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Modelling capacity of Near Eastern Neolithic non-domestic architecture

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ABSTRACT

Previous estimates of the capacity of archaeological architecture have been based on cross-cultural studies that have determined an average amount of roofed dwelling space occupied by an individual. These studies are problematic when applied to non-dwelling spaces though. In this paper I use scenario modelling to estimate the capacity of any structure using AutoCAD, taking into account the variability of different spaces, as well as different requirements for movement and visibility. This results in more accurate estimates of the size of the group using the space, which can then be compared to estimates of the size of the population to enhance our understanding of the way the groups functioned within the wider community. This methodology is demonstrated using a series of non-domestic structures found at Near Eastern Neolithic sites.

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The anthropological and archaeological study of architecture has tended to focus on the interpretation of function, using artifacts and features to determine what activities were taking place within the space. These interpretations are then used to explore social organisation, family structure, life practices, and other aspects of ancient life. In particular, anthropologists have developed several methods for estimating how many people were living in houses and settlements, but all of these methods ignore non-domestic structures. In this paper I present a method of modelling the capacity of non-domestic structures contextually, taking into account idiosyncratic details of the space to determine the size and nature of the groups participating within these non-domestic structures. This is then applied to a case study of the Neolithic Near East, where there are a series of enigmatic non-domestic spaces, and discussed in relation to a number of ethnographic case study structures.

The methodology demonstrated here builds on previous methods used to estimate capacity of both domestic and non-domestic structures, but unlike previous methods, can be adapted for use in many different time periods and regions. This method models the number of people occupying a space without making assumptions as to the nature of the group using it or the types of activities being performed, as it can be modified based on the available evidence. This means that researchers can move beyond describing the structure and detailing the types of features, and begin to explore how people were actually using the space. Modelling the number of people that could have occupied a given space, regardless of

whether it was domestic or not, also permits discussions of how people were creating and maintaining social groups.

The Neolithic is widely regarded as the period when sedentary villages, agriculture, and herd management practices first emerged in the Near East (Belfer-Cohen and Bar-Yosef, 2000; Asouti and Fuller, 2012). The development of sedentary villages in the Neolithic resulted in larger groups of people living together for longer periods of time, therefore requiring new types of coping mechanisms to diffuse the interpersonal stress of not being able to move away from problems (Bandy, 2004). Many researchers have postulated the existence of these coping mechanisms in reference to a number of different lines of evidence, including changes in mortuary practices, personal adornment, and domestic architecture (Byrd, 2000; Kuijt, 2000a; Wright and Garrard, 2003). All these lines of evidence point to developing complexity in interpersonal relationships, as well as a concern for materializing those relationships, perhaps for mnemonic purposes.

Many Near Eastern Neolithic sites also had large non-domestic structures, which have been interpreted as another coping mechanism (McBride, 2014). These structures have not been very well explored, with most excavators identifying their distinctiveness as compared to the contemporary architecture and then dismissing them as having a ritual function, with little discussion of the types of activities taking place or the groups using the spaces. More recent contextual research is leading to a more nuanced exploration of the structures (McBride, 2012), but much work remains to be done. The emergence of non-domestic structures at Near Eastern Neolithic sites indicates that groups were engaging in regular activities that required dedicated purpose-built space. The institutionalisation of these activities through the construction

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of dedicated space suggests the development of new kinds of relationships within communities and a new concern with materializing these relationships, suggesting that the groups using the structures represented larger or more complex social units than existed before. The nature of these social units is unclear, though understanding of the capacity of these structures would help clarify this issue.

In order to understand how groups building and using these structures functioned within Neolithic communities, first, the capacity of the structures needs to be estimated to determine how many people might have been attending events within them using computer scenario modelling, described below. The size of the groups can then be compared to the size of the wider population to calculate the proportion of the community participating. This will elucidate whether stringent selection criteria existed and whether differentiation within the community was materialized through these structures. All of this information can then be used to elucidate the nature of the groups building and using the non-domestic spaces.

While there have been many previous approaches to the calculation of settlement population, discussed below, there has been comparatively little analysis of the capacity of individual structures (Adler, 1989). The most influential study was by Naroll (1962), who used cross-cultural comparisons to determine that 10.2 m² of domestic space was required per adult, allowing researchers to calculate household size based on dwelling space (LeBlanc, 1971; Weissner, 1974). It is therefore tempting to simply calculate the capacity of all structures using Naroll's figure; however, there are some problems with this method. Naroll's study only examined roofed space, ignoring other occupied spaces (Kolb, 1985: 583), focussed solely on dwellings, and there are also questions about the validity of his statistical analysis (Brown, 1987). A restudy of Naroll's work, as well as other studies, has shown that a better approximation of the amount of roofed dwelling space per person would be 6 m² (Brown, 1987). This reassessment of the relationship between household size and roofed dwelling space assumes nonetheless that there is a basic human need for roofed shelter, and it is therefore reasonable to study this in a cross-cultural way.

Despite these problems with Naroll's work, some recent examinations of Near Eastern Neolithic non-domestic structures have applied methods similar to Naroll, using a set amount of space per adult, though using different numbers (Verhoeven, 2002: 247). Verhoeven calculated the capacity of several non-domestic structures, but he was not explicit on the criteria he used; however, we can infer that he allowed 2–4 m² per person based on the size of the structures and the size of group he proposes (2002: 247). While 2–4 m² might be a more realistic figure for non-domestic spaces than allowing 10.2 m² per person, as suggested by Naroll, and is closer to the 6 m² suggested by reassessments, there is no justification for Verhoeven's figures.

The cross-cultural anthropological work of Naroll and others only addressed living space and domestic architecture. Public and non-dwelling structures are not discussed, and in fact, are deliberately removed from the studies. This means that their results are not good constants to estimate the number of people occupying public spaces or other structures with more complicated uses. While Naroll and his successors can point to a basic human requirement for shelter in order to determine how many people lived in each structure, the same cannot be said for public spaces. These non-domestic spaces can be used in many different ways at different times. People could have crowded in at physically uncomfortable levels for short periods, or have been widely dispersed. To compound the problem, personal space is culturally constructed, with different levels of public crowding acceptable for different cultures (Batchelor and Goethals, 1972; Bauer, 1973; Draper,

1973; Baldassare and Feller, 1975; Karlin et al., 1976; Kaya and Erkip, 1999). This contrasts with dwellings, which are generally associated with similar numbers of people expecting a culturally appropriate amount of space in which to perform various tasks. Attendees at events in non-domestic structures might require nothing more than the space to breathe. Therefore, it is unlikely that any methodology for calculating capacity based solely on the allocation of a set area per person will accurately describe all non-domestic architecture due to the variability in the activities taking place and the idiosyncrasies of each space.

In this paper, I demonstrate a contextual analysis of non-domestic architecture to calculate capacity. This methodology uses digital scenario modelling to reconstruct the way people might have been occupying the structures, taking into account movement, visibility, acoustics, hearths, storage, and any other activities that might have been taking place. This scenario modelling uses polygons to represent the physical body of an adult, which can then be used to fill the structures in variable ways, demonstrating the way people naturally cluster and occupy space, while also allowing researchers to take into account specific information about the structure. Therefore, occupants can be packed as tightly or spaced as loosely as the individual evidence of a space indicates, rather than relying on a set amount of personal space per person. This means that scenario modelling is a powerful tool for determining potential capacity of structures, without relying on assumptions concerning the type of structure analysed or the amount of space occupied by each individual.

I demonstrate how scenario modelling can be used by estimating the size of the participant group at events within Neolithic non-domestic architecture found at a number of sites. The sites with clear evidence for non-domestic architecture include Jerf el-Ahmar, Göbekli Tepe, Nevalı Çori, Jericho, Çayönü Tepesi, Asikli Höyük, and Beidha (Bar-Yosef, 1986; Schirmer, 1990; Esin and Harmankaya, 1999; Hauptmann, 1999; Stordeur et al., 2001; Byrd, 2005; Schmidt, 2007). These sites have architecture that departs from the commonly constructed structures at the site, and these have been interpreted as ritual structures. As the interpretation of how these structures were used is ongoing (see McBride, 2012, 2014), understanding how many people used these structures enhances interpretations of the way these structures were perceived and how they functioned within the wider community.

1. Scenario modelling

Scenario modelling uses representative polygons to populate spaces to create realistic scenarios of occupation. Hemsley (2008) began to develop and implement this methodology, examining the contextual affordances of Pre-Pottery Neolithic A domestic architecture, but I have expanded it to include non-dwelling and public space, as well as incorporating a wider range of physical senses. While I initially modelled these spaces based on people occupying them in a variety of stances, such as lying, sitting cross-legged, and sitting with their knees to the side, I have generally used the stance of people sitting with their knees to the side as it was the largest seated stance (see Fig. 1), encompassing the width required to accommodate hips and shoulders (see Table 1 and Fig. 2). Using AutoCAD, polygons based on modern measurements of people sitting in this way, as well as comparisons of the stature of modern individuals and Near Eastern Neolithic skeletal remains (Hemsley, 2008: 82–86) were created. The representative polygons delineate the amount of space taken up by a person sitting with their knees to the side based purely on their bodies, not the culturally determined space surrounding them. These polygons can then be inserted into the structures to determine the capacity (see Fig. 3).

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