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The Lifecycle of a Medieval Stone House and How to Model it in 4D

Abstract: The goal of this paper is to examine the different phases in the life span of a medieval stone building and to document the archaeological observation, stratigraphic interpretation and three-dimensional modelling of those phases. The paper also aims to investigate the kinds of human induced or natural processes the building had undergone prior to archaeological observation. Another question of interest is how the stone buildings and their adjoining cultural and natural layers were previously related, in comparison to the situation at the time of the documentation.

Introduction

The 3D modelling of archaeological findings has recently been under development. The most challenging issues have been the methods used in gathering measurements and the accuracy of the modelling software. For some years it has been possible to model the soil layers of an excavation, but this requires very accurate documentation of the relevant field work, which is not always available. The everyday standard of archaeology is still miles away from a 3D unit excavation (LOSIER / POULIET / FORTIN 2007; PAVLIDIS et al. 2007; UOTILA / TULKKI 2001).

One of the most challenging phases in the work is the actual building of the 3D model, in which the archaeological accuracy of details (1 cm) is often set aside in revising the material. Very often graphic artists build their models with circa 10–20 cm accuracy, making them much more easy to visualize. An accurate surface layered on an inaccurate model may function well visually, and excellent game environs can be constructed using them, but they make a poor base for scientific research, especially for the future. It is important that this issue is not exasperated by trying to include unnecessary details in the model, when a simpler model can often portray the relevant information both faster and with greater accuracy. Another challenge is the fact that future researchers will find it difficult to use revised and generalized research material (HUVILA 2006; UOTILA / HUVILA 2006).

Medieval Mortar Houses in Turku

Since the 1990s, excavations have been carried out on the medieval villae of Turku (sw. Åbo) in the area

around the Aboa Vetus & Nova museum, Finland. The Abo Vetus museum presents Turku's history throughout the centuries in the authentic surroundings of cellars dug up from beneath the city. The museum's permanent exhibition presents the latest research information on the various stages of the Convent Quarter and on Turku itself (*Fig. 1*). In the excavated streets of the town, both archaeology and history are brought to life in a unique way. The museum has conserved the most extensive stone and brick medieval town with houses and alleyways in Scandinavia. New excavations since 2005 attempt to examine, model and simulate the cultural and natural changes to the extensive town area over time (UOTILA / SARTES 2000).

Brick buildings that were built very close to the waterfront present one topic for investigation. In the museum area there are five or six medieval buildings which today lie 1.5–2 m above sea level (asl.). Corresponding buildings are known to exist in several towns and castles in the northern Baltic. The natural history of the northeastern Baltic brings on the challenge of land uplift, with the crust rebounding after the latest ice age, presently at a rate of approximately 50 cm per hundred years on the west coast of Finland. A simple map simulation based on this data has been made, and shows the areas that could be built on in medieval times to be at approximately 3–4 m above sea level. The simulation rests on the assumption that the mortar used in the Middle Ages made it impossible to build sustainable constructions below sea level, or even close to the shoreline, which rose with seasonal storms (UOTILA 2004).

The archaeological layers at the Aboa Vetus museum have, whenever possible, been documented three-dimensionally by means of a total station



Fig. 1. The ruins of medieval mortar houses in Aboa Vetus (a museum in Turku, Finland).

and digital images. The resulting material has been transmitted through 3DWin (a Finnish measuring program) to Auto Cad 3D Civil and finally to 3ds Max, which has created a simplified animation of how a building and the adjacent soil units would have travelled downwards over time. The project will continue to render all of the building remains in the area around the museum into digital format and feed them into the modelling software, and by doing so create different simulations of the entire area. Our target is not only to model the excavations

in 3D, but also to model different scientific ways to understand the excavations (Fig. 2).

Excavations in the area around the museum between the years 2005 and 2006 have made it possible to date several buildings built below 2 m asl. more accurately. By using dendrochronology or archaeological datings, these buildings were identified to be from the period between 1390–1450 AD. The challenge for research into these findings is to account for the fact that these buildings would have been situated between 1–1.5 m below the estimated sea level of the period, with some even as low as 2 m. There are no records in Finland of any method of building which would have made this possible, nor are there any interpretations of the possible functions of such submerged constructions.

In the research of the basements of the various stone buildings, the excavations often reach a text book example of a Harris' matrix situation – a broad ditch is dug out of the blended basement clay where the wall is to stand, a grate of beams built in it, followed by a foundation with no mortar on top of which the actual mortar enforced wall stands. During the building process the ditch has been filled, deliberately or otherwise, with material often comprised of sand and mortar or blended, humus-rich layers. Very often the layers rich in finds only extend

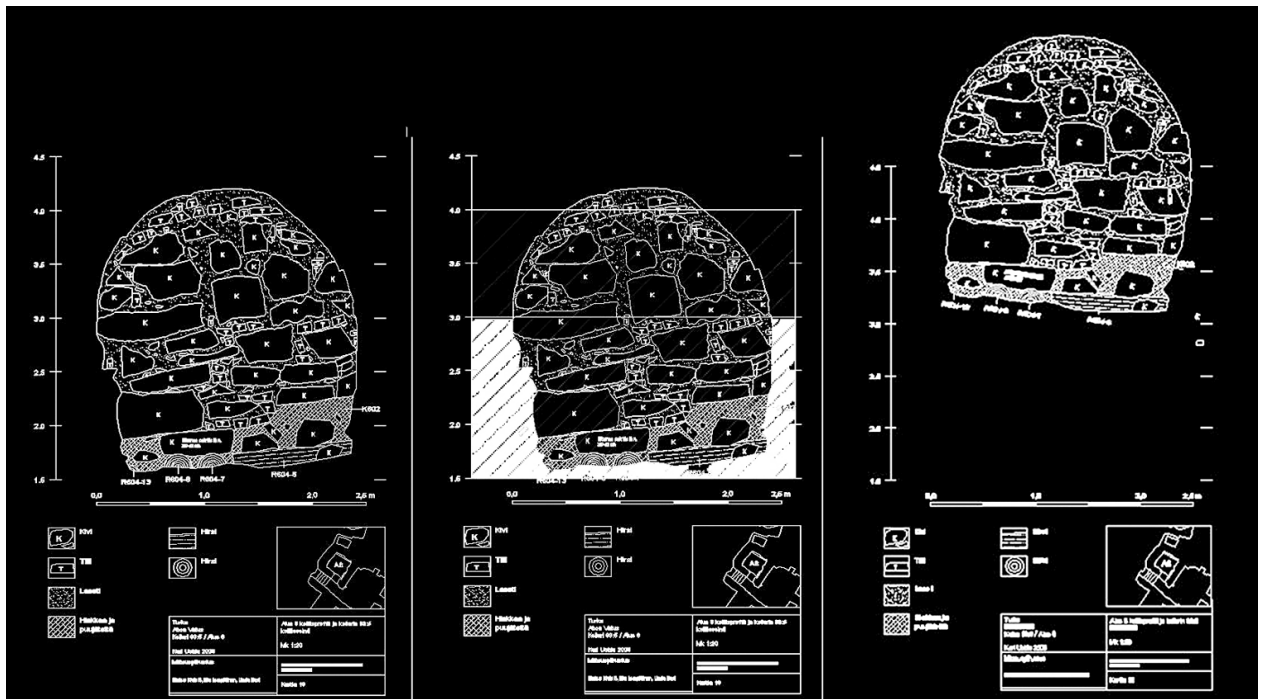


Fig. 2. The east wall of cellar of the stone house in the Aboa Vetus museum. From left to right: The state of the wall in 2006, the state of the wall in medieval times if the Baltic sea level were 2–3 m higher, the position of the wall during the building's lifetime after simulation.

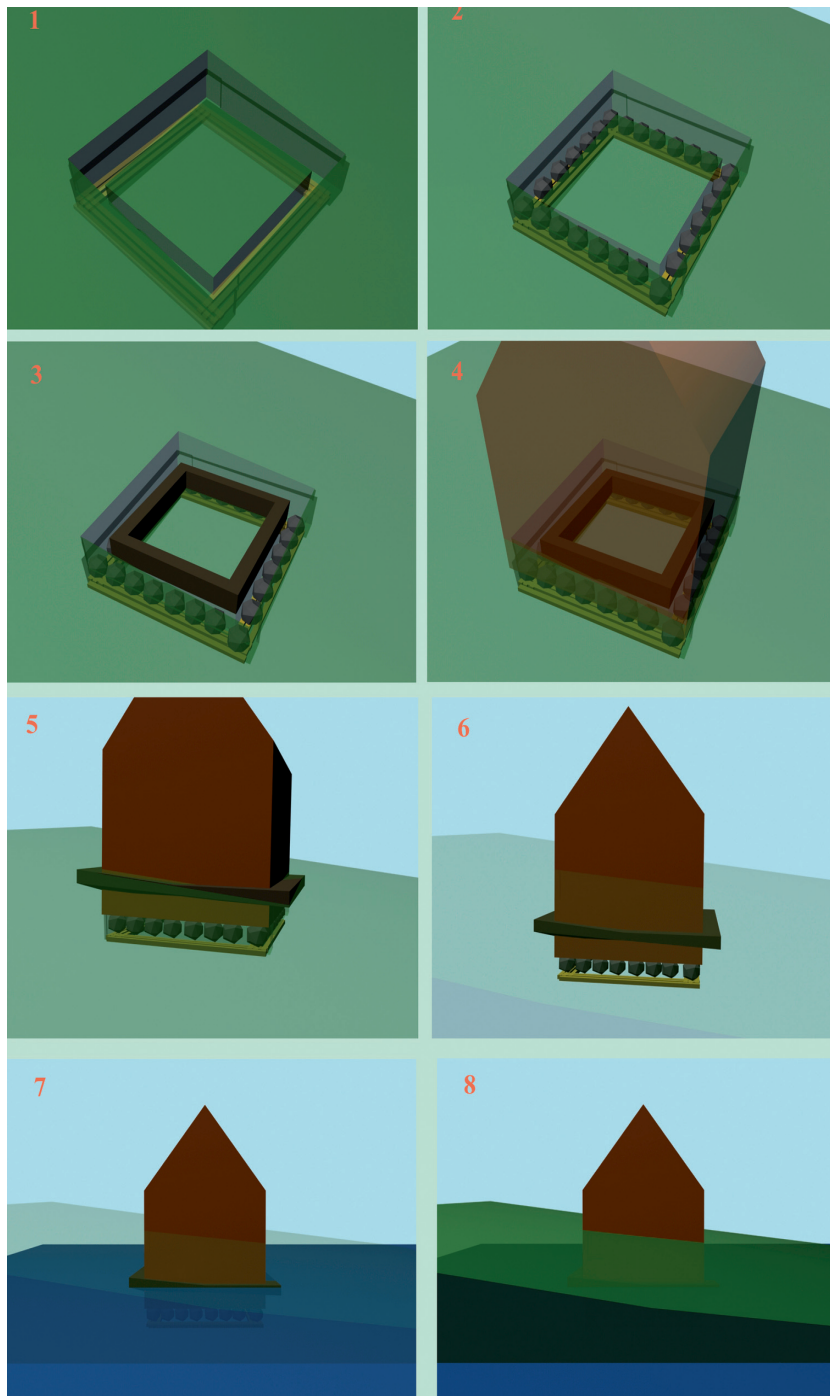


Fig. 3. The lifecycle of a medieval stone house and stratigraphical units of walls and layers. Pictures 1–3 show what happened to the structures and cultural layers during the building's extended lifetime. Pictures 4 and 5 show the situation of the house and layers at the time of the building's use. Pictures 6 and 7 show how the building may have sunk down 2 m after the medieval period, and the last picture shows the situation of the house after sinking.

to the level of the original flooring. Normally we understand these layers to be a part of the building process of the whole house. According to the presented interpretation, both the wall structure and

the mass of cultural layers at its base would have made their way up to their excavated levels even hundreds of years after their formation.

Modelling Different Historical Possibilities

A new challenge in excavation modelling is maintaining the distinction between modelling the excavation's situation as found and modelling one's interpretation of this situation, i.e. how to handle the point when the different interpretations of the layers and structures become a simulated model of the excavation. To properly address this challenge, it is not enough to simply model the excavation in 3D; the excavation needs to be modelled in 4D as well. Such modelling could help answer questions such as how medieval buildings and their foundations will sustain the rising of sea levels due to climate change.

An undeniable conflict in research leads to two possible interpretations, the first of which supports the prevailing view of the even regression of the Baltic shoreline and the rate of land uplift. The geological research traditionally pays little attention to the last millennium of changes in natural phenomena, and very often accurate records of sea levels 2000–5000 years ago terminate around the year 1000, after which the receding shoreline is represented by a straight line spanning to the present. A very extensive collection of archaeological research material suggests, however, that this generalisation does not represent the whole truth and that significant changes to the Baltic sea level have taken place during the past thousand years (UOTILA et al. 2006).

The second interpretation suggests that the stone buildings of the medieval town of Turku, being built on a bed of postglacial clays, would have sunk several metres to their present low level. This would mean that at some point during the period between 1500–1800 a very significant portion of the town would have sunk several metres into the ground. It is of great archaeological and stratigraphical interest to meditate on how such a strong setting could be observed in stratigraphical analysis during an excavation.

This leads to the question of whether it is worthwhile to document an excavation to centimeter accuracy (using a laser scanner or a total station) if the object of interest and also the stratigraphical layers are not in their original position but merely represent the result of several different processes over an extended period of time (Fig. 3). In the wider scheme

of things, this case shows that it is not enough just to model an excavation in 3D – the whole lifecycle of the site must be understood. In order to understand the different possibilities, we have to make different simulations and only then try to find the right one. Stratigraphical information must be analyzed in 4D, and for that more flexible modelling programs are needed.

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