Building virtual tombs: the Archaic chambers of Cisterna Grande (Crustumerium, Rome, Italy)

1. Introduction

This paper presents one aspect of my postdoctoral research, funded by the Academy of Finland. I directed funerary excavations at Cisterna Grande (Fig. 1), one of the cemetery areas of Crustumerium (Rome, Italy), as part of the *Remembering the Dead* project between 2004 and 2008. The area of Cisterna Grande was chosen for the excavations after recent illegal excavations in this area. The first tombs exposed in 2004 were chamber tombs and due to the rarity of their excavation[1] the project concentrated on their study. This project was carried out under the umbrella of the Crustumerium project, funded by the Academy of Finland and headed by Dr. Eero Jarva from the University of Oulu; his team is working in the settlement area of this ancient Latin town.

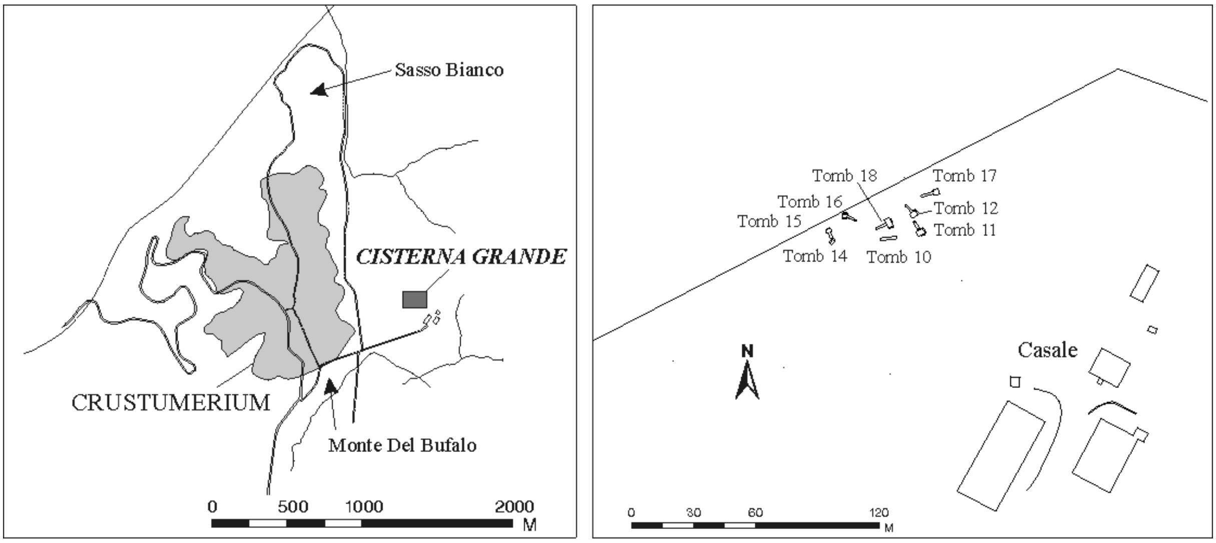

Figure 1. Crustumerium and the excavations at Cisterna Grande

The excavations at Cisterna Grande were carried out in collaboration with *Soprintendenza Speciale per i Beni Archeologici di Roma* and Dr. di Gennaro, the director of this archaeological area. The excavation project run for five years with the final publication hoped to follow in the nearest future. The main aim of the project is to study the metaphorical funerary representations of a Latin late Iron Age and Archaic community. Tombs form part of a wider ritual landscape that have been studied at a local level using digital and traditional methods. In addition to digital single context planning, the project makes use of GIS and virtual modelling.

The chamber tombs at Cisterna Grande were cut into tuff on a south-east facing slope and its environs. The Archaic chambers at Monte Del Bufalo, the main Orientalising cemetery area, on the eastern side of the settlement, have normally been simple rectangular, room-like spaces, which they were entered through a door via an entrance corridor (*dromos*)[2]. Many

[1] U. Rajala, ‘Archaic chamber tombs as material objects: the materiality of burial places and its effect on modern research agendas and interpretations’, *Archaeological reports from Cambridge* 22:1 (2007), 43-57.
[2] F. di Gennaro (ed.). *Itinerario di visita a Crustumerium*, Roma 1999.

chambers have niches (*loculi*) carved into their walls but the earliest do not have any. Chamber tombs were the dominant tomb type throughout the Archaic period during the sixth and fifth centuries bc[3]. They generally accommodated more than two deceased and are likely to have been family tombs. The chambers excavated so far at Cisterna Grande, although limited in number (Fig. 1), present a higher level of variability than expected.

In this paper I will present our recording strategy and how the data collected is used in virtual modelling using ArcGIS and 3D Studio Max programs. I will also examine the possibilities to visualise the different postdepositional histories of the chambers and emphasise the importance of virtual modelling in reconstructing destroyed entities.

2. Modelling chamber tombs

2.1. Recording strategy

The recording strategy at Cisterna Grande aimed at fulfilling multiple functions. Firstly, it produced data for the creation of plans and sections needed in single context recording. Recording was done mostly with a total station using the Italian UTM coordinate system. The equipment was supplied by Muuritutkimus ky (Turku, Finland), and we had a series of instruments at our disposal. In 2004 a Nikon 350-NL with a laser pulse was tested but it was found to be too unreliable in the summer heat with its external laptop. In 2005 a Shokkisha set 4 with data logger Husky F/S2 was found to be more appropriate for the local circumstances. Nevertheless, a Nikon DTM 720 was used in the following years. The data was downloaded onto a Hewitt Packard laptop and edited and transformed using topographic measurement program 3dWin, created by the Finnish company 3d Systems. Additionally, total station was used to measure grid points for the finds and recording special features. All surveying was carried out by Mr. Janne Hymylä and his assistant Otso Manninen under my supervision. Despite digital recording, the most important features were also drawn by hand on permatrace in order to create a traditional archive, which preserves the key information for the future generations. Due to the archiving requirements and the limited number of contexts, paper forms were still used. Digital photos with a resolution of 8 MB and 2 MB were taken but slides were used as well as an alternative format. Another Hewitt Packard laptop was used for general data entry and the data was stored on DVDs and memory sticks for backup.

The strategy was relatively low cost, which is essential for a small project. The digital data created was simplified for efficient data entry but sufficiently accurate for data integration. However, the strategy resulted with plenty of data transfer. All the permatrace maps were scanned at Cambridge and digitized in AutoCad. The slides were also transferred into a digital format and all context information was typed into a partly customised Access database.

2.2. Chamber tombs and their postdepositional histories

Although the excavations at Cisterna Grande have revealed a full series of tombs from an Orientalising *tomba a loculo tipo Narce* to a series of Archaic chamber tombs, the virtual modelling has been concentrated on the chambers. This is due to the fascinating phenomena revealed by these structures. Their design showed a higher level of variability than expected with chambers of different shapes, sizes, depths and orientations. The *dromoi* differed as well; their lengths, widths and depths showed wide variation. Most of the tombs had door slabs and

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[3] G. Colonna, 'Un aspetto oscuro del Lazio antico. Le tombe del VI-V secolo a. C.', *PP* 32 (1977), 131-65; C. Ampolo, 'Il lusso funerario e la città arcaica', *AION(archeol)* 6 (1984), 71-102; A. Naso, 'L'ideologia funeraria', in M. Cristofani (ed.), *La Grande Roma dei Tarquini*, Roma 1990, 249-51.

other blocking features still *in situ* at the entrance. Many were blocked with a pile of stones but others had large single slabs closing the door. The varied architecture suggests that there were more than one standard chamber tomb type simultaneously in use. These excavations suggest that the chambers fell into at least two categories, if not three[4].

Firstly, there are fairly large rectangular chambers with one or more *loculi* on their walls and additional burials in coffins or trunks on the floor. Among these larger chambers there was one, the digging of which had to be halted for safety reasons, which seemed to be more 'monumental' and higher-status than the rest. However, its monumentality was down to the depth and length of the *dromos* and the apparent survival of its ceiling and architectural integrity, and thus, may only be a perception. The second chamber tomb type was more modest with its semicircular chambers, low ceilings and two slightly irregular *loculi* on the opposite walls. The stone surfaces were left relatively uneven with clear visible pick marks. The latter type would have required much less man power for its construction. The finds in the tombs of the former tomb type, although not luxurious, seemed generally to be more elaborate than in the latter.

Another feature, which makes these chambers interesting, is their postdepositional histories[5]. The local geological characteristics at Cisterna Grande made the excavation of these chamber tombs challenging. The bedrock of the hill is formed by numerous relatively thin soft volcanic stone layers that cannot properly support tuff ceilings over the voids of the chambers. The harder rocks tend to locate nearer the surface whereas the softer varieties dominate at the depth of the *loculi*. *Breccia tufacea* and volcanic clay are especially weak and soft. This weakness of volcanic layers has resulted with many chambers collapsing. The tombs that have not collapsed have been filled by accumulated clay. As a consequence, thick layers of stone and clay had to be removed. The visualisation of these collapses and accumulations is one of the features allowed by virtual modelling. No two tombs seemed to have had identical postdepositional histories, which gives an opportunity for creating unique models and reconstructions.

2.3. Software

Autodesk AutoCad is used for basic data processing in most archaeological modelling[6]. I have used AutoCad Map 2003 for digitising by default but also in editing different data files for three-dimensional modelling. For the modelling itself I use Autodesk 3D Studio Max 8, provided by my funding body. These programs, notwithstanding their apparent differences, are highly compatible and commercially distributed by the same software provider.

I have also used Esri ArcGIS with its ArcScene module and tested its virtual capabilities. This package can be used in 3D visualisation although its capacity is more limited than those of a professional modelling program. Both ArcGIS and 3D Studio Max allow the use of real-world co-ordinate systems and metric units.

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[4] Cf. Rajala, cit. in Note 1.

[5] U. Rajala, 'Ritual and remembrance at Archaic Crustumerium: the transformations of past and modern materialities in the cemetery of Cisterna Grande (Rome, Italy)', in F. Fahlander and T. Oestigaard (eds.), *The Materiality of Death* (BAR International 1758). Oxford 2008, 79-87.

[6] G. Lock, *Using computers in archaeology: Towards virtual pasts*, London & New York, 2003.

3. Building virtual models

Although a relatively shallow Tomb 16 was chosen to be the object of a pilot model[7], all models are built in the same way. However, the building processes differ depending on the software used.

ArcScene in ArcGIS creates Triangular Irregular Networks (TINs) out of mass points. Lines and breaklines can be used but only in relation with contours, not with 3D polylines created in the field, and thus, the result is not satisfactory. The walls of the chambers are too irregular, and the program joins the points incorrectly; concave surfaces are especially problematic since the density of the measurements was relatively low in the field. Thus, the most efficient way of using collected data is to use only a selection of the points in order to create a simplified model from separate vertical and horizontal objects that represent walls and floors of different structural elements, such as *dromoi* and doorways. Suitable colours can be chosen from simple colour palettes. This compilation process results with a simplified approximation of the cut of the tomb (Fig. 2).

Figure 2. The cut of Tomb 16 (in ArcScene)

The simplest way to visualise different postdepositional histories of the tombs is to create the upper surfaces of different collapse layers and accumulated clay fills. In this way the relationships of different deposits and their relative thicknesses can be presented.

Unlike in ArcGIS, in 3D Studio Max the 3D polylines measured in the field can be used in creating surfaces. The program gives different possibilities to create surfaces, including extruding and creating ruled and blended surfaces. The modelling is very easy and quick although all conjoining surfaces have to be created by hand (with a mouse). However, all point data have to be joined in 3D polylines in AutoCad before modelling. Furthermore, the program works best near the origo and the long UTM coordinates cannot be used directly; all edited files have to be moved nearer the origo for modelling purposes.

[7] U. Rajala, 'Visualising Latin Archaic tombs and their postdepotional histories: the 3D modelling of the tombs from Cisterna Grande, Crustumerium (Rome, Italy)', *Proceedings of the 35th CAA Conference, Berlin 2007* [in press].

Although most structural elements could be created in a single file, I have chosen to create different elements separately. This is done in order to keep the amount of lines manipulated in minimum, and thus, minimize the possibility of error. This also safeguards the files against corruption during the modelling process. In addition, different elements can later be used in different reconstructions.

Normally, two different models are created. The first one presents the cut of the tomb in the end of the excavation process in its modified form. All chambers were excavated from above and the possible ceiling or its remains were removed. Furthermore, the soft tuffs crumbled when exposed to the sunny weather and the original (or what was thought to be original) walls had to be 'trimmed' in order to keep the diggers safe. Most of the chambers changed during the excavation and it is difficult to say which surfaces represented the unaltered state. Nevertheless, the program allows the creation of realistic textures based on samples extracted from the digital excavation photos. These 'real' textures can be used to render the models (Fig. 3).

Figure 3. The cut of Tomb 16 (in 3D Studio Max)

The second model is always the reconstruction of the tomb in its original state (Fig. 4). These models are based on the excavation measurements but due to the complex postdepositional histories of the structures they have to be regarded as approximations of the originals. These models present the empty chambers which then contain different depositional and postdepositional deposits. Further elements, such as door slabs and skeletons, can be added depending on the purpose of the model. The outer surfaces of any deposit can be presented in its measured detail.

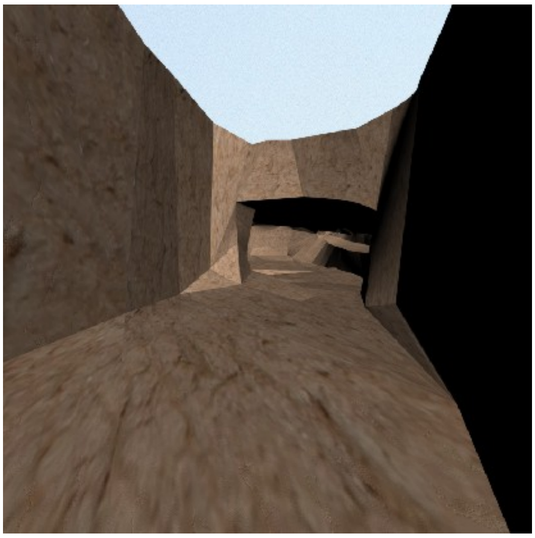

Figure 4. The reconstruction of Tomb 16.

4. Discussion and conclusions

Postdepositional events and processes have altered the Archaic chamber tombs excavated at Cisterna Grande. Many of the tombs have collapsed due to the local geology and other contributing factors, and they and other tombs cut open for the excavation have lost their original architectural form. Digital recording together with virtual modelling allows reconstructing not only the cut of the tomb but different funerary deposits and features created during the postdepositional history of a tomb.

In this paper I have presented the different processes used in modelling the chamber tombs at Cisterna Grande. These processes are software specific but they allow the use of the original georeferenced field data. However, the different software packages have different usabilities. For example, 3D Studio Max performs poorly with large, real-world UTM coordinates and all data have be in line format; thus, the 3D polylines have to be created from any point data and these files have to be moved nearer the origo. On the other hand, this program allows creating realistic textures, something ArcGIS cannot do. The latter in its turn uses only mass points. Considerable errors can only be avoided by simplifying the data and limiting the number of points used. Furthermore, the vertical and horizontal structural surface elements have to be created separately.

All this modelling could not be made without AutoCad. It is indispensable in checking and editing field data. The two programs used in virtual modelling, perform best when used in specific tasks. ArcGIS can be used in creating simplified visualisations whereas 3D Studio Max allows reconstructing pseudorealistic replica. This means that ArcGIS and ArcScene are at their best when creating two-dimensional illustrations of three-dimensional models whereas 3D Studio Max is better suited for creating interactive models and animations. Both can be used in modelling postdepositional histories with a relative ease but 3D Studio Max makes the best use of the data created in the field. Thus, this program will be used in the future to recreate a replica of the excavation area.

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