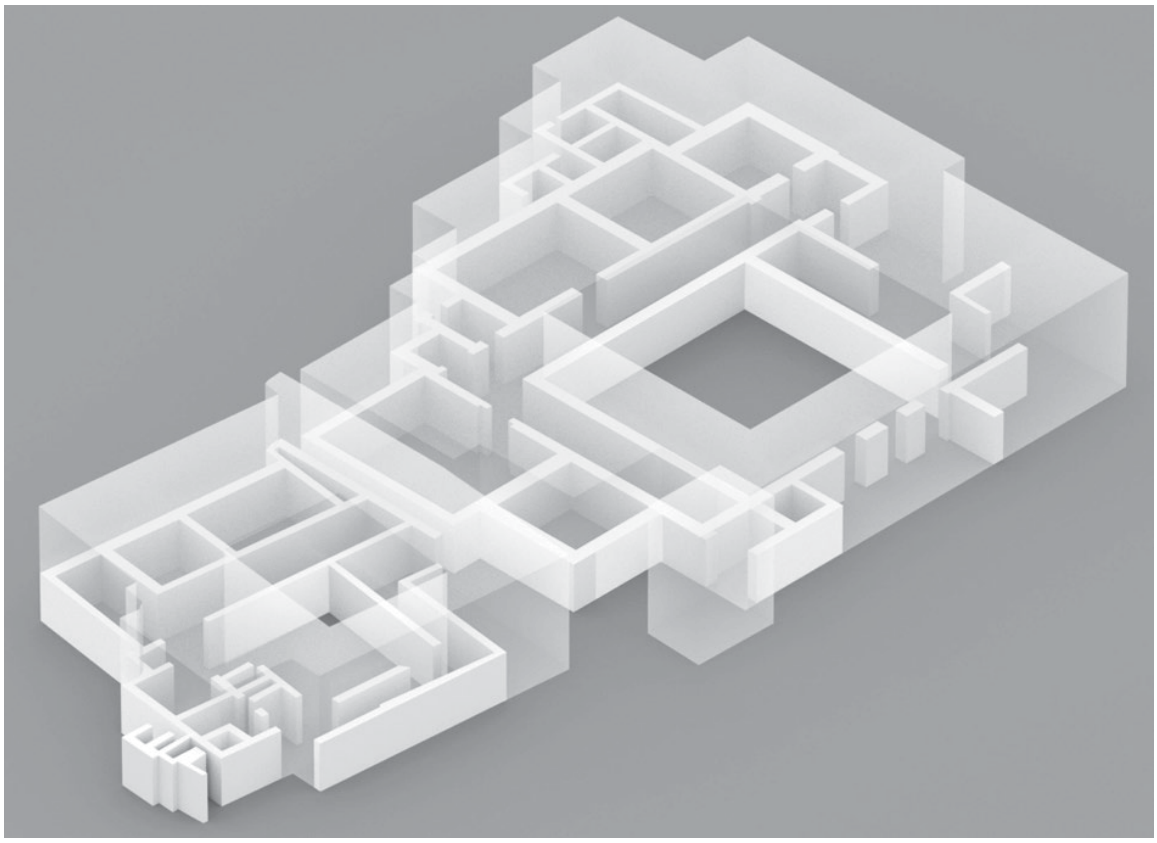

Fig. 4 Pergamon 200 AD, palaces IV and V. (Virtual photography of digital 3D model, 2008).

Lines in space instead do not suppress the natural spatial impression. They indicate that beyond the shown spatial impression there is supplemental information. In this example, the smaller temple relies on certain reconstructions. The wires show an outline of a larger temple that might have originally been planned at this site. Some building parts used in the small temple would certainly match the larger one. The hypothesis is therefore that after some parts had already been finished, the overall size was reduced, probably because the slope of the site is too steep (fig. 5).

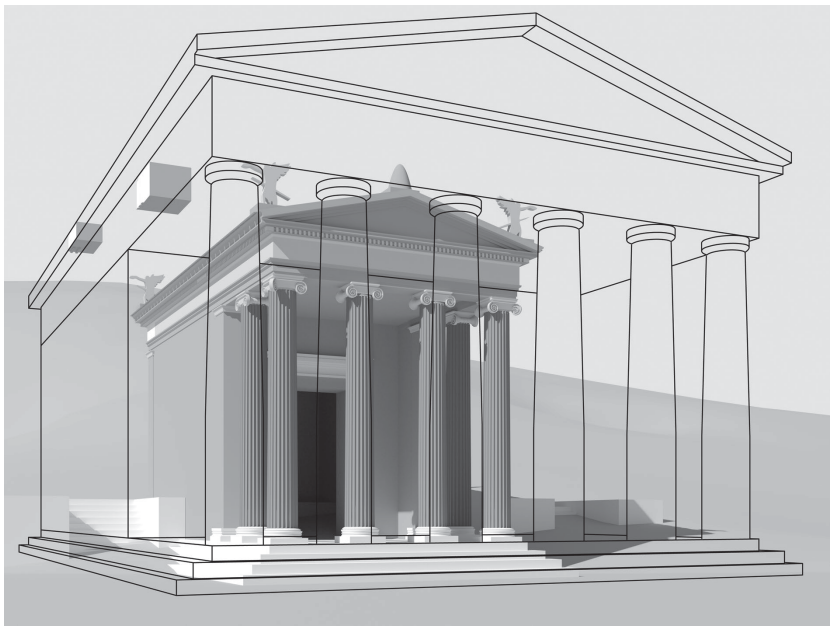

Fig. 5 Pergamon 200 AD, temple R. (Virtual photography of digital 3D model, 2008).

If there are contradictory hypotheses, it seems impossible to maintain the spatial qualities and the ambiguity at the same time. In this case, we show the hypotheses separately, so it is clear, that all hypotheses are equally significant (fig. 6).

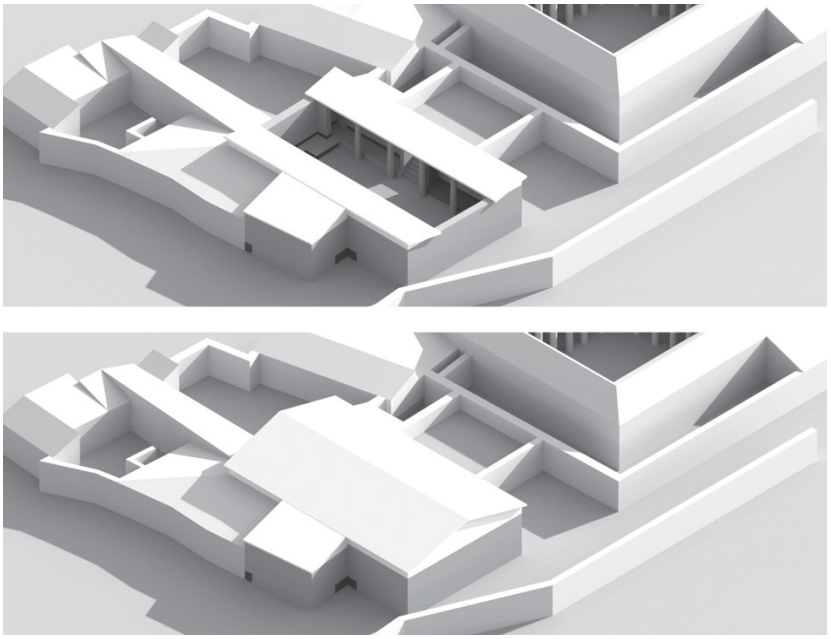

Fig. 6 Pergamon 200 AD, temple of Hestia. (Virtual photography of digital 3D model, 2008).

Levels of detail have to be reconsidered as well. In Visualisation of Uncertainty, their purpose is as follows: Too many details contradict the uncertainty, while too few details obscure the spatial character. Flat roofs for instance suggest a completely different cultural environment than pitched roofs. On the other hand, it seems that windows do not have an effect on the identification of buildings (fig. 7).

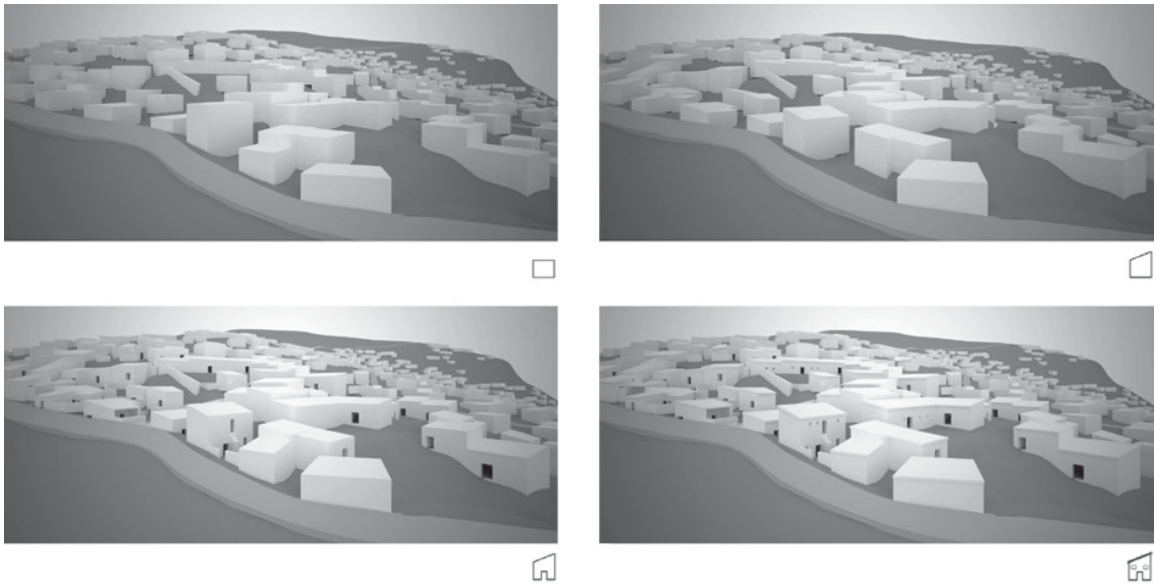

Fig. 7 Pergamon 200 AD, byzantine housing. (Virtual photography of digital 3D model, 2008).

In order to make the visualized uncertainty as self-explanatory as possible we defined a set of conventions: First of all the visualization has to maximize the spatial impression. This means that whatever method is appropriate to represent a building's or situation's uncertainty, the natural spatial impression has to be considered very carefully. In other words, if a method would distort the spatial impression, it should not be used. Three main aspects are responsible for an appropriate spatial impression: the projection and the view point, the unambiguous presence of solids and the lighting.

Just like in architectural photography, the natural perception depends on the perspective projection. First, a perspective is either viewed from a bird's eye or from eye level. Second, the projection plane is either perfectly vertical or undoubtedly tilt. And most important, there is nothing in between (figs. 8-9). Even more explicit than bird's eye perspectives are parallel projections, and even more clearly diagrammatic are tilt axonometries like ground plan axonometries (fig. 10).

Fig. 8 Pergamon 200 AD, Traianeum. (Virtual photography of digital 3D model, 2011).

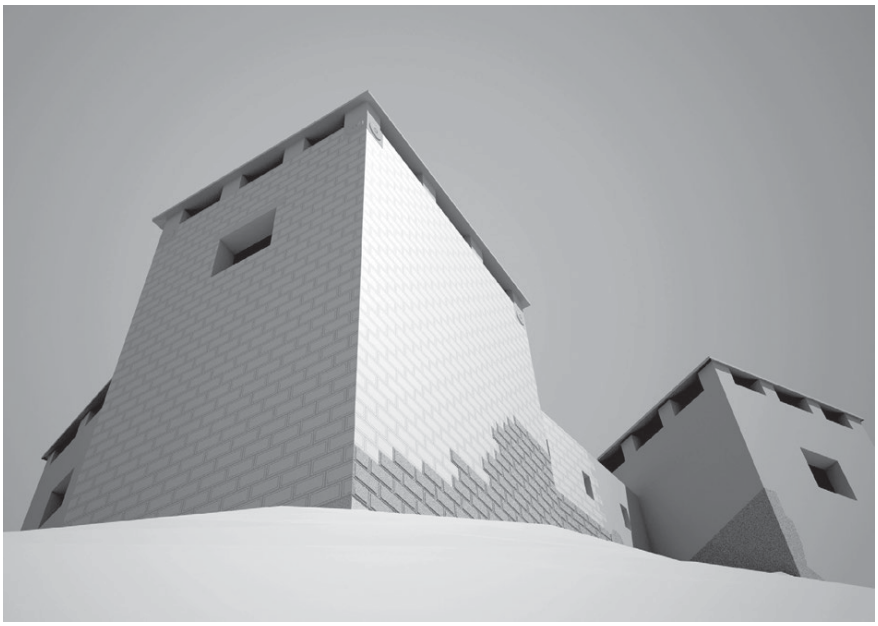

Fig. 9 Karasis, fortress, ca 2nd century BC. (Virtual photography of digital 3D model, 2009).

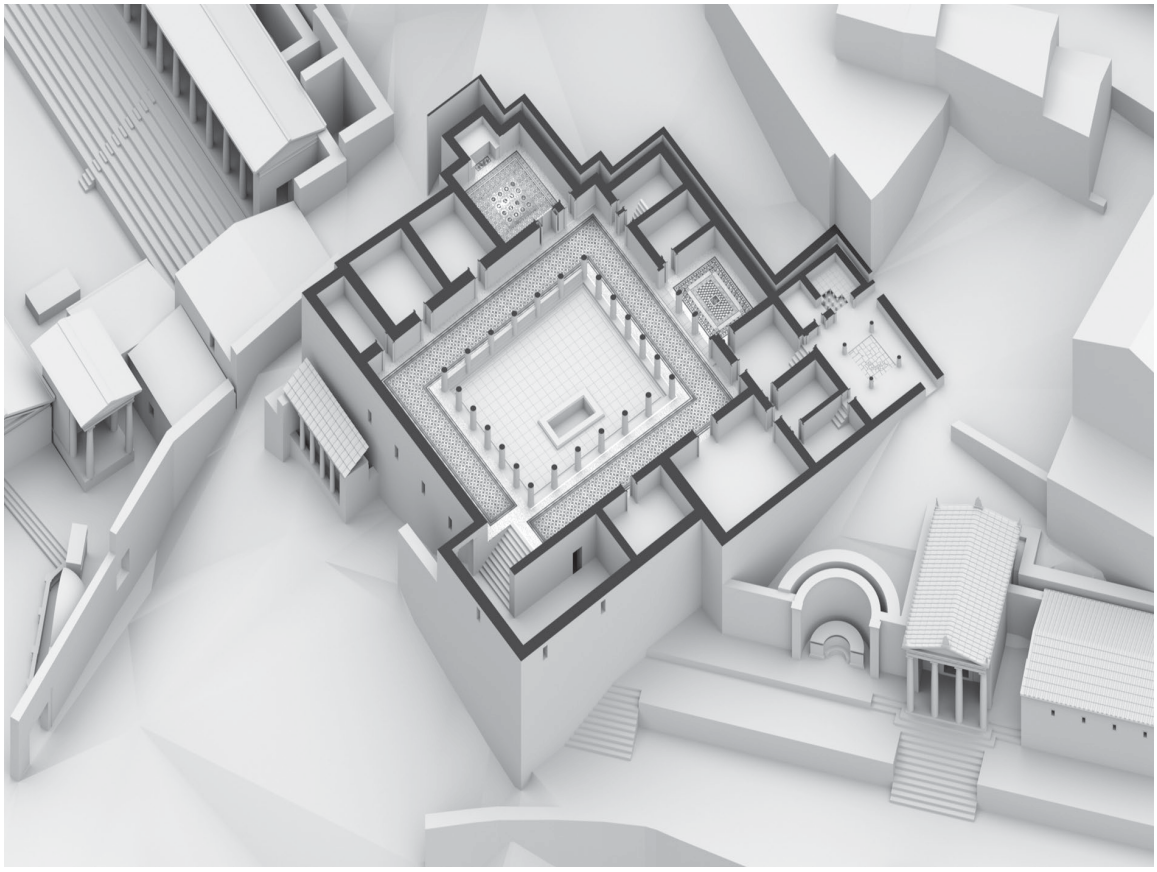

Fig. 10 Pergamon 200 AD, building Z. (Virtual photography of digital 3D model, 2011).

The undoubted presence of solids ensure that if volume is part of the visualization, it will also be perceived as such. Transparencies contradict this and hinder the understanding of a spatial situation. Either there is an object, and in this case its rear is invisible, or there is not an object and the view is not obscured. With transparency, the spatial impression is distorted (fig. 11).

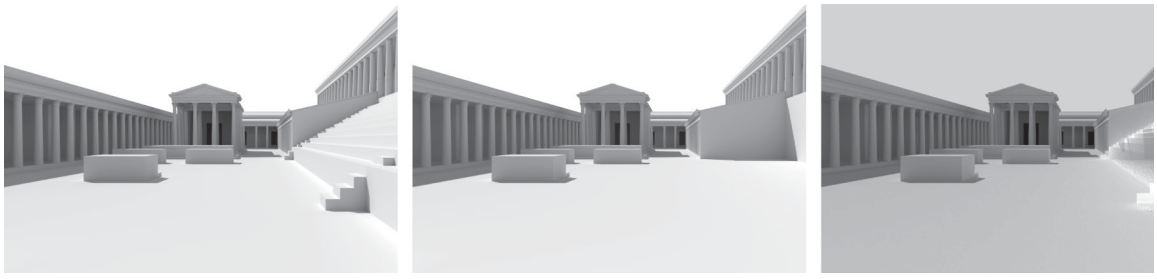

Fig. 11 Pergamon 200 AD, sanctuary of Demeter. (Virtual photography of digital 3D model, 2010).

Finally the spatial impression depends on the lighting. The lighting should not contradict the information about uncertainty. If a scale of shading is used to express the degrees of uncertainty, the lighting must be set to undoubtedly leave the scale untouched. The degree of uncertainty can range from observable remains to absent parts and objects whose former existence is absolutely certain to assumptions firmly rooted in science. So light must not interfere with this code (fig. 12).

Fig. 12 Pergamon 200 AD, gymnasion. (Virtual photography of digital 3D model, 2011).

The second convention ensures the unity of the visualisation, or in other words, the compatibility of the single parts of a visualisation. A convincing impression of a large city can only be achieved if the buildings suit one another and form a unity. This is far more important than

the individual uncertainty. Otherwise, if some buildings were detailed while others were rough sketches, the overall impression would be unsuitable (fig. 13). We are working on the balance between the highest detail possible and the least detail necessary, to achieve a look that is adequate and homogeneous at the same time. For large city overviews we introduced a cubic grid of one by one by one meters: objects that fill more than half of this one meter cube are shown, while objects that do not fill half of the cube are not shown. This does not work down-the-line, so there are exceptions to the rule. Columns for example clearly fill less than half of the space. But if you consequently left them away, colonnades would simply disappear. It is the same with steps and sculptures (fig. 14).

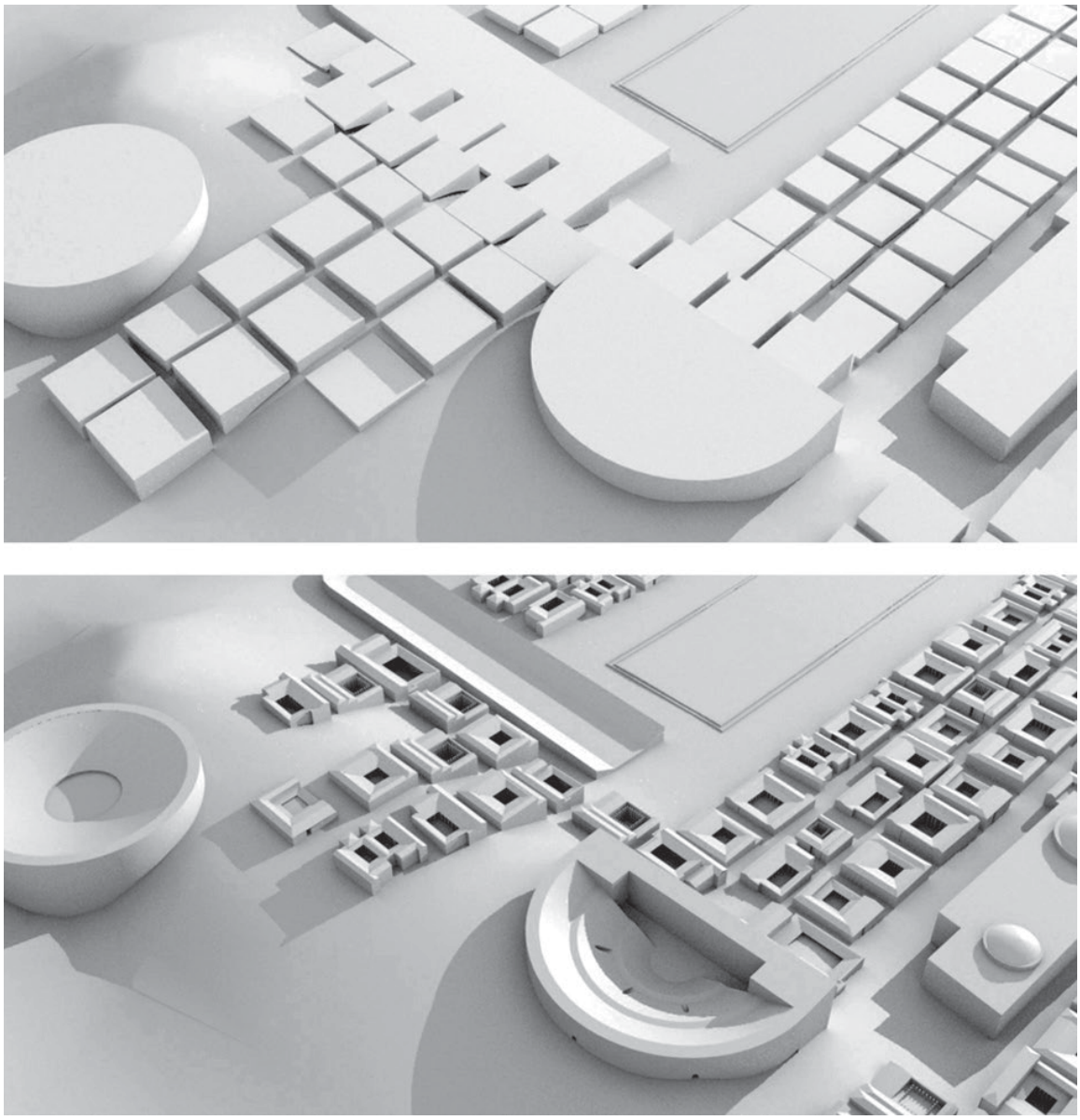

Fig. 13 Pergamon 200 AD, roman city extension. (Virtual photography of digital 3D model, 2008).

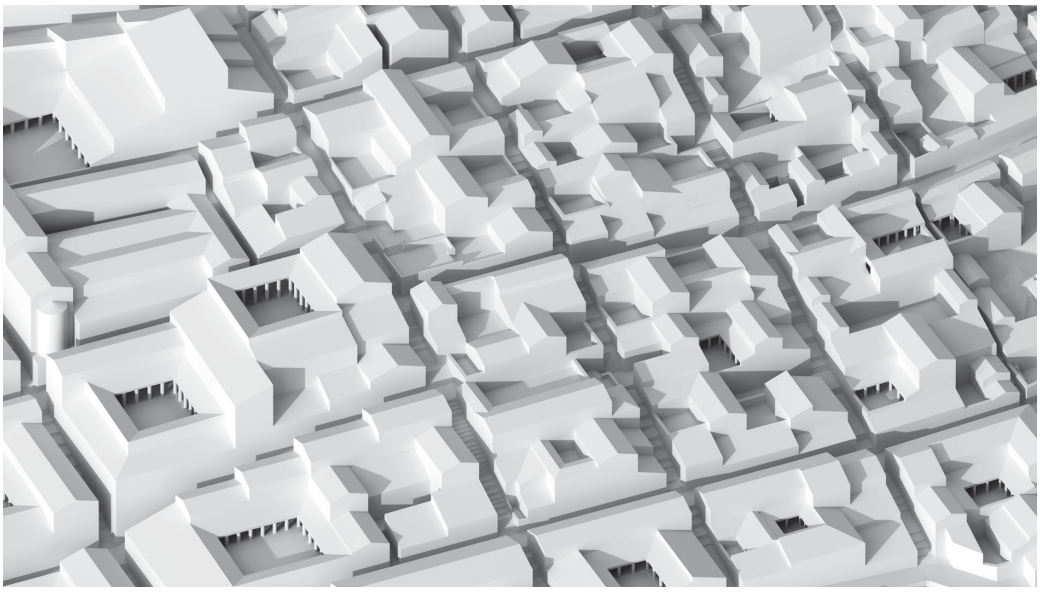

Fig. 14 Pergamon 200 AD, eastern hillside. (Virtual photography of digital 3D model, 2011).

In the case of the visualisation of Pergamon we altered this convention and maximized every individual building's detail according to its individual degree of certainty. This has been agreed in order to visualize the archaeological state of research. This is why there is detailed architecture next to abstract geometry. Still this mainly matches the state of knowledge, so this decision does not contradict the visualisation of uncertainty (fig. 15).

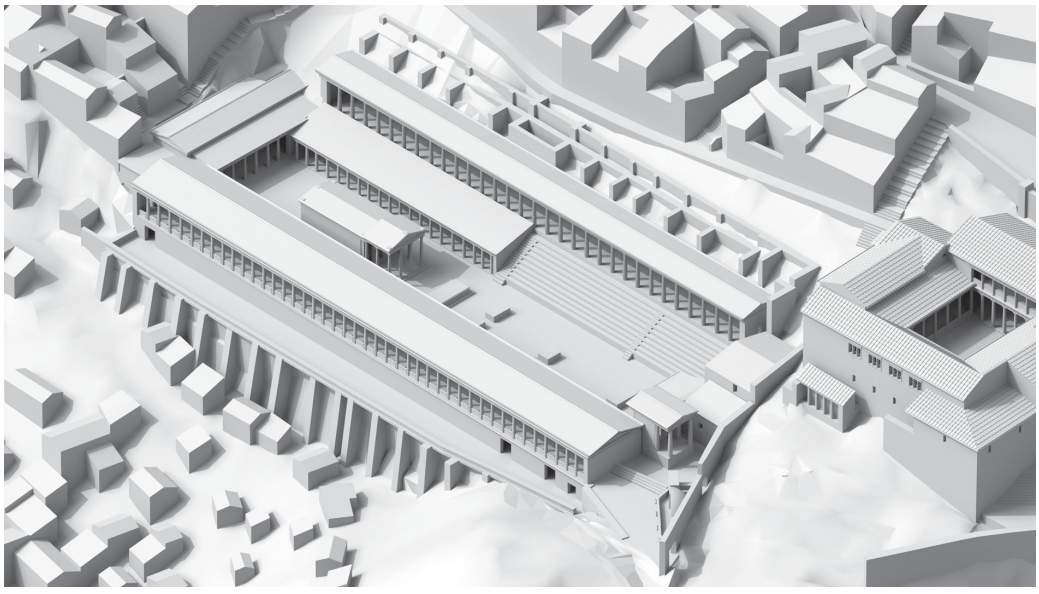

Fig. 15 Pergamon 200 AD, sanctuary of Demeter. (Virtual photography of digital 3D model, 2012).

The third convention concerns the flexibility of the virtual model. The purpose is to associate the viewer's distance with the individuality of the method of representing uncertainty. This means that the closer one gets to a single building, the more individual its uncertainty can look. And the farther one gets, the more the look becomes homogeneous. This dynamic change again excludes the use of physical models.

Here also the visualisation of Pergamon focused on an overall geometric state of research to function as a reference for further research. Apart from the time phase flexibility the model therefore mostly resembles a physical model (fig. 16). We have originally implemented different temporal states according to the building history. But every building complex has its own particular history. Since there is too little information to show the whole process continuously over the centuries, the Pergamon model in the context of the excellence cluster TOPOI focuses on 200 AD to achieve one complete state in time. 200 AD is the most prosperous epoch: most of the buildings are erected and the least are destroyed (fig. 17).

Fig. 16 Pergamon 200 AD, acropolis hill. (Virtual photography of digital 3D model, 2011).

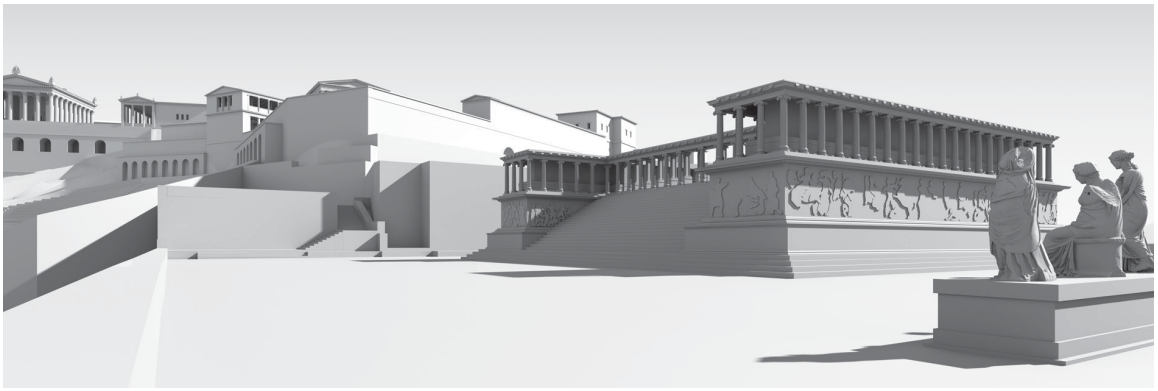

Fig. 17 Pergamon 200 AD, terrace of Great Altar. (Virtual photography of digital 3D model, 2012).

Left for further development is the transformation in time. The most important steps are: the ancient city on the mountain, the roman extension in the valley, fortifications from the byzantine time and the present-day town of Bergama (fig. 18). Before the mentioned decision to concentrate on one complete and detailed state, there have already been three different states of the model: the remains and two types of a reconstruction, a simplified one for overall city scapes and a detailed one for building levels (fig. 19).

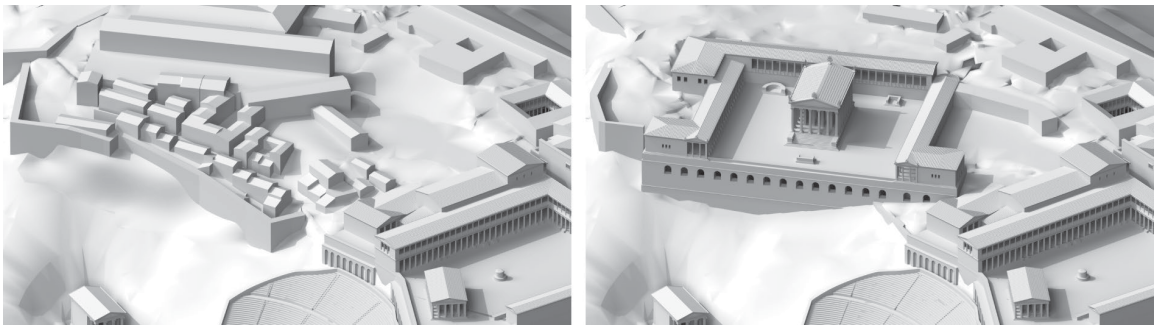

Fig. 18 Pergamon 200 AD, Traianeum and preceding buildings. (Virtual photography of digital 3D model, 2012).

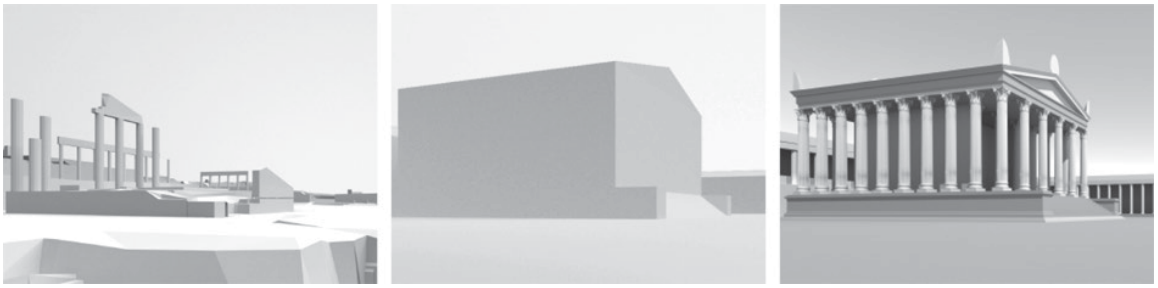

Fig. 19 Pergamon 200 AD, Traianeum. (Virtual photography of digital 3D model, 2009).

The model is intended for two different audiences. The first is the archaeological research itself. Having our model at hand on site, archaeologists hope to get impulses for their research, and to be able to develop and validate hypotheses instantly – with the remains visible in physical reality and their reconstructions in virtual reality (fig. 20). The second audience is the public. Our model is equally intended to promote the comprehension of the history of Pergamon in general as well as to explain the archaeological work as such to the public (fig. 21).

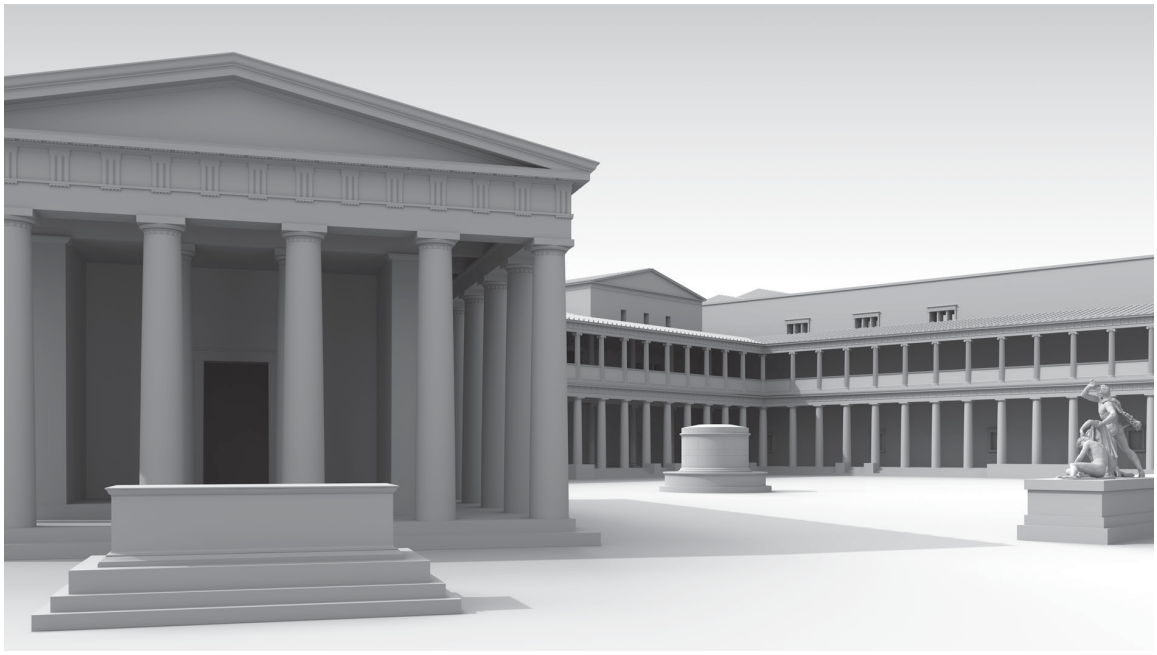

Fig. 20 Pergamon 200 AD, sanctuary of Athena. (Virtual photography of digital 3D model, 2011).

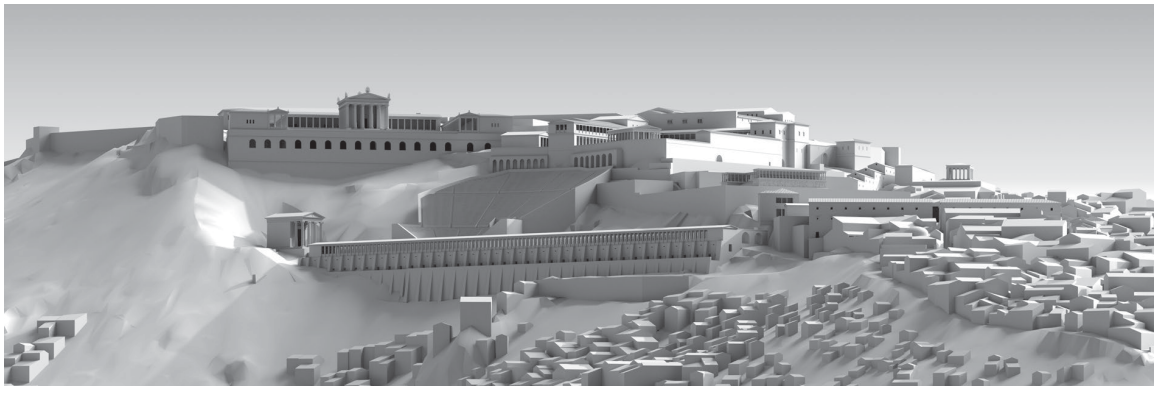

Fig. 21 Pergamon 200 AD, panorama from opposite mountain.
(Virtual photography of digital 3D model, 2012).

From September 2011 to September 2012 the current state of development is being presented at 'Pergamon. Panorama of the Ancient Metropolis', the first monographic exhibition about Pergamon at the Pergamon Museum Berlin since its inauguration in 1930.

Research Partners

Archaeology: Chair for Building History, Brandenburgische Technische Universität Cottbus-Senftenberg, Germany Archaeological Institute / Department Istanbul, Berlin State Museums – Collection of Classical Antiquities, University Freiburg / Institute of Archaeology (DFG-SPP 1209)

Measurement and model of remains: University of Applied Sciences Karlsruhe / Institute of Applied Research / Geoinformatics

Illustrations

Fig. 1, 8, 10, 12, 14, 16 Lengyel / Toulouse 2011*

Fig. 2–7, 13 Lengyel / Toulouse 2008

Fig. 9 Lengyel / Toulouse 2009

Fig. 11 Lengyel / Toulouse 2010

Fig. 15, 18, 21 Lengyel / Toulouse 2012*

Fig. 17 Lengyel / Toulouse 2012***

Fig. 19 Lengyel / Toulouse 2009**

Fig. 20 Lengyel / Toulouse 2011***

* in cooperation with the German Archaeological Institute, Prof. Felix Pirson.

** in cooperation with the German Archaeological Institute, Prof. Felix Pirson, remains by University of Applied Sciences Karlsruhe, Prof. Ulrike Klein.

*** in cooperation with the German Archaeological Institute, Prof. Felix Pirson, and Berliner Skulpturennetzwerk (Staatliche Museen zu Berlin, Freie Universität Berlin et al.).