The use of experimental archaeology to examine and interpret Pre-Pottery Neolithic architecture: a case study of Beidha in southern Jordan

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Abstract

Many significant cultural transitions, including the beginnings of sedentism, domestication, and farming, are thought to have taken place during the Pre-Pottery Neolithic (PPN) in southern Jordan. The settlement sites of this period (often referred to as the first villages) are rich in architectural remains, and this evidence is frequently used to support hypotheses on the degree of sedentism and how societies were structured. This research reexamines these issues through the construction, maintenance, destruction and decay of four experimental reconstructions built between 2001 and 2006 at the PPNB site of Beidha. The results of the experiments provide a more intimate understanding of PPNB architecture, including prehistoric construction methods and techniques, maintenance costs, spatial organisation, and post-abandonment events. The results also contributed to the conservation and presentation of early prehistoric sites to the public.
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The use of experimental archaeology to examine and interpret Pre-Pottery Neolithic architecture: a case study of Beidha in southern Jordan

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Abstract:

Many significant cultural transitions, including the beginnings of sedentism, domestication, and farming, are thought to have taken place during the Pre-Pottery Neolithic (PPN) in southern Jordan. The settlement sites of this period (often referred to as the first villages) are rich in architectural remains, and this evidence is frequently used to support hypotheses on the degree of sedentism and how societies were structured. This research reexamines these issues through the construction, maintenance, destruction and decay of four experimental reconstructions built between 2001 and 2006 at the PPNB site of Beidha. The results of the experiments provide a more intimate understanding of PPNB architecture, including prehistoric construction methods and techniques, maintenance costs, spatial organisation, and post-abandonment events. The results also contributed to the conservation and presentation of early prehistoric sites to the public.
Chapter One
Introduction – the aim of this thesis

This volume of research into the early Neolithic architecture of Beidha in the southern Levant is driven by the words of Coles:

…it has been stressed that those who fail to exploit the experimental approach do so in the knowledge that they neglect one of the very few mechanisms which can transform hypothesis into legitimate inference (1979:243).

The series of experimental reconstructions built at Beidha from 2001 to 2006, and described here, was expressly designed to challenge standard perceptions of Neolithic architecture - its construction, life history, and transformation within the archaeological record.

To place this research in its academic context, an overview (Chapter 2) of the history and recent developments in the field of experimental archaeology is provided. Many would agree that experimental archaeology is not simply a reconstruction of past activities, artefacts or architecture but is instead a quest to understand ancient and prehistoric techniques and methods through a scientific experiment that tests theories through practice (e.g. Coles 1973, 1979; Mathieu 2002; Mathieu and Meyer 1997, 2002; Reynolds 1978, 1979, 1995a, 1995c, 1999; Reynolds and Shaw 2000; Thomas 2005a). However, this simple definition of the experimental process has been widely adapted by experimenters and researchers over recent decades placing a question on the validity and even the role of experiments in archaeology (e.g. Binford 1978; Schiffer 1976). Various definitions of experimental archaeology, ranging from using experimental archaeology to create mathematical models (Saraydar and Shimada 1973) to using it as an educational tool (Reynolds 1995a), are discussed in Chapter 2 in order to set the experiments at Beidha in their theoretical environment.

Chapter 3 addresses the archaeology of the early Neolithic in the Near East, with particular reference to the similarities and differences seen in the architectural styles recorded in the region. New evidence from ongoing excavations in the region, such as Ba’ja (Gebel 2000) and Shkarat Msaied (Rehoff Kaliszan et al. 2002), continues to change our views of the events at the key transitions (e.g. domestication, agriculture, and food production) that took place during the Neolithic. As a crucial setting in which these processes and transitions evolved, the domestic architecture of this period is central to discussions concerning many
aspects of these changes. It is therefore on domestic architecture and inhabited spaces that the thesis focuses, based on evidence available to the author up to 2007. Amongst the most intriguing problems these architectures present are issues relating to structure size and organisation, function of individual buildings, site location, organisation of interior space, and intra- and intersite variability over time.

A critique of the structures in place at five experimental sites opens Chapter 4. The main sites reviewed include Lemba Experimental Village (Cyprus), Khirokitia (Cyprus), Butser Ancient Farm (England), Howick Project (England), and Archaeolink Prehistoric Park (Scotland). The issues raised introduce potential successes and failures in the construction and presentation of experimental buildings. A comparative study of selected elements of these programmes allows them to be assessed alongside Beidha on a manageable scale. Key factors that were considered include site size, the research and education objectives, target audiences, health and safety considerations, and budget. The critique of these five sample sites indicates that poor communication between experimenters and their audience is the primary weakness in the success of experimental sites, and that their strengths lie in the development of an ongoing programme of experiments. This examination of just five sites provides essential lessons for the successful development of experiments at Beidha and places the site in its experimental context both in terms of academic objectives and their meaning for the general visiting public.

Chapter 5 introduces the objectives behind the experimental reconstructions at Beidha. This chapter breaks down the primary aim of the reconstructions at Beidha (i.e. the use of experimental archaeology to examine and interpret early Neolithic architecture) into individual construction techniques and methods to be tested. This series of objectives aims to inform the debate concerning structural techniques used, type and quantities of raw materials, function and form of structures, and social organisation of early Neolithic space and settlements. This will further our understanding of the early Neolithic, its architecture, culture and people. Taking these objectives we can move on to examining the archaeological evidence from the site, as described in reports by the excavator in the 1960s (Kirkbride 1960, 1966a, 1966b, 1967, 1968, and 1985) and subsequently in a volume on the social organisation and architecture of Beidha (Byrd 2005b). Some supporting evidence from other early Neolithic sites in the southern Levant region is also cited in relation to the points and issues raised (e.g. Rollefson 1989; Banning and Byrd 1984, 1987), placing Beidha in its cultural context. This is followed by the construction of a series of questions and
issues that arose from the archaeological evidence presented by my predecessors at the site, and by my own reconsiderations of their evidence and analysis. These questions and issues (hypotheses) are addressed individually with reference to the experimental objectives.

All experiments …represent problems in archaeological material, through incomplete survival, through loss of understanding of purpose, through doubts about presumed function. All begin with reconstruction, and all go on to tests for function and suitability. All represent a series of steps: problem > idea > procedure > result > assessment (Coles 1973:14).

Following an assessment of the so-called problem in Chapter 5, the series of steps from idea to procedure is developed in Chapter 6, which also includes a critical examination of the parameters and recording method of the work at Beidha. Each of the four experimental reconstructions is then detailed - first by addressing the different types of raw materials used in the construction. An understanding of the materials used leads to a description of the construction process, including observations from the builders’ experiences, beginning with digging a foundation pit through to the final touches made to the roof and walls. A description of the experimental process continues with observations made during the maintenance and monitoring of each structure over the four-year period.

As it is known that certain of the buildings at Beidha and at other contemporary sites burnt down (Kirkbride 1960, 1966a, 1966b, 1967, 1968, and 1985), apparently resulting in the preservation in the archaeological record of additional structural and artefactual evidence not usually recovered from such buildings, one of the three experimental circular structures was set on fire in an experimental conflagration. In Chapter 7, the details of the burning event and the results from the trial excavation that followed the fire further fuel debates on current perceptions of the construction and destruction of early Neolithic buildings at Beidha. The debate focuses on the circumstances of the fire and considers the evidence for intentional versus accidental fires at Beidha.

It is not my intention to limit the work at Beidha solely to academic ends. Efforts were made to interpret and present the experimental reconstructions within a site management and conservation plan, appropriate to, and sustainable at, a site remote from professional day-to-day curatorial care and visited by a broad range of tourists, locals, students and professionals.
Chapter 8 presents the role of the experimental reconstructions on the site in this wider framework and the ethos of the Beidha Project within which they are set. The balance between experimentation, conservation, and presentation is focal to the future of the site.

The experimental objectives defined in Chapter 5 presented a number of key research issues; these can be grouped into the following thematic questions:

- How does the experimental construction, maintenance and destruction of structures at Beidha alter the current interpretation of early Neolithic architecture at the site?
- What can researchers learn from these experiments?
- What is their value to non-specialist visitors, either those on an extended tour from the nearby ruins of Petra or those specifically touring the many Neolithic sites in the region?
- How were these early Neolithic houses built?
- What led to their collapse?

To answer these questions each of the experimental objectives presented in Chapter 5 is reassessed in Chapter 9 in light of the results and insights gathered during the experiments. The architecture is analysed as physical constructs as well as social constructions. It is contended that the design, form, construction materials and techniques of structures within a settlement reflect individuals’ relationships with their constructed environments (Cutting 2003). Therefore, still framed around the reconstructed buildings at Beidha, further comments can be made on issues central to the study of Pre-Pottery Neolithic settlements. These include speculations and postulations on matters such as the impacts on social organisation of settlement types, significant patterns of domestic activities and storage space, the concomitants of sedentism, the impacts of seasonality, and, by extension, how understanding these issues sheds further light on the transition from mobile hunter-gatherers to sedentary farming villages.

The details observed and insights gained during the experiments at Beidha further our understanding of early Neolithic architecture (Chapter 10). The programme of experiments at Beidha proved successful as a means of examining and interpreting the archaeological evidence from the site. The research has provided observations to guide archaeologists excavating and interpreting timber, stone and mud architecture, and are of themselves amenable to re-investigation and subsequent challenge. As well as furnishing data from the process of erecting and maintaining the building, the work on these buildings also had another, and in its way equally important, function: to give an insight into human dimensions
of putting up these structures, and thus contribute experiential observations of the construction process that are not directly detectable in the archaeological record. In addition, the outcomes of these experimental studies provide new hypotheses and considerations on architectural, social, economic, and technological issues in relation to the precocious settlements that were the early Neolithic villages in southern Levant.
Chapter Two
Experimental Archaeology

Placing the experimental reconstructions at Beidha in context requires a critical review of relevant aspects of experimental archaeology, its history and recent developments, combined with a knowledge of the archaeology of the Pre-Pottery Neolithic B (PPNB) in southern Jordan (see Chapter 3).

The use of experimental archaeology at Beidha to investigate the architecture of the early Neolithic in Jordan was unprecedented. There are no records of similar life-size experiments conducted in the region or relating to PPNB architecture. The closest experiments, geographically, are those conducted at Lemba and Khirokitia in Cyprus on Chalcolithic and Neolithic architecture, respectively. The marked differences observed in cultural material and building tradition between prehistoric Cypriot and Levantine villages, for example the predominant use of terre pisé in Cyprus in contrast to stone in the Levantine region, called for new experiments intended to focus specifically on Levantine prehistory. In the absence of both regional and ethno-historic parallels, I relied on lessons that could be gleaned from the extensive history of experimental archaeology in Europe, and on the currently active and growing theory-based discussions of experimental archaeology both in Europe and America.

Section 2.2 below considers ethnoarchaeology and discusses reasons why it does not feature strongly in the experiments conducted at Beidha.

2.1 Experimental Archaeology

Experimental archaeology has been used for well over 150 years to contribute to our understanding of the past. Amongst the most influential of experimenters were John Coles and Peter Reynolds, whose contributions helped define the framework of the experimental procedures adopted today. Their work, amongst that of others, has contributed greatly to expanding the range and uses of experiments carried out in archaeology. Throughout this overview the focus is placed on experiments investigating constructs and architectural studies rather than on the array of experiments aiming to reproduce artefacts or simulations/trials of archaeological methods and technical innovations, such as testing new scientific equipment.
2.1.1 The History of Experimental Archaeology

In the late 1800s experimental archaeology was regularly performed alongside archaeological studies, such as the work of Nilsson (1868) in Denmark, Evans (1897) in England, Lartet in France (Lubbock 1878:561), Cushing (1894), and McGuire (1891; 1892; 1893) in the United States (for further examples see Ascher 1961:794). These experimenters focused primarily on investigating the technology and use of artefacts such as stone tools and pottery, or manufacture and industry such as hearths and ovens (see, for example, oven-kilns built by Cushing (1894:94-6)).

Experiments investigating artefactual remains continued to dominate early studies and fieldwork well into the early 1900s. Investigations generally focused on answering questions relating to the main body of archaeological evidence which primarily related to subsistence and technology (e.g. Barnes 1939). These experiments included the work of Garrod in 1934 following the discovery of sickles from a cave in Mount Carmel. The experiments aimed to prove that the stone tools were used for cutting grass and hence provide the earliest date for the introduction of agriculture into the region. Still very few experiments on the archaeology of architecture were documented during the early 1900s with the exceptions of experiments conducted by McHardy exploring the nature of vitrified walls (Mc Hardy 1906) and Hansen’s reconstructions of early prehistoric houses (Hansen 1966).

Experiments on the construction and destruction of prehistoric and ancient buildings emerged in the 1950s alongside the continuing trend for experiments on artefacts (e.g. experiments on stone projectiles (Evans 1957) and pottery decoration (Quimby 1949)). Amongst these early experiments are the observations made by Gordon (1953) whilst taking part in torching villages in war-torn Waziristan and his subsequent attempts to relate his findings to the archaeological evidence of burnt houses from the second millennium BC. His observations are amongst the few experiments on conflagration that could be used as comparative material at Beidha during the burning experiment (see Chapter 7). However there was still a poor representation of architectural experiments in the mainstream of experimental archaeology programmes.
In the last fifty years the key figures influencing the development of experimental archaeology as a field of study include Ascher (1961), Binford (1968), Saraydar and Shimada (1973), Schiffer (1976), Stone and Planel (1999) and Mathieu (2002). Notably, experiments relating to the architecture identified archaeologically, including its construction, use and abandonment, have remained peripheral throughout the history of experimental archaeology when compared to experiments relating to artefacts and technology. That said, numbers of experimenters have constructed buildings of Mesolithic

Table 2.1 Experimental sites relevant to the research carried out at Beidha

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<td>Lake dwellings</td>
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<td>Mesolithic hut</td>
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<td>Mud wall houses</td>
<td>Çatal Höyük, Turkey</td>
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<tr>
<td>Timber roundhouses</td>
<td>Hampshire, UK</td>
<td>Reynolds 1982</td>
</tr>
<tr>
<td>Crannog</td>
<td>Scottish Crannog Centre, UK</td>
<td>Andrian et al. 2007</td>
</tr>
<tr>
<td>Timber longhouses</td>
<td>Aisne Valley, France</td>
<td>Firmin 1987</td>
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<tr>
<td>b) Experimental Processes</td>
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<tr>
<td>Experimental Earthworks Project</td>
<td>Dorset/Wiltshire, UK</td>
<td>Bell et al. 1996</td>
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<tr>
<td>c) Ancient technology centres, archaeology theme parks, and open-air museums</td>
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<tr>
<td>Ancient Technology Centre</td>
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<td>Butser Ancient Farm</td>
<td>Hampshire, UK</td>
<td>Reynolds and Shaw 2000</td>
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<td>Archaeolink</td>
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<td>Oerlinghausen</td>
<td>Germany</td>
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or Neolithic types which are of particular relevance to the Beidha fieldwork. Examples known to the author are tabulated in Table 2.1. These are generally categorised as a) comparative examples of experiments on Mesolithic and Neolithic architecture; b) the experimental process; and c) experimental sites aimed at educating and entertaining the public.

The most influential experimental projects, in relation to the approach adopted in the experiments conducted at Beidha, were those undertaken by Coles (1967, 1973, 1979) and Reynolds (e.g. 1995) in Britain in the 1970s, 1980s and 1990s. They were arguably the leading figures in the field of experimental archaeology known for their use of experiments to explore prehistoric and ancient structures, as well as establishing a precedent for presenting experimental archaeology to the public.

Coles’ work

Coles’ Archaeology by Experiment (1973) provided a set of guidelines (Table 2.2), for establishing basic levels of confidence in archaeological experiments which continue to be employed to validate experiments today (e.g. Thomas 1995). In Archaeology by Experiment (1973) and Experimental Archaeology (1979), Coles, as well as outlining his own work, collated others’ experiments covering a broad range of subjects from food production to heavy industry. The construction of houses and monuments belonged to the latter category and includes descriptions of Reynolds’ Iron Age round house based on evidence from Breiddin and Hansen’s Iron Age house built in Denmark.

Reynolds’ work

The late Dr Peter Reynolds was the driving force behind the experiments carried out at Butser Ancient Farm (see Chapter 4 for more details). The publications he produced on the subject over a 35-year period are extensive, starting with ‘Experiment in Iron Age Agriculture’ in Trans. Bristol and Gloucestershire Archaeological Society in 1967 through to ‘The scientific basis for the reconstruction of prehistoric and protohistoric houses’ in the Journal of (Re)construction and Experiment in Archaeology in 2006. He reached out to a wide audience by publishing material, before his untimely death, in over thirteen regional archaeological society newsletters and papers, nine archaeological journals, thirteen books, eight conference proceedings, over twenty-four foreign publications (including papers appearing in publications in France, Germany, Spain, Denmark, and Holland), four
education packs, and a variety of specialist publications including research looking at landscape studies, rare breeds trusts, and meteorological data (see Appendix 2.1).

There are several types of experimental archaeology according to Reynolds (1995). These include:

- building structures,
- testing the limits and efficiency of processes and functions of items such as tools,
- simulation trials such as constructing and observing taphonomy of earthworks,
- probability trials in crop yields, and
- technological testing of new methods and machinery such as ground penetrating radar.

His classification system has recently been reiterated by Mathieu (2002). Reynolds’ approach contributed heavily to the development of the definition of experimental archaeology today, as seen below in Section 2.1.2.

2.1.2 Defining Experimental Archaeology

Experimental archaeology is often simply defined as:

a combination of different methods and techniques used to generate an interpretation of the past based on archaeological evidence (Wikipedia Feb 2007).

However, variations on this definition have emerged in the literature over many years. These provide for an array of experimental approaches, objectives, and criticisms – as shown below (2.1.2 a – h).

a) Experimental Archaeology is hands-on research

Experimental archaeology is a form of hands-on study based on questions about past human activity and behaviour. Understanding is achieved through the action of reconstruction and recreation of environmental conditions, structures, transport, tools, domestic objects, and so forth. Focusing on the active role of the experimenter, Peirce described the essential ingredients in the experimental process as being:

First, of course, an experimenter of flesh and blood. Secondly a verifiable hypothesis…The third indispensable ingredient is a sincere doubt in the
experimenter’s mind as to the truth of the hypothesis. Passing over several ingredients on which we need not dwell, the purpose, the plan, and the resolve, we come to the act of choice by which the experimenter singles out certain identification objects to be operated upon. The next is the external (or quasi-external) act by which he modifies those objects. Next comes the subsequent reaction of the world upon the experimenter in a perception; and finally his recognition of the teaching of the experiment (Peirce 1934:424).

It is this hands-on approach to experimental archaeology that is most prevalent at many open-air museums, ancient technology centres and archaeological theme parks.

b) Experimental Archaeology is a scientific process

In the public eye, experimental archaeology has unfortunately gained a stigma as being unscientific because of the popular portrayal of re-enactments such as the televised programme *Surviving the Iron Age*, filmed at Castell Henllys and broadcast by the BBC in 2000 (Firstbrook 2001). In such cases the media has too often glossed over accuracy and authenticity for the sake of entertainment and visual impact. However, within the field of research there is a strong case for focusing on the scientific steps of the experimental process, especially the role of developing and testing hypotheses.

Ascher (1961) creates the impression of a scientific approach to experimental archaeology through the use of phrases such as “converting the limited working hypothesis into a verifiable form” (1961:810). Indeed his approach is a forerunner of the definitions enhanced and implemented by Reynolds. The scientific approach stresses the repetition of experiments to increase the confidence of the results and the importance of the selection of appropriate experimental materials. In his adaptation of the experimental process in archaeology, Reynolds (1978) suggests that the process is cyclical. The process begins with the examination of primary data, leading to the development of hypotheses, then the experiment which in turn produces experimental data that will eventually feed back to the examination of prime data. Reynolds believed that “only experiment can yield the scientific model in the form of real data against which the material evidence from excavation can be compared” (Reynolds 1995:25). This perspective reiterates McHardy’s earlier realisation that experimental archaeology was a process of trial and error. During his experiments on the vitrification of forts he noted that his positive results were poor but “a good many negative results” were obtained (1906:141).

Perhaps in response to Ascher’s (1961) appeal for more theoretical discussion on experimental archaeology, a similar theoretical approach, unfortunately not supported by
practical work as in the case of Reynolds’ work, was put forward by Odell and Cowan (1986:210):

In archaeology, experimentation, however defined, has assumed an ever increasing role in hypothesis-testing and controlling elemental variables.

To date, the Experimental Earthworks Project, the longest standing experimental archaeology project in Britain, can be viewed as the most successful series of scientific archaeological experiments; indeed the project was initiated by scientists rather than by archaeologists (Bell et al. 1996:228). The project emphasises the importance of developing science in all aspects of archaeology, including experimental archaeology, beyond the limits of laboratory analysis and geoarchaeological techniques.

c) Experimental Archaeology as mathematical models

Simply stated, experimental archaeology “can be used by the archaeologist to transform a belief about what happened in the past into an inference” (Ascher 1961:795). Following this vision, Saraydar and Shimada (1973) strove for an approach that aimed to produce formulas that would not only explain the material culture of the past but would also provide mathematical models to catalogue activities of the past.

Their approach can be summarised thus

…when enough basic data has been generated, models can be built which simulate the functioning of specific kinds of past subsistence systems (Saraydar and Shimada 1973:350).

Unfortunately, this approach has left experimental archaeology open to criticism. For decades the results from archaeological experiments have been challenged as being inconclusive, and are often dismissed or disregarded outside the sub-field. The weakness in a mathematical approach such as that of Saraydar and Shimada’s is that it does not allow for the influences of human behaviour on actions in the past. Archaeological experiments are unlike those in other scientific disciplines because they attempt to replicate cultural factors; they are not solely experiments involving chemical and physical reactions. In interpreting the past there may be more than one way to produce outcome B in an experiment, in other words - if I do A’ or A”, I will also get B. The experimenter’s success in achieving B does not mean that B was necessarily achieved in the same way in the past. It means that B “could have been achieved in the manner indicated by the limited working hypothesis” (Ascher 1961: 810 - my emphasis). The experimenter’s knowledge, capabilities, and skill affect the outcome of the experiments. “Clearly, the same subjective elements are involved
Accounts of the practical application of Saraydar and Shimada approach are limited. They (1971) applied this theory in their experiment on the efficiency of using a steel axe to chop down trees compared to a stone axe. The results indicated that a stone axe took over six times as long as a steel axe and required five times as much energy (1971:217). However, their experiment also illustrates the inconclusive nature of the trial in that it did not include variables such as the quality of either the steel or stone axe, or the skill and experience of the labourer chopping the tree, or the hardness of wood. In other words, in applying mathematical models it is necessary to acknowledge all the variables that may influence the results if these are to be meaningful. Arguably such a task would be virtually impossible.

d) Experimental Archaeology to create analogies, patterns and type-specimens

Mathieu defines experimental archaeology as

a sub-field of archaeological research which employs a number of different methods, techniques, analyses, and approaches within the context of a controllable imitative experiment to replicate past phenomena (from objects to systems) in order to generate and test hypotheses to provide or enhance analogies for archaeological interpretation (Mathieu 2002:1 – emphasis original author’s).

Results from experiments involving primitive or ancient objects and technology provide vital insights into the past, and provide interesting questions relating to past cultures. Mathieu and Meyer state that

...experimentation provides a better understanding of the context of past human behaviour. By providing an appreciation of past phenomena, their complexity, and the issues that affect them, it allows inferences to be made, which generate hypotheses, theories, and interpretations. By allowing the experimenter to potentially put themselves in the shoes of a past person, experimentation lets us confront the world of possibilities as past people may have (Mathieu and Meyer 2002: 76).

This is a rather poetic approach to the process of carrying out experiments but it does stress the importance of experiential results. The belief that experiments involving primitive or
ancient technology incorporate experiential observations has only evolved in recent years (Townend 2002, 2007).

Another approach, predominantly in relation to the experimental manufacture of cultural materials such as pottery, focuses on revealing patterns and type-specimens. Variations in the pattern within the same classification (for example the production of similar pounders by two different individuals) could be explained by “incomplete transmission of the pattern from generation to generation or within a generation, variation in manual dexterity, availability of proper materials…” (Ascher 1961:806). A range of physical properties would be observed and no two would be identical, though they would look more similar to each other. The patterns observed define the parameters of a type-specimen which can be used as the basis for experiment.

But even classification is based on a hypothesis in which the outcome of trial and error is significant. The main assumption in experimental archaeology is that past cultural material can be replicated through testing set patterns of behaviour (Ascher 1961). For example, testing different plastering techniques will not only result in the physical representation of a replica plastered wall but will also simulate a pattern of past behaviour. This leads to a second assumption: all artefacts, or in this case architectural techniques and constructs, produced from an observed pattern and exhibiting similarities, can be from the same classification. These two assumptions have enabled many experimental archaeologists to devise type-specimens and establish artefact classifications.

It is important to remember that analogies, patterns, and type-specimens are essentially hypotheses that can only be validated through tests carried out against the archaeological record.

e) Experimental Archaeology is art and science
This definition predominantly encompasses experimental archaeology in the form of two-dimensional reconstructions. Often reconstruction drawings and models “embody a powerful interaction between art and science, demonstrating how archaeologists think and express their ideas visually” (Moser and Gamble 1997:186). As with experimental archaeology as an educational tool, the creation of coherent reconstructions on a page forces the artist, archaeologist and audience to take a closer look at the archaeological interpretation
in a comprehensible visual language as opposed to the exclusive and often complex language of science (Hodder 2000).

Although reconstruction drawings and models have often been used by archaeologists to present interpretations to their audience, little critical analysis has been made on the use of images within archaeological research (Smiles and Moser 2005). An exception is Kinzel’s interpretation of a variety of experimental reconstructions exploring early Neolithic architecture at Basta, Jordan (Kinzel 2006). The successful portrayal of these structures in a two-dimensional manner relied heavily on his architectural training, without which drawings can easily illustrate, and sometimes too convincingly, implausible reconstructions.

f) Experimental Archaeology is a social science

The few archaeological books on the topic of experimental archaeology have contributed little towards providing clarity of purpose and direction in the field. Ingersoll, Yellen, and MacDonald, for example, define “experiment” in the social sciences “…simply as a systematic approach to the explication of data” (Ingersoll, Yellen, and MacDonald 1977:ix). Similarly Odell and Cowan (1986) suggest that particular problems in archaeology, viewed as a social science, can be clarified through experimentation. Both sets of authors omit to define the methodology that could lead to such clarification.

When viewed as a social science, experimental work in archaeology can be categorised by the experimenter’s objectives (Ascher 1961). For example, cultural material recovered by archaeologists can be viewed in two ways. On the one hand an artefact may be seen as an expression of past ideas and behaviour; and on the other hand an artefact may be viewed as an object within a network of exchange and development. In the former the object defines the behaviour of people in the past and in the latter it defines its setting within spatial-temporal relationships. Broadly speaking, experiments can address a) the act of manufacture and use of an artefact; and/or b) the role of an object within a society. The majority of experiments carried out in archaeology still focus on the former objective, the technological aspects of past cultures and societies, and rarely look at the broader issues such as the economic and social context surrounding the object and/or technology involved. Few experiments have yet been taken forward to examine the experiential value gleaned from experiments (see Thomas 1995).
**g) Experimental Archaeology is an educational tool**

The success of experiments in archaeology can be measured by the ability to “respond to a variety of different needs over and above archaeological research” (Stone and Planell 1999:5). An example of one such need is education.

All experiments in archaeology aim to further our understanding of the past in some way, whether it be by learning how to knap flint, building an earth house, or cooking a Medieval feast. Each experiment, whether small or large, informs us of another aspect of past lives and thus forms an educational tool. However, rarely is education stated as a primary objective in an experimental programme, nor are measures usually taken to disseminate the findings from experiments beyond the relatively small catchment of researchers involved directly in the field of experimental archaeology. If experimental archaeology is to be viewed as an educational tool steps need to be taken to present the experiments to other archaeologists and further afield to the general public.

Relatively few publications focus specifically on experimental archaeology (e.g. Mathieu 2002) and only a handful of centres aim specifically at presenting experimental archaeology to the general public (for example, Butser Ancient Farm). Certain other centres, such as the reconstructed crannog on the shores of Loch Tay (Andrian and Dixon 2007), aim to address specific research issues as well as to educate. Archaeology theme parks, such as Archaeolink, do not normally present experimental archaeology to the public but instead entertain the public with a reconstruction of the past. Therefore, to an extent experimental archaeology is currently being used to educate the specialist and the general public; however it predominantly fails to educate the middleman - the archaeologist working in the field.

**h) Experimental Archaeology provides inconclusive results**

Experimental archaeology is criticised “for a frequent lack of clear purpose and an isolation of different researchers’ experiments from each other” (Odell and Cowan 1986:196). Despite the long history of the discipline, experimental archaeology lacks credibility and has not, as yet, established itself as an approach recurrently used in mainstream archaeological investigations. Adherence to a code of practice may install credibility and dispel accusations that experimental archaeology can falsify the archaeological reality and form modern creations that compromise the historical and aesthetic values of a site.
The main criticism of experimental archaeology is that it is simply an expression of contemporary fashions and trends. It is therefore not an accurate interpretation of the evidence (Sivan 1997); and ultimately is inconclusive. Experimental archaeology should be carried out in a scientific manner but this cannot be viewed as exclusive of subjectivity. The experimenter should retain an appreciation of their role in the process of reconstructing an ancient technology and be aware of their subjective input into what is seemingly an objective process (Ascher 1961; Saraydar and Shimada 1973). It is this need to consider the subjectivity in the experiments that leads to criticism.

In recent years, experimental archaeology has continually failed to receive general acceptance, and has been criticised because the evaluation of the procedures and results of its experiments are thought to be ambiguous. Demonstrating that an observed outcome may have happened one way does not eliminate all other possibilities. Therefore such experimentation only produces results with a level of confidence ranging from impossible to possible, even probable; it is not conclusive. Identifying the weaknesses of results from experimental archaeology, Coles (1973) attempted to validate the experimental process by setting out eight guidelines for determining the basic level of confidence for each experiment carried out. To increase the level of confidence the experimenter should:

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<tr>
<td>1.</td>
<td>use local materials applicable to the period of study</td>
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<td>2.</td>
<td>use primitive/ancient technology</td>
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<td>3.</td>
<td>use modern technology to provide results but not to interfere with experiments</td>
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<tr>
<td>4.</td>
<td>beware of scaled models</td>
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<tr>
<td>5.</td>
<td>the experiment should be repeatable</td>
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<td>6.</td>
<td>a desired result should be maintained alongside an open mind and uncertainty</td>
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<tr>
<td>7.</td>
<td>there is no absolute proof so corroborative evidence should be used to increase confidence</td>
</tr>
<tr>
<td>8.</td>
<td>assess the reliability by a) asking the right questions, b) checking that the procedure was applied honestly, c) the results were observed and assessed fairly, and d) all errors were stated openly.</td>
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Table: 2.2 Guidelines established by Coles (1973).

These guidelines are still very applicable to experimental programmes today.
The eight guidelines defined in Table 2.2 illustrate the diverse contributions experimental archaeology can make towards archaeology for the public, educators and researchers. Unfortunately, experimental archaeology is still not seen as a credible research tool in the eyes of archaeologists perhaps because it lacks a clear methodology and a forum for sharing results. On reading recent publications (e.g., Mathieu 2002) it becomes apparent that these perceived weaknesses in experimental archaeology may result from a geographical and cultural divide on an academic level, in which American and European experimenters continue to work independently of each other. Fortunately, experimental archaeology is still a growing sub-discipline, currently experiencing a revival and shows great potential in the near future. A new generation of experimental archaeologists is now emerging from specialised university courses (for example the MA course at University of Exeter); conferences are organised specifically to discuss theoretical issues such as how to communicate experiments and results to the academic community (Experimental Archaeology Day Conference, Exeter 2007); open-air laboratories are producing site-specific publications (for example Butser Ancient Farm and Lejre Historical Archaeological Research Centre); and mainstream archaeological publications are now focusing solely on experimental archaeology (for example, forthcoming *World Archaeology*). The increasing popularity, flexibility and simplicity of the internet have also provided a means for disseminating experimental results and observations to a wider audience.

The experimental archaeology programme at Beidha is set in this growing field of archaeological research.

*Experimental Archaeology as defined in experiments at Beidha, Jordan*

There are no previous examples of life-size experiments focused on PPNB architecture in the southern Levant upon which to model the current experimental programme at Beidha. To date, documented examples of experimental archaeology in Jordan have focussed on ceramic technology (Cline 2000; Glock 1982; Mershen 1985; Vaillant 1988). More recently related experiments in the region have begun to investigate technological innovations and related archaeological features such as the production of plaster in lime-kilns, conducted alongside excavations at Kfar HaHoresh (Hershkovitz *et al.* 1995); and plaster production in open-pit fires at Beidha (Brown 2006); and experiments in early Neolithic lithic technology, production and use-wear patterns (Smith 2006).
A study of architectural reconstructions of Late Pre-Pottery Neolithic B (LPPNB) settlements in southern Jordan in two dimensions has recently been carried out by Moritz Kinzel (Gebel et al. 2006). His explorations into the form, development, use, modifications, and destruction of LPPNB buildings, with particular focus on the architecture of Basta, relies on his distinction between the following three levels of probability: provable, plausible, and free. A provable interpretation, according to Kinzel, uses archaeological evidence, including excavations plans and photos. Plausible reconstructions use comparisons from similar structures, and predominantly address elements of architecture for which evidence is poor, such as above the line of preserved wall heads. A free interpretation uses evidence alongside elements of imagination, consideration given to aesthetic values, and ethnographic analogies. Kinzel believes that the use of all three levels of probability, including the controlled use of imagination, provides a comprehensive approach to understanding LPPNB architecture. A similar approach has been adopted in experiments at Beidha with the main focus placed on probable and plausible (in Kinzel’s terms) reconstructions.

In the absence of a regional tradition in life-size reconstruction experiments, the main influences upon the experiments at Beidha are the works of Coles and Reynolds (see Chapter 2.1.1), with a focus placed on experimental archaeology as hands-on research (Chapter 2.1.2a).

2.1.3 Experimental Archaeology: terminology used

There are numerous debates focusing on the terminology employed to encapsulate studies within the field of experimental archaeology. I will use the term ‘experimental reconstruction’ here to emphasize that the work described is not a construction reusing original cultural remains, nor are the structures under consideration physically on top of archaeological remains recovered during the excavations. Alternative terms such as ‘experimental construction’ and ‘construction site’ could also be used to emphasize that the experiments are works in progress based on contemporary interpretations of the past. Other terms such as ‘reconstruction’, ‘restoration’, ‘reconstitution’, ‘re-creation’, ‘imitative’, ‘simulation’, and ‘realization’ have also been used to describe experiments within archaeology (see Stone and Planel 1999; Coles 1979; and Reynolds 1999 for further discussions on terminology).
2.2 Ethnoarchaeology

By definition, ethnoarchaeology is an actualistic study that involves research aimed at providing material for incorporation into archaeological hypothesis building by analogy. It involves fieldwork, but not in laboratory conditions. It is similar to experimental archaeology in that it identifies analogous conditions for elements known within the archaeological record. However, the difference between ethnoarchaeology and experimental archaeology is the theoretically acultural and atemporal conditions with which its outcomes are redeployed.

The approach to ethnoarchaeology in this research lies between the polar views of Stahl (1993) and Binford (1968). Stahl believed that creating “visions of past lifeways is a primary goal of archaeology, and archaeologists are fundamentally reliant on analogy to achieve that goal” (Stahl 1993:235). This clear and simple statement by Stahl masks the pitfalls of using analogy-based study to interpret the past. The main criticism is that these studies (including ethnography, anthropology, and ethnoarchaeology) merely project the present into the past (Gould 1980; Stahl 1993:236). The limitations of ethnographic models were stressed by Binford (1968):

…fitting archaeological remains into ethnographically known patterns of life adds nothing to our knowledge of the past. In fact, such a procedure denies to archaeology the possibility of dealing with forms of cultural adaptation outside the range of variation known ethnographically (Binford 1968a:13).

Striking a balance between these polar views has been successfully achieved by Thomas in his work at Lemba Experimental Village (Thomas 1989, 1995, 2005a, 2005b). According to Thomas the traditional buildings surviving in the region, and in Souskiou village in particular, in southern Cyprus formed appropriate analogies for the Chalcolithic structures that once stood on the archaeological site at Lemba. His research showed that:

…enough evidence exists from the prehistoric periods to indicate that, on a certain level, a strong comparison can be made between these two architectural traditions and that data about site formation processes and construction detail would be forthcoming from these villages which would not necessarily be available from a prehistoric site (Thomas 1999:114).

The similarities in the use of raw materials, tools, and technology in response to the same environmental constraints were enough in the case of Lemba to hypothesise a working
analogy between recent circumstances and the Chalcolithic past. Excavations conducted on abandoned houses at Souskiou shed light on the multiple stages of collapse and decay affecting architectural remains. Thomas was able to use these results to interpret further the archaeological remains of the prehistoric village at Lemba (Thomas 1995).

Another successful application of ethnographic material is the data presented by McIntosh in his study of the deterioration of mud structures, made from both terre pisé and wattle-and-daub, in a modern village of Western Africa (McIntosh 1974). His research subsequently helped locate and identify decayed mud structures at an archaeological site nearby. The proximity of the modern village to the archaeological remains, the similarities in climatic conditions, and the comparable architectural forms provided valid ethnographic analogies and valuable taphonomic observations aiding archaeologists to recognise and interpret mud wall architecture. His studies successfully provided

…ethnographic analogies to throw light upon processes of decay and the subsequent deployment of altered material during all phases of deterioration, and to provide any indirect clues to the recognition of former walls (McIntosh 1974:154).

In southern Jordan, Kinzel (2006) studied aspects of vernacular architecture to shed light on the LPPNB architecture of the region. He saw an initial connection between the archaeological and ethnographic evidence based on the fact that they shared the same building tradition typically seen in architecture in such a semi-arid mountain environment. The two villages chosen as recent analogies in the region were Rajif and Dana. His case studies were used in an ‘illustrative analogy’ in which a poor archaeological interpretation could be fleshed out with ethnographic details (Stahl 1993). Despite his cautious approach to the use of modern analogies to interpret ancient technology, Kinzel’s source of interpretation does not satisfy the parameters enabling the valid use of ethnoarchaeology, as defined by Clark and Stahl, because of the temporal and economic differences between the LPPNB sites and the modern villages.

An appropriate analogy would ideally entail “selecting societies that occupied comparable environments and were in an equivalent developmental or economic stage (Clark 1947:166-167)” (Stahl 1993:241). Kinzel’s examples satisfy only the former of these criteria. At Beidha, despite broad similarities in architectural style to examples such as a round hut in Italy (Close-Brooks and Gibson 1966) and early stone houses in northern Scotland (Calder 1955-6), these were not considered as appropriate comparative models for Beidha because of the immense differences in cultural and environmental settings.
Examples set closer to Beidha from an environmental and geographical point of view were also considered. One such example is the architecture of the small deserted villages in the vicinity of Beidha that predominantly date from the 1800s and are built from locally sourced material. However the design, style, and form of these relatively modern structures diverged too greatly from the prehistoric architecture at Beidha to be used for direct comparison. Additionally, from a socio-economic point of view, these villages were occupied by well-established farmers therefore would not provide an adequate model for the hunter-gatherers and first farmers living in Beidha during the emergence of agriculture. Therefore, only observations on the raw materials used in the construction of these villages and the effects on materials at various stages of abandonment and collapse were noted during the experimental programme at Beidha and were not recorded as supporting evidence.

Casual observations were made during multiple visits to numerous small deserted villages in the vicinity of Beidha. A similar approach was adopted by Seeden in a study in Syria in the mid-1980s where non-systematic observations of traditional mud brick houses in the area helped explain architectural features during the excavation of a nearby Bronze Age site (Seeden 1985). For example, observations helped to explain the positioning and function of platforms, the frequency of maintenance work to the mud walls, and the use of recycled building materials. The case study hinted at features, some temporary and perishable, that could be included when visually reconstructing prehistoric houses.

The main two villages repeatedly visited during experimental work at Beidha were Shimakh (figure 2.1) and Dana (figures 2.2). Both villages are within 50 kilometres to the north of Beidha. These small agricultural and pastoral villages relied heavily on the line of natural springs at the edge of the plateau. They were mostly abandoned within the last forty years for the newly built replacement settlements, with houses fitted with electricity and running water, strung along the line of the highway. The houses in these abandoned villages are now in various stages of neglect ranging from being modified for seasonal use to being completely ruined.

Visiting these two dilapidated villages enhanced my understanding of vernacular architecture in the region, suggested possible explanations for regional variations, and led to an appreciation of organic material missing from the archaeological record. Observations of the houses in the villages focused on:

- Construction method, material and design
- Use, reuse, maintenance and repairs
• Collapse and decay processes

The villages of Shimakh and Dana typically consist of narrow winding alleys between small clustered, rectangular houses (figure 2.3). Only three or four of the houses in the villages have upper storeys. All were constructed in local materials, with in inner and outer face of stones infilled with mud and rubble. The walls were plastered both inside and out. The roofs were flat, constructed of large wooden beams (usually untreated juniper trunks) resting on the wall heads. The beams were overlain with a mat of brush/twigs or reeds, and covered with a thick layer of mud (figure 2.4).

During my visits the roofs were of particular interest because of the potential to supplement our poor understanding of roofing methods and materials from excavations of prehistoric villages in the region. The roofs of the houses, as described above, were used as platforms for activities and for sleeping. The ground floor was often used for storage or housing livestock. Although the roofs were originally built using juniper beams many had been subsequently replaced by railway sleepers or steel girders. The mud layer on the roof was traditionally maintained on an annual basis and involved pounding and rolling fresh layers of mud onto the underlying reed mats. However, occasionally the traditional roof construction had been replaced by sheets of corrugated iron. Similarly wooden panels in doors were substituted with beaten sheets of recycled metal.

The initial build up of material inside the dilapidated houses was characterised by random objects, such as broken furniture, abandoned by the owner. During the next stage of collapse construction material, typically wall plaster and roof material, fell on to the floor and over abandoned objects (figure 2.5). In the early stages of building decay, fragments of pottery could be seen eroding out of the wall and roof plasters. In the final stage of collapse, more roof material caved in and this material was mixed in with dumped rubbish imported from elsewhere (figure 2.6 - 2.8).

These observations, along with those made at other vernacular sites (Kinzel 2006; Thomas 1995), were used to enhance my understanding of structural materials, designs, uses and collapse, and further aid in interpreting the archaeological evidence used in the experimental reconstructions at Beidha.
Chapter Three
Pre-Pottery Neolithic

The sequence of events characterising the Pre-Pottery Neolithic is still hotly debated by archaeologists working in the Near and Middle East. However, the most important occurrences in the early Neolithic are without a doubt the circumstances surrounding the key transitions in sedentism, domestication, agriculture, and food production. An assessment of the architectural interpretations from excavations dating from this significant period focuses attention on some intriguing architectural issues: structure size and organisation; function of individual buildings; site location; organisation of interior space; and intrasite and intersite variability over time. In this study, particular focus is placed on the architectural remains that have been recently discovered at Pre-Pottery Neolithic B sites in the region (e.g. Gebel 2000; Rehhoff Kaliszanz et al. 2002) and on recently published excavation material (Byrd 2005b; Gebel et al. 2006).

To clarify the position of the experimental archaeology programme at Beidha the early settlement there will be placed in its chronological setting, the excavations in their geographical setting, and the research undertaken in its theoretical/academic setting. A clear background will thus be furnished for the experimental objectives set at Beidha (Chapter 5).

3.1 Pre-Pottery Neolithic in the Levant

3.1.1 Previous Research in the Pre-Pottery Neolithic

Research of the Pre-Pottery Neolithic in the Levant has, for decades, essentially centred on the transition from a nomadic lifestyle dominated by hunting and gathering to a settled lifestyle based on farming (Childe 1954). Our understanding of the Neolithic in the Near East has seen changes since Childe defined the Neolithic Revolution (Childe 1925, 1928). Indeed, even the term ‘Neolithic Revolution’ is rarely used to describe an event that is now thought to have been a much more gradual process (Price and Gebauer 1995). There is no single, widely accepted theory to explain this transition from a hunter-gatherer lifestyle to one of farming, nor is there one sole explanation for its point of origin. Indeed, there is now a strong case for abandoning polarised labels such as ‘forager’ or ‘farmer’, and instead adopting a broader view of adaptive subsistence behaviour (Harris 1996; Terrell 2003). Many theories have been presented over the decades to explain the events and consequences
of the Neolithic Revolution including the Oasis hypothesis (Childe 1956), natural habitat theory (Braidwood 1960), many theories based on population pressure (Binford 1968b, 1984; Cohen 1977; Flannery 1973), a competitive feasting model (Hayden 1990; Hayden and Gargett 1990), and more recently, environmental determinism (Henry 1998), and theories based on social behaviour (Bender 1978, 1990). This wide array highlights the many variables that could have influenced the transition and the need to explore new research methods to test these theories in the field.

Viewed as a regional phenomenon, the PPN sites in the southern Levant are thought to form one of the centres of Neolithisation, especially the mega-sites such as Ain Ghazal (Hole 2003). Along with sites in central and southern Anatolia and on the Euphrates, the southern Levantine cluster formed a key zone for the development of activities such as agriculture and domestication throughout the Neolithic. This southern part of the Levantine Corridor has also been interpreted as a core zone in which innovations developed and were diffused to secondary periphery zones (Rollefson 1987b). Watkins would reject this model in support of a network, or sphere, of sedentary communities that operated as self-regulating communities in an extensive region (Watkins 2003). Similarly, Byrd would argue that agriculture spread throughout the regions in the PPNB via a network involving both colonisation and the adoption of food production among local hunter-gatherers (Byrd 1992). Recently, Barker expanded the region of agricultural revolution beyond southwest Asia to a global scale by introducing evidence of foragers in periphery regions such as the Ganges Valley (Barker 2006).

Compared to their causation, the fruits of the transition are by contrast more easily identified in the archaeological record. Our understanding of the transition, and especially the emergence of agriculture and domestication, focuses on the analysis and interpretation of:

- material culture, such as sickle blades and querns indicating the adoption of new techniques and tools possibly used in plant exploitation;
- the manufacture and use of ceramics;
- forest clearance and altered landscapes identified through changes in pollen cores;
- the development of cultivation marked by the appearance of hard-shelled cereals in palaeoenvironmental samples;
- evidence of animal husbandry identified in animal bone assemblages; and
- permanent houses indicating growth and concentrations of settlement populations (Gebauer and Price 1992).
However, architecturally, Peter Wilson claims that permanent structures were introduced a long time before agriculture, not simultaneously with the adoption:

…the adoption of the practice of living in permanent homes and settlements, a practice that probably began in southwest Asia about 15,000 years ago and either spread throughout the rest of the world or was taken up at different times or independently hit upon (Wilson 1988:3).

– and referred to the process as ‘human domestication’. But how does an archaeologist identify a permanent settlement? Stone built houses do not necessarily equate to year round occupation. In an attempt to disentangle fixed from permanent architecture, Boyd has argued that “permanence of structure does not necessarily reflect permanence of occupation” (Boyd 2006:170). In his view, changes in architectural traditions, such as the use of stone rather than mudbrick or rectangular rather than circular houses, indicate innovative construction practices and strategies rather than reflecting new social organisation. Similar discussions on the permanence and scale of Natufian villages have arisen elsewhere in Jordan (Olszewski 1991).

The presence of stone architecture at some Natufian sites (e.g. Mallaha and Wadi Hammeh 27) has been interpreted as an indicator of the emergence of permanence or sedentism, followed by a return to a mobile lifestyle by the Late Natufian, with a return to sedentism again in the early Neolithic (Boyd 2006). Increasingly a grey area characterised by semi-permanent villages adopting seasonal hunting and gathering and farming has been debated by many archaeologists attempting to define sedentism during the Epipalaeolithic and early Neolithic of the southern Levant. For example, recent excavations to the north, at Göbekli Tepe in Turkey, have uncovered elaborate iconography of animals, fertility symbols, and geometric shapes carved into the monolithic pillars of temple-like structures leading to the suggestion that agriculture was a response to the construction of permanent settlements in the region (James 2007; Schmidt 2006). Watkins believes, in line with Cauvin’s theories (1994), that the creation of symbols first flourished at the beginning of the Neolithic, in a community practising ‘pre-domestic agriculture’ (Watkins 2000).

Wright claims that the early structures at Ain Mallaha were:

…initially the only type of building…this type of building served all purposes required by man at the time – everyman’s dwelling was equally his temple and his tomb, his factory and his fort. And equally all the very different sorts of buildings in later times evolved out of this one type (Wright 1985:24).
Though he may be right on the multi-functionality of early structures he does not take into account the possibility of the co-existence of structural types perhaps in the form of shelters made from organic material such as timber or animal skins, not detected in the archaeological record.

Interpretations of Neolithic architecture during the transition have primarily focused on identifying shifts in social organisation as reflected in the built form. Flannery identifies an increase in community regulatory mechanisms in early Neolithic architecture (Flannery 1972). His interpretations are based on the size of buildings and the increased elaboration of ritual symbols in public buildings. His theories were later reiterated by Hodder (1990) who similarly suggests an increase in political activity in the Neolithic and a need for social order. Retaining a focus on the use of architecture as a means of gauging the levels of social organisation within a community, a series of studies explored the use of the graph theory to measure the flow of individuals through buildings in the community (Banning and Byrd 1989; Hillier and Hanson 1984). The focus of studies on Neolithic architecture continues to be the location of the individual in his/her built environment and the distinction between private and public, domestic and corporate (Byrd 1994; Byrd 2005b).

Changes in architectural designs, forms and techniques have been used to distinguish phases and cultural developments. The substantial nature of PPNB architecture leaves less scope for confusion, compared for example with the finer points of distinguishing domestic from non-domestic in faunal assemblages, or the gradual technical changes noted in artefact manufacture. For details of the intricacies of classification of cultural material and terminology in the Neolithic see Banning (1998).

Recent trends in research continue to identify the Neolithic as marking the first major human impact on the environment and ecology, marked by greater depletion of forests through fires and sourcing of construction material, combined with the beginnings of clearances for cultivation and pastoralism, and construction of agricultural terracing and drainage systems (Knapp and Ashmore 1999; Kuijt et al. 2007; Raikes 1967). In the southern Levant, humans’ detrimental impact on the early Neolithic landscape may have depleted timber sources and consequently altered architectural designs (Rollefson and Köhler-Rollefson 1989).
Establishing dates for PPN sites and their associated cultural material is riddled with problems as seen in the conflicting figures published by various authors. For example, table 3.1 shows the chronological phasing of the Pre-Pottery Neolithic in approximate dates BP, calibrated dates BC, and calibrated years BP as presented in two separate sources (Rollefson 1998:102; Wright 2000:90). What initially seem to be discrepancies in the data tabulated below are clarified, though perhaps confusingly using another terminology, by Kuijt and Goring-Morris (2002). Rollefson’s approximate dates bp appear to tie in, give or take a hundred years, with Kuijt and Goring-Morris’ conventional 14C BP dates. Similarly, Wright’s calibrated years BP tie in, give or take less than a quarter millennium, with their calibrated 14C years BP.

<table>
<thead>
<tr>
<th>Period</th>
<th>Approx. dates bp</th>
<th>Calibrated dates BC</th>
<th>Calibrated years BP</th>
<th>Calibrated dates BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPNA</td>
<td>10,300 – 9,600 bp</td>
<td>12,400 – 10,750</td>
<td>10,450 – 8800</td>
<td></td>
</tr>
<tr>
<td>Early PPNB</td>
<td>9,600 – 9,200 bp</td>
<td>7,600 – 7,200</td>
<td>10,750 – 10,250</td>
<td>8800 – 8300</td>
</tr>
<tr>
<td>Middle PPNB</td>
<td>9,200 – 8,500 bp</td>
<td>7,200 – 6,500</td>
<td>10,250 – 9500</td>
<td>8300 – 7550</td>
</tr>
<tr>
<td>Late PPNB</td>
<td>8,500 – 8,000 bp</td>
<td>6,500 – 6,000</td>
<td>9500 – 8800</td>
<td>7750 – 6850</td>
</tr>
<tr>
<td>PPNC</td>
<td>8,000 – 7,500 bp</td>
<td>6,000 – 5,500</td>
<td>8800 – 8200</td>
<td>6850 – 6250</td>
</tr>
</tbody>
</table>


Table 3.1: comparing approximate dates for PPN cultural material from two separate sources (Rollefson 1998:102; Wright 2000:90) illustrates discrepancies in dates and calibrations in recent publications. The dating system adopted in this thesis is identified in **bold**.

The subtle differences in the terminology used by different authors make direct comparisons between PPN sites very difficult. For example, in Byrd’s recent publication (2005b:6) he refers to Natufian occupation at Beidha during the 11th millennium BC; one paragraph later the Natufian ranges between 12,910 BP and 12,130 BP (Byrd 2005b:7); twenty pages later Byrd tabulates dates as uncalibrated B.C. (2005b:26). In addition to the poor standardisation of PPN terminology, site comparisons are also problematic because various sources may subdivide a period differently thus including or excluding dates as suits their perspectives; incomplete excavation records have led to poor contextual information, conflicting interpretations of site stratigraphy, and/or lack specific provenance of dating material; and advances in identifying and interpreting calibration curves since excavations began on PPN sites in the early 1950s have amplified statistical discrepancies in published dates. These differences often make direct chronological comparisons between PPN sites extremely difficult and calls for a comprehensive recalibration of all PPN dates that meet modern standards of reliability. Throughout this research I have not attempted to standardise dates
published by authors (e.g. Byrd 2005a, 2005b) (Table 3.2), and have, where possible, adopted the chronological phasing and dating as used recently on PPNB sites in the region (e.g. Black 2008; Jensen et al. forthcoming), rather than provide a further chronological scheme, as such an endeavour was not a component of this research programme.

<table>
<thead>
<tr>
<th></th>
<th>Calibrated dates BP</th>
<th>Uncalibrated age estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPNA</td>
<td>12,000/11,700 – 10,650 BP</td>
<td>10,250/10,100 – 9400 bp</td>
</tr>
<tr>
<td>PPNB</td>
<td>10,650 – 8400 BP</td>
<td>9400 – 7600 bp</td>
</tr>
</tbody>
</table>

Table 3.2: Dates of PPN phases according to Byrd (2005a)

The dating system adopted in this thesis is identified in **bold**

### 3.1.2 Pre-Pottery Neolithic sites in the Levant

Our understanding of the PPNA in the Levant derives from the excavations conducted at the following main sites: Netiv Hagdud (Bar-Yosef and Gopher 1997), Gilgal (Noy 1989), Nahal Oren (Noy et al. 1973; Stekelis and Yizraely 1963), Iraq ed-Dubb (Kuijt 1995), Gesher (Garfinkel 1993), Hatoula (Lechevallier and Ronen 1985), el Kowm 2 (Stordeur 1989), Wadi Faynan (Mithen et al. 2000; Finlayson and Mithen 2007), ’Dhra (Finlayson et al. 2003), and Jericho (Kenyon and Holland 1981). The PPNA is characterised by the gradual appearance of domesticated crops (barley and emmer) at sites such as Iraq ed-Dubb; crude ground stone tools similar in type to examples excavated at Netiv Hagdud; and simple irregular oval houses as described at Netiv Ha gdud, Iraq ed-Dubb, Wadi Faynan and Nahal Oren.

Evidence for the emergence of human manipulation and management of resources and the environment may be recognised in the PPNA (e.g. research by Colledge 1998; and synthesised by Kuijt and Goring-Morris 2002) but it was in the PPNB that resource manipulation becomes well established and widespread. According to Gebel (1984) there were then over 150 Pre-Pottery Neolithic (PPN) sites in Syria, Lebanon, Palestine and Jordan, with many more discovered in the last twenty years. Unfortunately, the vast majority of the evidence from the 150 or more sites remains unpublished. Table 3.3 cites the relatively small sample of these sites which have been published, even if only in short interim reports, and which could therefore be consulted in preparing this thesis.
Of the PPNB sites, the main excavations in the Levant are: Beisamoun (Lechevallier 1978), Munhata (Perrot 1966), Abu Hureyra (Moore et al. 2000), Abu Gosh (Lechevallier 1978), Ain Ghazal (Banning and Byrd 1987; Kafafi and Rollefson 1995; Rollefson 1997; Rollefson et al. 1992), Ba’ja (Gebel et al. 1997), es-Sifiya (Mahasneh 1997), Ghuwayr I (Najjar 1990; Simmons and Najjar 1998), Basta (Nissen et al. 1987; Gebel et al. 2006), Shkarat Msaied (Rehffo Kaliszian 2002), Jerf el Ahmar (Stordeur 2000), Jericho (Kenyon and Holland 1981), Kfar HaHoresh (Hershkovitz et al. 1995), Nahal Oren (Noy et al. 1973; Stekelis and Yizraely 1963), Yiftahel (Garfinkel 1987), El Kown (Stordeur 1989), Ayn el-Jammam (Waheeb and Fino 1997) and Beidha (e.g. Kirkbride 1966). The excavations of these PPNB sites have produced remains that have been interpreted as ranging from hunting camps to large villages, or mega-sites. At all these settlements the economy of the PPNB community

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Southern Levant</th>
<th>Central Levant</th>
<th>Northern Levant</th>
<th>Taurus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early PPNB</td>
<td>10,750 – 10,250 cal BP</td>
<td>Wadi Jilat Motza</td>
<td>Mureybet Aswad Jerf el Ahmar</td>
<td>Çayönü</td>
</tr>
<tr>
<td>Middle PPNB</td>
<td>10,250 – 9500 cal BP</td>
<td>Jericho Munhatta Ain Ghazal Wadi Shu’teb Wadi Jilat</td>
<td>Abu Hureyra Assouad</td>
<td>Çayönü Cafer Höyük Göbekli Tepe</td>
</tr>
<tr>
<td>Late PPNB</td>
<td>9500 – 8800 cal BP</td>
<td>Basta Ba’ja Mossad Mazal Ghuwayr Ain Abu Nekheileh</td>
<td>Abu Gosh Ramad Beisomoun Ain Ghazal Wadi Jilat Es-Sifiya Khirbet Sheikh Khirbet Kharaysin Dhuweila</td>
<td>Bouqras Abu Hureyra Ras Shamra Cafer Höyük Grillié Çayönü Boytepe Hayaz</td>
</tr>
</tbody>
</table>

Table 3.3. Summary of PPNB sites based on Rollefson 1989:169 and Gebel 1987:346. Sites that are described in published monographs are highlighted in italics. Sites that are frequently referenced in this thesis are identified in bold.
was seen to be increasingly focused on cultivated cereals and legumes, and by the Late PPNB, also on domesticated sheep and goats.

In this study I have concentrated on comparative material from just four of these sites in order to place Beidha in its southern Levantine context. Three of these (Shkarat Msaied, Basta, and Ba’ja), located within 20km of each other, together illustrate increasing complexity in architectural form and also regional, or perhaps cultural, variations in architectural styles and artefacts. I have also included Ain Ghazal because this site has received extensive attention from archaeologists over the past twenty years. Data availability is, however, improving rapidly. At the time my research commenced in 2001 the excavation material from these five sites (including Beidha) had not been fully published. The limited published material on PPNB sites in southern Jordan then included a series of interim reports on Beidha (Kirkbride 1960, 1962, 1966b, 1967, 1968), on Ba’ja (e.g. Gebel 2000; Gebel and Bienert 1997; Gebel and Hermansen 1999), on Shkarat Msaied (e.g. Rehhoff-Kaliszan et al. 2002), on Basta (e.g. Nissen et al. 1987), and on Ain Ghazal (e.g. Kafafi and Rollefson 1995; Rollefson 1984; Rollefson et al. 1992). Unfortunately, even the fairly minimal descriptions available on these sites often present the research biases of their excavators (e.g. a focus on settlement patterns and networks at Ain Ghazal (Rollefson 1987b, 1992)). The recent publications of the stratigraphy and architecture of Beidha (Byrd 2005b) and Basta (Gebel et al. 2006) has greatly enhanced research opportunities on all aspects of material culture, including those central to this thesis, from PPNB sites.

The following overview of these five PPNB sites, in particular their architectural remains, reflects the limited evidence available in the absence of full excavation reports, especially from Ba’ja and Shkarat Msaied, when the experimental work at Beidha was under way. Some of the more extensive descriptions of architecture at Basta (Gebel et al. 2006) were useful in the final writing up of this thesis but were not accessible to the writer during the initial stages of the experimental programme at Beidha. Information from the ongoing excavations at Shkarat Msaied and Ba’ja was emerging during the course of the experimental programme.

**Beidha**

*Stats:*  1037m above sea level  
*Map coordinates:* 36R 0735206  UTM 3362433
Background

One of the key early Neolithic sites in southern Jordan is Beidha, located just 5km north of Petra (figure 3.1). Diana Kirkbride-Helbaek led excavations and surveys in the area from the late 1950s through to the 1980s (Kirkbride 1966a, 1966b, 1967, 1968; Byrd 1994). Eight seasons of excavations were carried out between 1958 and 1983 revealing 1425m² of Neolithic deposits (Byrd 1994) (figure 3.2). The excavations revealed 65 buildings initially allocated by the excavator to numerous phases, but the initial scheme was simplified in the final publication by Byrd (2005:11-13). He suggests three phases (Phases A, B, and C) of occupation from the early Neolithic (Pre-Pottery Neolithic B) as well as artifacts from earlier Natufian horizons.

Subsistence practices in the early Neolithic were characterised by intensive hunting and gathering. Plant cultivation, based on evidence for domesticated barley and domesticated wheat, appears either in the Natufian (Moore et al. 2000) or during the PPNA (Bar-Yosef and Gopher 1997). Throughout the PPNA the focus remained on intensive exploitation of diverse wild animals and plants. It is within this setting that sedentary agricultural villages first emerged. The nature of a site’s subsistence is defined by the absence and/or presence of domestic goats and sheep, cultivated cereals, and range of food processing toolkits. In the PPNB, settlements ranged from hunting camps to large agricultural villages. Beidha was cultivated in the Middle to Late PPNB, as witnessed by impressions of hulled two-row barley and emmer in burnt plaster fragments from PPNB deposits (Colledge et al. 2001). The presence of pistachio nuts, acorns and wild oats in the archaeological record suggested continued harvesting (Helbaek 1966; Kirkbride 1985). Amongst the faunal assemblage were wild goat species thought to be culturally controlled (for example, through culling) (Perkins 1966). The archaeological artefacts from Beidha suggested an increased quantity and diversity of food processing tools by Phase C (Wright 2000), along with allocation of space for food processing and preparation (Byrd 2005b). This would suggest the early stages of the establishment of a sedentary village population with food production practices.

The site has in recent years shown increasing signs of decay and neglect. No conservation took place following excavation seasons and therefore the exposed archaeological remains have gradually collapsed and decayed over the past 40 years. It was this increasing degradation that prompted the recent phase of intervention. The Beidha Project was initiated in 2001 to begin the process of conserving and presenting the complex archaeological
remains to the public. The project is a joint collaboration between the Council for British Research in the Levant (CBRL) and the Department of Antiquities in Jordan, with a strong emphasis on community involvement. The experimental archaeology programme forms part of the Beidha Project and aims to contribute to the conservation and presentation aims identified above.

Architecture
There are three main architectural forms at Beidha (figure 3.3):
- circular and curvilinear,
- sub-circular to sub-rectangular, and
- rectangular pier buildings

The structures from the early MPPNB (i.e. Beidha Phase A) and at Shkarat Msaied (see below for further description) were circular and semi-subterranean, joined together to form a network of cells. The architectural form of these structures from this first phase of occupation could conceivably have evolved from the simple celled structures known at PPNA sites in the region, such as those recently excavated at Wadi Faynan 16 (Finlayson and Mithen 2007) and Dhra’ (Finlayson et al. 2003). The domestic architecture in the PPNA, or Epipalaeolithic, constituted hut compounds able to accommodate large social units (Banning 1996). Indeed these PPNB structures at Beidha have been perhaps mistakenly labelled in the past as PPNA Multi-cell Round Houses (Wright 1985:figure 206) because of their architectural appearance. The main aspect by which Beidha Phase A deviates from the PPNB model developed elsewhere, as suggested by Banning and Byrd, is the shape of the buildings, especially in the earliest phases of occupation. These do not conform to the common Early and Middle PPNB architectural type which is described as consisting of small rectilinear houses, often described as special-purpose buildings (Banning and Byrd 1984), opening onto central courtyards. Indeed the type of circular architecture encountered at Beidha is typically dated to the late PPNA in the northern Levant whilst the early PPNB there is characterised by rectilinear structures, with circular forms apparently retained for non-domestic, public or ceremonial structures, for example at Jerf el Ahmar (Stordeur 2000; Stordeur et al. 2001).

In Beidha Phase A the walls of these circular semi-subterranean structures were built of two faces, totalling approximately 1m in thickness, consisting of limestone, sandstone and occasional flint nodules, the intervening gap infilled with rubble and a simple mud mortar (figure 3.4). Set in the inner wall face were slots for upright wooden posts, presumed to
have formed the supports for timber roof rafters, which are not considered to have rested on the wall-head. Therefore the dry stone walling was not thought to be essential in bearing the weight of the roof but instead the wall formed a curtain (Wright 1985:27). These walls were capped with large boulders and stood to a maximum height of 1.20m.

Similar structures were built in the Phase B, by then however the structures became more sub-square in shape and lacked evidence of slots for the upright timber posts. Structures in Phase B were poorly preserved, compared to Phases A and C, to the extent that no complete buildings were successfully excavated. This was largely due to subsequent building activity. The wall faces, built predominantly of sandstone slabs, appear much neater and are well-made compared to those of the preceding phase. Each building was thought to be semi-subterranean (Byrd 2005:83) with steps leading down into the structure. Phase B is the intermediary phase of occupation exhibiting architectural characteristics that may elucidate the transition from circular to rectilinear buildings.

The architectural form changed significantly in Phase C at Beidha. The most common house forms were pier houses, named for the piers that divided house space into two or three rooms (Wright 2000:103). It is this change in form of the domestic architecture that has intrigued archaeologists for many years (Banning 1996:167). This change in architectural form seems to mirror changes in economy, marked by an increase in production of prepared food and domesticated livestock.

The structures, although built using the same technique (in other words two faces of stone wall infilled with mud and rubble), were rectangular in Phase C, and possibly two-storeyed. Their main feature was a central corridor flanked by a series of small cells, usually three on either side of the long axis (figure 3.5). These structures have been called corridor houses by Byrd and Banning (1988) to highlight the uniqueness of their rectilinear form in comparison to pier structures excavated at Jericho and Ain Ghazal. The buildings at Beidha have thicker enclosing walls and internal piers, with very little space between the piers. In this thesis I have used the term pier structures for these buildings to highlight the uniqueness of the construction of their piers in contrast to using a descriptor that highlights the corridor space created along the main axis.

*Associated architectural features*

The main features excavated in association with structures from Phases A to C were hearths (located externally in courtyards), large slabs presumed to be working platforms, benches,
and grinding slabs (located within structures). In Phase C, possible evidence of hearths placed in the floors of the second storeys has been suggested.

**Further research issues**

The site’s well-preserved architectural remains, deep stratification (up to 6m of deposits), great horizontal exposure during excavation, clear occupation phases, and presence of *in situ* artefacts (recovered from 53% of all interior floor spaces) are all features that have kept archaeologists interested in Beidha for many years. Evidence from Beidha has fuelled many discussions such as those on community organization in Neolithic villages (Byrd 1994), the origins of pastoralism (Köhler-Rollefson 1987), and more recently the social organization and technical development of the manufacture of lime plaster (Brown 2006).

Along with the unusual architectural forms excavated at Beidha, departing from PPNB patterns recognised elsewhere, there may be doubt over the exact dating of the remains at Beidha. Recent sampling at Beidha from late Natufian layers and also from the basal layers of Neolithic deposits at Beidha has provided preliminary radiocarbon dates on charcoal (Black 2008):

- **Natufian layers** 13270 – 13040 cal BP (11260 +/- 70) [Beta-235215]
- **Neolithic layers** 10390 – 10320; 10310 – 10200 cal BP (9110 +/- 50) [Beta-235216]

This places the Neolithic occupation at Beidha on the border of the Early and Middle PPNB.

This new chronological evidence goes some way to bridging the gap between the MPPNB radiocarbon dates obtained in the 1960s (Barker and Mackey 1968) and the discrepancies in the style of architecture in Beidha Phase A. The new dates may help explain the striking similarities with conventionally dated earlier architecture in the upper Euphrates area. Equally the suggestion by Rollefson (1998), based on architectural form, that Beidha Phase C should date to the Final PPNB, rather than MPPNB, has been rejected by Byrd (2005b) on the grounds that architectural similarities between the corridor and pier structures do not provide an adequate basis for dating occupation levels. However, it should also be noted that other architectural features, such as the design and construction technique employed in plastered hearths at Beidha and Ain Ghazal, are also similar. Ideally future investigation at Beidha should explore the possibility of obtaining more samples for radiocarbon dating from each phase of occupation to refine the accuracy of dates obtained in the 1960s. Meanwhile I have cautiously adopted the dates obtained in the 1960s, as referenced by Byrd (2005b).
In terms of the experimental archaeology programme carried out at Beidha, the most significant recent contribution to research is the monograph by Brian Byrd (2005b). It is a substantial volume, including site plans, photographs and Harris matrices, that focus on the architecture of Beidha, from the Natufian and Neolithic layers; analysis and interpretation of the artefacts, lithics and palaeoenvironmental assemblages is due to be published in subsequent volumes. Like many (e.g. Boyd 2007), I anticipate that the forthcoming volumes integrating all archaeological evidence from Beidha will contribute greatly to our understanding of Neolithic life.

Byrd’s objective in this first volume was to address the following issues:

a) analyse community organisation of an early Neolithic village, and patterns of continuity and change through time, and

b) explore the construction, use, and reuse of individual buildings

He achieves this through a close examination of the stratigraphy and details of each excavated structure (Chapters 4 and 5, respectively), before going on to explore architectural patterning (Chapter 6) and implications on community organisation (Chapter 7). By Byrd’s admission, the success of this detailed analytical approach to Neolithic architecture must be attributed to Diana Kirkbridge-Helbaek’s diligent recording and fieldwork, as well as her well-considered research methods.

Ba’ja

Background

The early Neolithic (Late PPNB) site of Ba’ja, located in the mountains of the Greater Petra region, is currently being excavated by a team led by Hans Georg K. Gebel (Gebel 2000; Gebel 2006; Gebel and Bienert 1997; Gebel and Hermansen 1999) (figure 3.6). The site is extraordinary due to its dramatic location on a small terrace surrounded by deep gorges and can only be accessed today up a deep gorge using ropes and ladders.

Architecture

The architecture here is well preserved with some walls surviving to a height of 4.2m (figure 3.7) and showing strong similarities with the houses of Basta (considered below). All the buildings are described as either rectangular or sub-rectangular, some with evidence of upper storeys. These are thought to have been used for domestic life whilst lower rooms show evidence of workshops and storage. The structures were built on steeply sloping ground
(circa 45°), possibly accounting for the frequent cases of modifications, including the raising of floors as the basement filled up with slopewash and what had been the upper storey effectively became the ground floor (Gebel 2006). There is considerable evidence for staircases, terracing and upper storeys (figure 3.8).

Further research issues
Ongoing excavations at Ba’ja under the supervision of Hans Georg K. Gebel provide the opportunity to integrate new evidence into the wealth of stratigraphic and architectural evidence gained at Beidha and Basta.

Basta

Background
As with the early Neolithic site at Ain Ghazal (considered below), the archaeological investigations at Basta were prompted by the looming threat to the Neolithic village by development - in this case from the rapid construction of a new village including pipelines, roads and utilities (figure 3.9). The rescue excavations began in 1986, and over five excavation seasons revealed 3m depth of stratified material associated with Neolithic occupation. This extensive settlement, or mega-site, dates from the Late Pre-Pottery Neolithic B. It underlies deposits from the Final Pre-Pottery Neolithic B and Pottery Neolithic A, placing it slightly younger than the Middle PPNB deposits excavated at Beidha. The recent publication of the architecture and stratigraphy from Basta (Gebel et al. 2006), placed alongside the recent publication of architecture and stratigraphy at Beidha (Byrd 2005b), provides the opportunity for future research into the regional development of architectural form, design, and construction techniques from the MPPNB through to the PNA.

The site itself is located near a perennial spring approximately 15km southeast of Beidha.

Architecture
The architectural design of the buildings at Basta varied in the size and arrangements of rooms, but seems to fit within the following pattern, often described as a grid plan. In these structures, a large space measuring approximately 7m by 4.5m, possibly roofed, was flanked by small cells on at least one side. The small dimensions of these cells, approximately 1m by 0.90m, suggests that they could only have been used for storage (Gebel et al. 2006:156).
One example of this architecture at Basta, often cited as the specimen-type, has been named ‘Basta House’ (Building Unit B1). The main constructional element is the assemblage of walls of 0.40m to 0.60m thick built of local limestones roughly dressed to rectangular shapes. These were laid in lime mortar with joins quoined with thin flat stones to increase stability (figure 3.10). Rarely were gaps left between the two wall faces as had been seen at Beidha; hence the technique of infilling wall cores with rubble and mud was not employed at Basta. The walls were preserved to a maximum height of 2m, including the preservation of windows and doors with lintels (figure 3.11). Unlike at Beidha and Ba’ja, the excavators at Basta rather reluctantly admit that they have insufficient evidence for upper storeys (Gebel et al. 2006:221). Of particular note is a) the relatively high density of buildings, and b) the networks of underground channels presumed to have been air chambers aimed at providing insulation and ventilation to the building above (Gebel et al. 2006:211). These channels are reminiscent of the ‘air chimneys’ described at Ghwair I (Simmons and Najjar 1998).

The construction technique of buildings at Basta involved extensive preparations made at foundation level. Like most PPNB sites, Basta was situated on the shallow slopes of a valley basin. However, unlike other early Neolithic settlements such as Ba’ja and Beidha, the foundations of buildings at Basta were built on artificial terraces, rather than being cut into the side of the slope. In other words, a series of terrace walls were built to provide level ground before construction started on the buildings.

**Associated architectural features**

The floors were plastered with a lip running upwards from the base of the wall suggesting that the floor plaster originally continued up the wall. The plastering technique, as interpreted by the excavators, includes three main steps:

- the application of a layer of coarse mud
- the application of a smooth coat of lime-based plaster with a thick reddish-brown paint
- in cases, further decoration with a fine white lime plaster

These structures included storage spaces on the lower floors similar to the small chambers between piers in buildings of Phase C at Beidha.

**Further research issues**

Comparisons between the Basta House type and pier houses of Beidha Phase C show that both use internal compartmentalisation. However, the construction technique, associated
architectural features and settlement organisation are all different. One theory is that a socio-economic trend involving multi-roomed buildings was imported into Basta from northern regions and absorbed the existing rectangular architecture of the region in the form of the pier houses from Beidha (Gebel et al. 2006:219). Similarities with architecture at Ain Ghazel have also been suggested (Banning 1998:220), intimating a network between PPN sites for the exchange of architectural innovations. The recent publications of the stratigraphy and architecture from both Basta and Beidha now make such comparisons possible and provide the opportunity for such discussions on an intersite and intra-regional level.

**Shkarat Msaied**

**Background**
Shkarat Msaied is a Middle Pre-Pottery Neolithic B village of similar age to the first PPNB village built at Beidha (Phase A). The site is located in the sandstone mountains approximately 8km north of Beidha (figure 3.12). It was first noted by Kirkbride in 1964 whilst she was working at Beidha; the area was then surveyed by Hans Georg Gebel in 1988, and this site was subsequently excavated by a team of archaeologists from the Carsten Niebuhr Institute of Near Eastern Studies at the University of Copenhagen beginning in 1999. The excavations at the site are on-going.

The excavators aimed to establish a chronology relative to neighbouring sites comprising Basta, Ba’ja, and Beidha to the south and east, and to Neolithic sites towards the west in the Wadi Araba (e.g. Ghwair I). The site is small in comparison to neighbouring sites and is therefore ideal for full horizontal exposure with the aim of studying intrasite spatial organisation (Rehhoff Kaliszans et al. 2002).

**Architecture**
The archaeological evidence suggests that the architecture of Shkarat Msaied is similar to structures from Phase A at Beidha: circular buildings arranged in a honeycomb fashion, each averaging 4m in diameter, with wooden posts set in the walls (figure 3.13). The walls, surviving to a height between 1m and 1.8m, were built of two faces of roughly dressed sandstone and limestone blocks set on large foundation stones and with the wall core infilled with crude mud mortar. The inner walls were often faced with a row of upright flat slabs (figure 3.14) – an architectural feature that is only occasionally noted at Beidha. There is
strong evidence from Shkarat Msaied for second storeys in a few of the buildings, including internal staircases, and for use of flat roofs as work space.

Associated architectural features
Hearth, lime plastered surfaces, storage facilities, doorways, and platforms have been identified during excavations at the site (figure 3.15). Five of the structures in the northern part of the site were coated with a fine pink lime plaster, though not showing the cement-forming minerals recorded at Ain Ghazal and Basta (Rehoff Kaliszanz et al. 2002). As at Beidha, stone platforms were recorded in a sample of the structures and have been interpreted as working platforms because of the assemblage of groundstone tools found in association with these features. Two small hearths, measuring approximately 0.30m to 0.40m in diameter, were found. The apparent rarity of storage facilities at Shkarat Msaied is also reminiscent of Phase A at Beidha. However, occasionally small rooms of very irregular shape, unsuitable for domestic living, were built in the spaces between two or more circular buildings.

Further research issues
The ongoing investigations of the Neolithic site at Shkarat Msaied implement new techniques in survey, excavation, and post-excavation analysis unavailable at the time of excavations at Beidha in the 1960s. The current research at Shkarat Msaied will continue to provide stimulating comparative material for all early Neolithic sites in the region.

For example, five radiocarbon dates from recent excavations have provided absolute as well as relative dating for Shkarat Msaied. The dates obtained range from 11,198 cal BP to 9706 cal BP (9590 ± 90 BP to 8880 ± 80 BP), placing the site within the Early PPNB and early-middle of the Middle PPNB (Jensen et al. forthcoming). However, the excavators are currently hesitant to adopt the early date that was obtained from possible re-used timber since it is possible that the determinations are for the wood that was re-used from earlier unidentified contexts. More radiocarbon dating is planned in the current programme of research at Shkarat Msaied, meanwhile the previously proposed Middle PPNB date is maintained for the main occupation of the site.

Ain Ghazal

Background
Ain Ghazal was a permanent farming settlement located in a valley system on the northeast outskirts of present-day Amman. The site was partially excavated in six seasons from 1982
to 1989 following the identification of early Neolithic remains in a road cut in 1974. Rescue excavations revealed remains from a series of nine levels of uninterrupted occupation dating from the PPNB through to the late Neolithic. A thorough study of the architecture was not amongst the primary aims of the rescue excavations. The focus was placed on: rescuing endangered portions of the site; documenting the extent of the site; clarifying the chronology; researching economic and technological change; exploring settlement patterns and regional networks; investigating ritual behaviour; and identifying reasons for site abandonment. The following overview will concentrate on the current general understanding of the architecture and spatial organisation gleaned from the available evidence recovered from the PPNB levels of occupation through excavation and photographic surveys in Ain Ghazal.

<table>
<thead>
<tr>
<th>PPNB occupation</th>
<th>Radiocarbon dates</th>
<th>years BC, uncal.</th>
<th>Calibrated years BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ain Ghazal MPPNB phase 2</td>
<td>7050 ± 90 &gt; 6980 ± 60</td>
<td>6800-6600 BC</td>
<td>8019-7690 BP</td>
</tr>
<tr>
<td>Beidha MPPNB phases</td>
<td>7080 ± 50 &gt; 6770 ± 150</td>
<td>7000-6596 BC</td>
<td>8001-7421 BP</td>
</tr>
</tbody>
</table>

Table 3.4: comparison of radiocarbon and uncalibrated BC dates from Ain Ghazal and Beidha (source: Ain Ghazal (Rollefson 1989) and Beidha (Byrd 2005b)). The calibrated BP dates were calculated by the author using OxCal 4.1.

The preserved portion of the early Neolithic settlement at Ain Ghazal covered approximately 12 to 13 hectares in the LPPNB. The settlement is described as a mega-site, a term usually restricted to sites in the southern Levant, in comparison to other smaller PPN sites of the Levant (Table 3.5):

<table>
<thead>
<tr>
<th>PPN settlements</th>
<th>Area in hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ain Ghazal</td>
<td>12 –13</td>
</tr>
<tr>
<td>Tell Abu Hureyra</td>
<td>11</td>
</tr>
<tr>
<td>Basta</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Jericho</td>
<td>4</td>
</tr>
<tr>
<td>Beidha</td>
<td>&lt; 4</td>
</tr>
</tbody>
</table>

Table 3.5: Comparison of PPN settlements in hectares (source: Basta (Gebel et al.2006); Ain Ghazal, Tell Abu Hureyra (Rollefson et al. 1992); Beidha, Jericho (Byrd 2005b)).

By the LPPNB period, Ain Ghazal is thought to have expanded to its peak size of 13 hectares, almost doubling in area within a hundred years. It is suggested that this sudden expansion in settlement size resulted from the arrival of migrants from outlying villages such as Jericho (Rollefson et al. 1992). Moore (1975) and Rollefson (1987b) suggest that PPN
villages may have large sites, such as Ain Ghazal, serving as regional centres. In this model, villagers from Beidha, which was thought to have been abandoned towards the end of the MPPNB, may have been amongst those attracted to the relative lush environmental settings of mega-sites such as Ain Ghazal and Basta.

*Architecture*

Traces of at least 54 buildings with 71 associated floors were exposed, leading to an estimation of the total size of the settlement: “if we make the untested assumption that the density of the settlement along the road-cut is representative of the site as a whole – would be approximately 350 houses” (Banning and Byrd 1984:15).

The buildings in the PPNB levels of occupation at Ain Ghazal predominantly took the form of walls constructed of natural stones laid in mud mortar directly on the ground, often without any foundation trenches. These walls, thought to be quite substantial, were preserved to a height of 1m (Banning and Byrd 1984:17). The principal type of structure was

…a two-room dwelling…the interior faces of these were covered with mud plaster and coated with a thin laminum of fine plaster, often decorated with red ochre. Floors were made of a high-quality plaster burnished to a high gloss and frequently painted red. Sunken plastered hearths are characteristic of the main living quarters, while the second rooms appear to have functioned as storage and/or food processing areas (Simmons and Rollefson 1984:389).

Here the excavators have interpreted the buildings in terms of modern properties, for example spaces are described as ‘main living quarters’.

<table>
<thead>
<tr>
<th></th>
<th>Maximum area of individual buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ain Ghazal</td>
<td>40 m²</td>
</tr>
<tr>
<td>Beidha</td>
<td>38 m²</td>
</tr>
</tbody>
</table>

Table 3.6: Comparison of maximum floor surface of individual buildings from Ain Ghazal and Beidha (source: Ain Ghazal (Banning and Byrd 1984), Beidha (Byrd 2005b)).

Amongst the architectural variations at Ain Ghazal were semi-subterranean corridor buildings similar to the pier buildings excavated at Beidha. For example, House 12 in Ain Ghazal is very similar in plan to Building 10 in Beidha (figure 3.16). The strong similarities between these building types, despite their attribution to separate cultural phases, has placed a question over the dating of the final phase of occupation at Beidha.
Associated architectural features

Despite the similarities in the basic construction technique seen at Ain Ghazal, individual variations in architectural form and in the design of associated features were also noted. For example, one structure incorporated the construction of a high mudbrick ‘counter’ in one room, while another structure’s floor contained a raised plaster ridge, possibly used as a drainage device. All of the structures seemed to have been modified and renovated during their use-life (Simmons and Rollefson 1984:389).

Buildings were excavated with hearths and associated sub-floor burial pits. Hearths, set with the plastered rims flush with surface of the floors, were approximately 0.70m in diameter curving downward into bowl-shaped depressions approximately 0.10m to 0.14m deep.

Further research issues

Some of the wider PPNB issues raised by the excavators of Ain Ghazal included social organisation, ritual/religious practices, environmental impact, and political associations within a local and regional network (Simmons and Rollefson 1984:394). These issues can only be partially discussed based on the limited published material available and can only be fully pursued following the full and comprehensive publication of the excavation material. Meanwhile, the experiments conducted at Beidha aim to address some of these wider PPNB issues considered here.

3.1.3 Summary of Pre-Pottery Neolithic Architecture in Southern Jordan

Neolithic architecture is thought to be more than simply a shelter and is perceived as “the private and concrete expression of a particular family group” (Watkins 1990:344). In contrast to the more ephemeral architectural remains from the PPNA, the common PPNB architectural features, according to Banning and Byrd, are rectangular buildings of stone or mudbrick, plastered and often also painted red, burials beneath floors, and dense concentrations of houses with courtyards and lanes separating them (Banning and Byrd 1984). As such, the domestic architecture of the PPNB was at one time thought to show remarkable adherence to a standard, megaron plan: a square room entered through a porch and with a roof supported by two posts. Evidence from recently excavated sites such Shkakat Msaied, along with existing evidence from Beidha, would now begin to suggest that there is not a general plan for PPNB architecture, but instead a wide variety of types ranging
from circular to complex rectilinear structures. The growing body of known and excavated PPN sites in Jordan is changing our perceptions of what is common or standard in the period.

Environmental constraints, such as the availability of raw materials, do not by any means explain the range of variation present (for example the honeycomb arrangement versus free standing structures at Beidha). Rollefson (1987b) suggests that ‘fundamental ethnic variation’ was present in the southern Levant such that common regional cultural traits were expressed distinctively at each settlement. Redman (1983) suggests that this variability was linked to the growing importance of agriculture and food storage, and to a restructuring of the entire range of daily activities associated with the specialised production of artefacts and materials. There was much experimentation and change in the organisation of space and in the materials and techniques employed, with some of the innovations continuing for long periods while others were quickly abandoned (Smith 1990:323). Redman (1983) has also suggested that circular structures reflect specialised processing or manufacturing activities as well as storage (in contrast to pier buildings whose functions, he suggests, related to food storage and single-family residence).

PPNB architecture, as seen at Beidha, Ba’ja, Basta, and Shkarat Msaied, clearly indicate a transition from circular to rectilinear structures in accord with Upper Euphratine evidence, as seen as at Jerf el Ahmar (Stordeur 2000). Beidha, the only site with both styles represented, shows that the architectural styles were punctuated by a phase characterised by an intermediary sub-rectangular building form. In contrast to the fairly homogeneous circular architecture at both Beidha Phase A and Shkarat Msaied, the rectilinear architecture at Beidha Phase C, Ba’ja and Basta exhibit a wider diversity in architectural form and construction methods. The similarities and differences in architecture from phase to phase and from site to site raise several issues that the experimental programme at Beidha attempts to address, including -

- Why change from circular to rectilinear style as seen at Beidha, and also seen when comparing Shkarat Msaied and Ba’ja?
- Does the transition is architectural style reflect a change in economic lifestyles and an increasing need to store agricultural produce?
- Did the transition accommodate a shift in social organisation and a desire to segregate extended family units?
Chapter Four
Review of a sample of experimental sites

This chapter critically reviews five experimental archaeology sites that I visited between the spring of 2001 and autumn of 2005. These sites are Lemba Experimental Village, Khirokitia, Butser Ancient Farm, Howick Project, and Archaeolink Prehistoric Park. The sites varied greatly in scale, budget, and objectives (e.g. research, education and/or tourism) but each example was chosen for my study because of its relevance to prehistoric architecture, and/or its location, and/or its prominence in the public eye.

Previous critiques of experimental sites include Petersson’s work in Scandinavia and Masriera I Esquerra’s work in Spain. Bodil Petersson (2003) carried out an extensive review of archaeological open air centres, reconstruction of maritime vessels, and re-enactment events in Scandinavia. That review identified national and regional interests as well as contrasting objectives apparent on individual sites including: scientific vs humanistic; showing vs proving; identification vs alienation; and physical reconstructions vs mental images. Clara Masriera I Esquerra carried out extensive research on the presentation of Bronze Age and Iron Age sites in Europe using reconstructions (Masriera I Esquerra 2007). Her hypothesis was based on the fundamental assumption that visitors struggle to conceptualise physical space and therefore reconstructions help them to understand the space better. Her results showed that this was indeed the case and, more importantly, archaeological sites without reconstructions could actually lead to a decreased understanding of European protohistory on the part of the public.

I will begin my review by detailing each site, providing information gathered from literary sources and observations from field visits. Each site is then assessed on its varying levels of success as an experimental site, before drawing a conclusion on the placement of experimental archaeology in public settings compared and contrasted with its placement within an academic environment.

4.1 Experimental sites

Project: Lemba Experimental Village, Kissonerga - Cyprus
Built by: Gordon Thomas (University of Edinburgh)
Maintained by: Paul Croft
Features: Seven experimental Chalcolithic roundhouses built alongside an archaeological site

Entrance fee: free (voluntary contribution box on site)

Webpage: http://www.arcl.ed.ac.uk/arch/lemba/

Background

Lemba is a Chalcolithic site in southern Cyprus that was excavated by the University of Edinburgh from 1976 to 1983 (Pelttenburg 1985). The Lemba Experimental Village, established in 1988, intended to examine our understanding of Chalcolithic buildings and help develop models regarding the formation processes on archaeological sites by observing full-scale reconstructions of buildings from the Chalcolithic period (3500-2800 BC) (Thomas 1999). The project also intended to provide visitors to the site with an insight into archaeology through a changing programme of experiments based at the visitor centre.

Comments from project publications

The published material from Lemba Experimental Village is primarily academic in nature (Thomas 1989, 1995, 1999, 2005) with the exception of a short visitors’ guide printed in 1999 (Croft et al. 1999). Available papers focus on prehistoric building traditions, Chalcolithic architecture, the formation of archaeological sites, and the role of education and research in experimental projects. According to these publications the aim of the experimental village was to “explain some aspects of the workings of archaeology through the medium of an ongoing and dynamic research project” (Thomas 1999:109). The experiments consist of several houses built using different materials and different designs, and left at different stages of construction and collapse. These structures were specifically made to enhance our understanding of archaeological site formation processes by observing the effects of building construction, use, decay and collapse. They also provide a test ground for archaeological questions such as survival rates of materials, methods of collapse, rate of accumulation of varying deposits, and decay history of a building.

In addition to gaining a better understanding of the processes involved in site formation and Chalcolithic architecture, the experimental village at Lemba was designed to provide an educational tool in the form of an archaeological visitor centre. Education on site was to be aimed at two main audiences: professional archaeologists (including university students) and tourists.
Comments on the experimental site

Lemba Experimental Village project clearly contrasts with the World Heritage Site of Khirokitia (described below) in terms of the financial support received. At Lemba there is no entrance fee, no public toilets, and the pathway is merely a beaten track. In contrast to Khirokitia, Lemba attracts fewer visitors – perhaps only 8000 a year (Thomas 1999). The relaxed atmosphere of the site reflects that of the majority of sun-seeking holiday makers that visit the site during the summer.

The site is small and inviting though is clearly not maintained adequately (figure 4.1). Arguably, the charm may be in its informality compared to a developed and sanitized appearance. However, proper care and maintenance of an archaeological site should be considered as a priority over and above the romantic appearance of ruins. There is no permanent research staff here, nor do funds allow for a caretaker or guard to tend to the site on a routine basis. Even though some of the excavated areas have been partially backfilled, the remaining exposed archaeology seems to be neglected and in a poor state of conservation with some remains being consolidated with a type of cement that now is causing more harm than good. Weeds have become well rooted and are damaging the archaeological remains.

The Experimental Village lies immediately adjacent to the excavated area (figure 4.2). The location of the experimental village places it in an ideal position to enhance visitors’ understanding of the archaeological remains. However, based on observations I made of visitors to the site, the experimental buildings dominate the site and distract the visitor’s attention away from the significance and importance of the archaeological remains. The experimental buildings were not originally designed for tourists, but with the encouragement of the local village cooperative these buildings have subsequently been overwhelmed by the need to cater for tourism and in the process have lost their potential as a research tool. The negative impact of tourists can be seen in the damage, both accidental and intentional, to experiments in progress, in particular those involving the monitoring of the rate and nature of decay of buildings. The largest of the experimental roundhouses now functions as a visitor centre, in contrast to the reconstructions in Khirokitia, it does contain some information on the site and related finds.

The literature says that the project aims to examine the current understanding of Chalcolithic architecture, the formation of architectural remains in the archaeological record as well as to provide visitors with an example of a Chalcolithic village (Thomas 1999). These three main aspects of the experimental project can be characterised by the three central individuals...
involved in the Lemba Experimental Village: Eddie Peltenburg, Gordon Thomas and Paul Croft, who focus on cultural history, experimental archaeology and site presentation respectively. However, on site the value and purpose of Lemba Experimental Village is unclear. These three main aspects of experimental projects do not appear to be compatible in the programme of archaeological work carried out at Lemba and, as Thomas has indicated, the experimental value of the site has diminished whilst its role as a visitor resource has taken over (Thomas 1999). It is unfortunate that the presence of visitors at Lemba, and potential interference they cause, has negated the scientific value of the experimental structures.

Despite the increasing influence of tourism at the site, the transition from a research area to a visitor attraction is not complete. The site has been consolidated, pathways created and notice boards erected in what the published literature claims to be an attempt to “explain the archaeology to the general public and to relate it to the various aspects of the project of experimental archaeology which will develop over the years to come” (Thomas 1999:115). However, although the signs posted on site are informative and concise (figure 4.3) they do not make clear the relationship between the archaeological evidence revealed by the excavation and the adjacent experimental structures. A clear tension exists between the need to maintain these structures as a centre for tourists and the use of these structures for scientific experiments. This can be seen on site when faced with the decision to either let structures collapse for scientific study or rebuild structures, complying with health and safety regulations, to serve the tourism industry. Consolidation and rebuilding in line with visitor requirements seems to triumph at Lemba.

*Assessment of the site*

Lemba Experimental Village is a success in its deliverance of data for enlightening archaeological interpretations on site, if judged by the various research papers published to date (Thomas 1989, 1995, 1999, 2005). However, the transition of the site from research to education and entertainment, if that is the chosen path of the project, is incomplete. The organisation and management of Lemba Experimental Village has illustrated the tension that can exist between conservation and exploitation, and between research and tourism.

The objectives established at the Lemba Experimental Village parallel closely with those recently set at Beidha. Lemba therefore provides a cautionary tale of the difficulty of finding the balance between research and tourism.
Project: Khirokitia - Cyprus
Built by: Odile Duane-LeBrun
Features: 5 experimental aceramic Neolithic roundhouses alongside an archaeological site
Entrance fee: small fee

Background
Khirokitia, an aceramic Neolithic site, was designated as a cultural World Heritage Site in 1998 for its outstanding preservation and important role within the prehistory of the Mediterranean region. The site covers approximately 1.5ha in the foothills of the Troodhos massif, in southern Cyprus. The site consists of a series of Neolithic villages, dating from the eighth to seventh millennium BC, and has been periodically excavated since 1934 (Le Brun 1997).

Comments on the published literature
With the rising number of visitors to the site and increasing concern for the site’s protection, the Ancient Monuments section of the Department of Antiquities of Cyprus initiated a project to “preserve the authenticity of the Neolithic in its entirety, to protect the human and natural surroundings, and to provide richer information by the creation of a Visitor Centre” (Le Brun 1997:61). This visitor centre took the form of experimental reconstructions of five Neolithic buildings (figure 4.4). The reconstruction of Neolithic houses was seen as preferable to constructing modern buildings as a means of interpreting and presenting the archaeological remains to the visitors.

Research-based publications on the experiments carried out at Khirokitia include occasional references within interim reports written by the principal excavator of the site, Alain Le Brun. However, these deal predominantly with the excavated material (e.g. Le Brun 2001, 2005). The aim of the experiments seems to have been to create an opportunity to test hypothesis concerning the construction techniques and materials of the structures at Khirokitia and in particular to explore the techniques used in building in pisé and earth (Daune-Le Brun 2001, 2002). Similar research into techniques used in mudbrick constructions has been carried out on a Neolithic house at Çatal Höyük by Mirjana Stevanovic (Stevanovic 1999).
Comments on the experiments

Its World Heritage Site status brings with it numerous conveniences for the tourists at Khirokitia, including clear road signs leading to the site, large visitors signs at the site, a small collection of tourist shops, a car park large enough to accommodate several buses, toilets at the gate, and a small ticket office with site guidebooks (figure 4.5). Visitors pay an entrance fee of only 75 cents at the ticket booth, where they can also purchase comprehensive guidebooks. A clean and organized appearance is conveyed by the new World Heritage Site ticket booth, toilets and pathways.

Unfortunately, the experimental structures at Khirokitia do not fulfill the requirements of a visitor centre in that no information is provided in or near the experimental reconstructions themselves. There are no signs to explain the presence of the experimental reconstructions, their relevance to the archaeological site, nor their significance in relation to archaeological research on the Neolithic period. Luckily there are signs posted on the archaeological site to explain its various complex features, however these do refer back to the experimental reconstructions which the visitor will have seen first.

The reconstructions have been built along the footpath leading from the ticket office to the archaeological site. Before climbing the hill to the excavated site, visitors can pass through the archaeological park to see the reconstructed village. This provides the visitors with a visual image of the Neolithic village which many visitors would find helpful before they approach the archaeological remains (figure 4.6) - if they were told what they are passing. The reconstructions, based on the archaeological evidence from the site, have circular ground floor plans and are constructed of light-coloured limestone foundations with mudbrick walls. The interior and exterior faces of the walls are covered in whitish earth plaster with the occasional visible stone set at the base to protect the walls from alluvial erosion. The roofs are flat, constructed using a wooden frame layered with plants, twigs and reeds, then layers of pisé and earth. The structures are built to a high standard with an emphasis on aesthetics and tidiness. There are metal bars across the entrances of the reconstructions preventing visitors from entering them (figure 4.7).

Unfortunately, these physical barriers and the nature of the maintenance of the structures have led to a sterile portrayal of the Neolithic here. This is the main drawback with the reconstructions at Khirokitia: there is a low level of interaction. One of the main advantages of using Neolithic reconstructions for a visitor centre must surely be the creation of at least
one building that visitors can explore. Instead the bars on the windows and doors prevent the visitors from truly experiencing the buildings. As with the viewing platforms on the archaeological site, the physical barriers reinforce the distance between the visitor and the Neolithic experience. Additionally, the reconstructions appear immaculate in construction and have benefited greatly from knowledge gained from skilled workmen using local traditional building techniques, for example in the making of mud bricks for the wall. Primitive technology does not necessarily imply crude craftsmanship, however the finished product at Khirokitia has the air of a polished modern vernacular, and not prehistoric, structure. Once again this distances the viewer from a deeper understanding of the Neolithic. It may not have been a deliberate decision by the experimenters to provide visitors with a sterile image of an aceramic Neolithic village, but perhaps was an unfortunate consequence of a decision aimed at protecting the reconstructions and in situ archaeological remains from attrition by visitors, together with minimising maintenance costs as well as ensuring the safety of visitors.

Along the pathway leading up the hill to the excavated site are various information points. These include relevant, although long, excerpts from the guidebook and are written in Greek, English and French. They also include plans and reconstruction drawings to further help the visitor understand the archaeological remains. A wooden fence around the site prevents visitors from straying onto the excavated areas and protects all the archaeological remains from visitor erosion. Selections of structural remains have been further protected by an array of consolidation methods ranging from the application of types of cement mortar to the excavated features through to the construction of large shelters. The site as a whole is easily viewed from two wooden walkways that provide panoramic views over the excavations.

Assessment of the site

The project aimed to preserve the authenticity of the Neolithic site, and to protect the human and natural surroundings, while providing a richer source of information to visitors to the site (LeBrun 1997). However, the experimental value of these reconstructions is very unclear to a visitor. The structures do not seem to contribute to an experimental programme to further our understanding of formation processes or other issues regarding Neolithic architecture; neither do these reconstructed buildings serve as a visitor centre because of restricted access to them and the lack of information boards.
The objectives of the reconstruction project at Khirokitia may parallel those set at Beidha, for example providing a richer source of information to visitors. However, the execution of the objectives are contrasting. At Beidha the emphasis was placed on the use of experiments for research and education purposes, which further led to presenting the experimental results to visitors. At Khirokitia the visitor centre, and not the experimental process, remained focal.

*  

**Project: Butser Ancient Farm**, Hampshire - England

*Built by:* Dr Peter Reynolds, currently directed by Christine Shaw

*Maintained by:* Friends of Butser Ancient Farm

*Features:* experimental reconstructions are on-going and currently include four Iron Age roundhouses and associated features, one Roman villa, a series of earthworks, a weather station, crops and livestock, a geophysics area, and a small indoor visitors shop.

*Entrance fee:* fee

*Website:* [www.butser.org.uk](http://www.butser.org.uk)

**Background**

Butser Ancient Farm, in the Hampshire countryside, was founded in 1972. Essentially it can be described as a replica of a British Iron Age farm from circa 300 BC consisting of structures, livestock, crops and earthworks (figure 4.8). Butser Ancient Farm does not accompany an archaeological site, instead the reconstructions are based on evidence from various sites in Britain including Longbridge Deverell, Pimperne, Moel y Gerddi (Wales), Balksbury, Glastonbury Lake Village and Longdown. In recent years Butser Ancient Farm has also started experimenting in features from the Roman period, such as a villa from Sparsholt, to make it more compatible with the English school curriculum. The striking element of this site, compared to the majority of experimental centres, is that it is a permanent and continuous working farm and not a one-off reconstruction. Despite moving locations from its former site in the early 1990s, it is also a centre for very long-lived experiments.

**Comments on the literature**

Butser Ancient Farm project has led to many publications aimed at two main audiences: archaeologists and students of all ages. This reflects the project’s primary two-fold objectives: to form an institute of archaeological research and interpretation; and to form a centre of presentation of prehistory and history for students. In other words, Butser is aimed
at archaeologists and students, with less focus on the general public. It is highly successful at achieving these two objectives. Looking at the two aims, research and education, separately brings further insight into the workings of Butser Ancient Farm.

According to the guidebook, Butser Ancient Farm is an unusual place in that it is designed as a “unique open air laboratory devoted to exploring by direct experimentation the problems and theories which emerge from archaeological excavations” (Reynolds and Shaw 2000). This site and its aims are not unique, however its ability to fulfil its aims over the long term in Britain is unequalled. It has achieved this through an on-going programme of experiments dealing with all aspects of ancient and prehistoric life including agriculture, husbandry, architecture, and crafts such as weaving and metalwork. As such, Butser is a full-scale research programme in which modern science is applied to ancient problems (Reynolds 1978).

The results, as well as the various methodological approaches, from the experiments carried out over the years at the farm have been diversely published in journals (both international and local), a series of collected papers, conference proceedings, books and chapters within edited volumes (Reynolds 1978, 1979, 1982, 1994, 1995a, 1995b, 1995c, 1999, 2000, 2006; Reynolds and Shaw 2000). Articles were also published in an array of amateur society newsletters, highlighting the importance of the participation and interest of amateur societies in the successful running of the project. The experiments bring an insight into the construction of Iron Age houses, notably the shape and design of their thatched roofs; in addition the experimental process enlightens excavators regarding the formation of archaeological deposits. For example, in the construction of the replica of the Balksbury House it was noted that deep grooves in the ground were formed whilst the rafters were manoeuvred into position. An explanation for such groove-like features had previously eluded archaeologists.

The archive of publications and records relating to Butser Ancient Farm is stored at the Hampshire Record Office (accession number 63AO5D3).

Comments on the experiments
The experimental farm moved from its original site to its current location in 1991. This move reflects awareness of the increasing interest in the educational value of the experiments. The original site at Little Butser was difficult to access and could not
accommodate large numbers. Research continued at Little Butser until 1989 whilst visitors were directed to the new site.

Its major contribution may well be non-academic since it provides for the general public, schoolchildren, students and even professional archaeologists, a new appreciation of the Iron Age (Reynolds 1978:151).

Students can appreciate the site through an array of events and activities that predominantly involve hands-on experiences (figure 4.9). The focus on educating students, perhaps at the expense of ignoring the general public, can be felt on site. Additional information on experiments is posted nearby for those visitors seeking more details (figure 4.10). A guidebook with all the relevant information is available for purchase; however reading the guidebook in wet weather (as is often the case) is not ideal. Admittedly information boards placed on sites can detract from the aesthetics and ‘feel’ of the reconstructions, and they are inflexible in their content and constantly require up-dating, equating to a rather costly exercise. Perhaps the lack of information available to visitors on site is not relevant in Reynolds’ opinion if we consider that “even if the details of the structure is in error, the space it confines and the materials with which that space is confined is accurate” (Reynolds 1978:151). Experiencing the Iron Age is at the heart of Butser Ancient Farm.

Assessment of the site

The literature may place a focus on the scientific research and be targeted at students, however the hands-on experience offered to all visitors to the site establishes Butser as a centre for everyone to learn about the past. Attempts have been made to appeal to all ages and interests through the array of publications, guidebooks, activity packs, and souvenirs available at the visitor centre and shop located on site (figure 4.11).

For many years Butser Ancient Farm has made a significant contribution to our understanding of the Iron Age and Roman Period, both from an archaeologist’s point of view and for members of the general public. But could the success have been down to the driving force and motivation of one man, Peter Reynolds? Indeed, all contributions to archaeological research from Butser Ancient Farm were penned only by Reynolds. The site has continued to thrive in the public eye since his untimely death, thanks to the work of groups of volunteers. However, the next few years will indicate whether the success of such a specialised research site was overreliant on the experience, dedication and enthusiasm of one individual. Will the archaeological experiments conducted at Butser continue to be
published and feedback into archaeological excavations, or will the focus turn more heavily towards tourism?

The objectives of a small-scale experimental project such as Beidha can not be compared with the array of publications and activities at Butser Ancient Farm. However, scaled down Butser provides an ideal model of how to balance experimental research aims with the needs of the public.

* Project: Howick Project, Milfield, Northumberland - England
Built by: Clive Waddington
Features: reconstructions of a Mesolithic hut and a Neolithic henge as part of the Maelmin Heritage Trail.
Entrance fee: free
Website: www.ncl.ac.uk/howick/reconstruction/reconstruction.htm

Background
In addition to the construction of a Neolithic henge, an experimental reconstruction of a Mesolithic hut was built at Milfield in 2002 as part of the BBC series Meet the Ancestors (figure 4.12). The construction replicates archaeological evidence from the excavation of a Mesolithic hut at Howick, Northumberland.

Comments on the literature
The literature currently available concerning the reconstructions is two-fold: on the one hand is the archaeological report from the excavations at Howick (Waddington et al. 2003); and on the other is the archaeological guide for the heritage trail at Maelmin (Waddington 2001). The excavations at Howick were carried out to recover remains threatened by coastal erosion. The excavations revealed the remains of a Mesolithic hut delineated by a dark circular stain in the sand. The structure, further defined by a circle of postholes and stakes, is thought to have been approximately 5m in diameter (Waddington et al. 2003). The occupation is dated to around 7800 BC (cal) from carbonised hazelnuts recovered from hearths inside the hut; the structure is thought to have been rebuilt twice during its 100-year use-life. The excavators argue that the evidence indicates that this may represent one of the earliest permanent settlements represented by a built structure in Britain.
The main publication to date concerning the reconstructions (but excluding the Mesolithic hut) is *Maelmin: an archaeological guide* (Waddington 2001). This beautifully illustrated booklet introduces readers to what life may have been like in the area during the Mesolithic, Neolithic, Bronze Age, Iron Age, Roman Period and Medieval Period. With supporting archaeological evidence, Waddington describes experiments carried out when building a henge, using primitive tools, brewing, and making clothes. Unfortunately, the experimental reconstruction of the Mesolithic hut, carried out a year after the booklet was printed, is not yet published.

*Comments on the experiments*

Visitors to the site are free to wander around the reconstructions placed along a heritage trial in a quiet rural location. Once again, very good illustrations on information boards draw the visitor into the site (figure 4.13). The reconstruction of the Mesolithic hut built in 2002 consists of large timbers with hazel rods woven between poles to support the main framework. The roof was thatched.

*Assessment of the site*

As yet the experimental archaeology at Maelmin has only been described in small booklets for visitors and on television programmes, and has not been discussed in archaeological publications. It is unfortunate that, as yet, the work has not been critically assessed by the experimenters for its potential contribution to archaeological research. Equally, it has not been fully described in the guidebooks for the site. A subsequent experimental reconstruction using different construction materials and design was built near Howick in 2005 and one can only hope that this experiment will also be published soon. The experimental value of the reconstructions has not yet been shared with its audience, both academic and public.

The aims of the reconstructions at Howick remain unpublished. However, when drawing parallels with the Beidha Project it can be noted that some of the experiments at Howick and Beidha are similar, for example both sites explore the construction of roofs. However, Howick appears to have relied on experiential data and lacked the scientific observations that were deemed essential in the experiments conducted at Beidha.
Project: **Archaeolink Prehistoric Park**, Aberdeenshire - Scotland

**Built by:** Dr Hilary Murray

**Features:** reconstructions of a Stone Age camp, a stone circle, a henge, a Bronze Age cist, a Bronze Age smithy, an Iron Age farm, and a portion of a Roman Marching Camp. The centre also includes an excavation of an Iron Age enclosure and an indoor exhibition.

**Entrance fee:** fee

**Website:** www.archaeolink.co.uk

**Background**

Archaeolink, which opened to the public in 1997, is a tourist attraction that presents 10,000 years of northeast Scottish history. According to the glossy leaflet, Archaeolink is an “all-weather facility based on prehistory” (though this short statement, in itself, is inaccurate because it also presents a historical reconstruction of a Roman Marching Camp). The ‘living history’ park is very strongly aimed at entertaining families and especially small children, by providing a playground, sand pit, and activity sheets. It focuses on entertainment, education, and participation. The indoor facilities include a café, shop, display rooms, two exhibitions, and a video gallery (figure 4.14). The car park has capacity for several coaches.

**Comments on the literature**

The details of reconstructions at Archaeolink have not been published. The only published material concerning the site is a series of education packs available for history classes within the school curriculum.

**Comments on the experiments**

The indoor facilities are modern, consisting of large open spaces, a gift shop, coffee shop, and exhibition rooms housing introductory films on Scottish prehistory and a series of interactive displays. It is clear that the park has run low on resources and the outdoor exhibits have suffered as a result. The reproduction of images on signs outdoors is incredibly poor, with the text being almost illegible and often much too long (figure 4.15). At the time of my visit in 2004, many display boards were empty, or in other instances did not relate to the adjacent reconstruction. In contrast the display boards in the exhibition hall were interactive and of high quality.

The most impressive reconstruction is of an Iron Age house measuring 10m in diameter, with walls of wattle coated in clay, and roofed in heather thatch. However, the experimental value, if there ever was one, of the structure and the park as a whole has been lost. For example, joints in the prehistoric structures have been clearly reinforced using modern metal
bolts and supported with modern materials (figure 4.16). In other instances attempts to be ‘authentic’ have been half-hearted, for example staff dress in prehistoric costumes but wear trendy modern shoes.

In addition, the stone circle reconstruction does not do the prehistoric structure justice. It is supposedly based on the stone circle at Easter Aquhorthies, but the dimensions of the circle are not the same, the stones are smaller, it lacks a ring ditch, has been built in a hollow rather than on a hill, and is missing stones. The sense of place and atmosphere, and in essence the true meaning and popular mystical attraction of stone circles has been lost.

Assessment of the site
This site was built to cater for the public with the focus placed on facilities, access and safety. Contrary to the initial plans it has not been developed with experimental archaeology in mind, nor does it contribute towards archaeological research in the prehistory of north-east Scotland. The reconstructions are not successful even within the limited objectives of providing public entertainment – only the indoor visitor centre is a success. As such there are no parallels from this site to be drawn with the experimental objectives proposed at Beidha.

4.2 Successes and Failures

The five examples cited here have succeeded to varying degrees in developing experimental reconstructions through examining and interpreting the archaeological evidence. However, in assessing the success of placing these experimental archaeology projects in a public setting I have, without hesitation, discounted the work carried out at Archaeolink simply on the grounds that the reconstructions do not represent experimental archaeology (see Chapter 2 for definitions of experimental archaeology). Instead they are simply constructions of prehistoric and historic buildings. I would not, however, discount the value of the site which lies instead in its ability to provide young children with an arena, like ARCHEON in the Netherlands (Ijzereef 1999), in which to learn about the past through hands-on activities and hopefully begin to understand at a young age the need to appreciate and conserve our history.

Of the remaining four sites studied here, Khirokitia is an example of how experimental archaeology can fail to make a contribution to archaeology. The key at an experimental site is communication, both to archaeological researchers and to the general public through
multiple publications off-site and information on site. The stones and mortar of a reconstruction only tell a small part of the story. As illustrated in Chapter 2, the defining elements of experiments include their cyclical nature and the continual process of trial and error which helps to provide a series of possible interpretations. Without communicating these defining elements of experimental reconstructions, the built structures will present, at most, a stimulating visual recreation devoid of interpretation. No doubt the structures at Khirokitia represent a thorough examination and well-considered interpretation made by the project directors of the archaeological evidence from the nearby excavations. However, they have neglected to educate visitors on the significance and value of experimental reconstructions and thus exploit their potential role as educative tools in both archaeology and conservation. Also, the limited publication of the academic aspects of the reconstruction work greatly restricts its contribution to archaeological research.

These sites have shown that, for the majority of cases, the ideal experimental programme in which a prolonged set of experiments can be carried out is virtually impossible. Despite strong, valid research agendas, such as those at Lemba, the experimental value of the site can be jeopardised by the increasing presence of visitors to the site. Ideally all experimental sites would retain the scientific value of projects such as the Experimental Earthworks Project. This project incorporates experiments carried out on Overton Down (Wiltshire) and Morden Bog (Dorset) that started in 1958-1960. The overall objective is purely scientific in nature in that it aims “to study short and medium-term changes in order to help bridge the gap between contemporary observations of environmental processes and the much longer timescales with which archaeologists are concerned…a new understanding could be brought to the way in which the archaeological record is formed, preserved and recovered” (Bell et al. 1996:1). The experiments are based on a progressive timescale of 1, 2, 4, 8, 16, 32, 64 and 128 years. There is no attempt within the Project to invite the public to experience the archaeological earthworks or witness the formation processes. In so doing it has retained its scientific value and hence contributes purely to archaeological research.

So what lies between these two extremes: the entertainment visitors can find at Archaeolink and scientific archaeological research carried out on the Experimental Earthworks Project? We can turn to Butser Ancient Farm for some answers to the successful placement of experimental archaeology in both a public and academic setting. Firstly, there is a long list of publications (Appendix 2.1) relating to the site, both for specialists and the lay-person, which stand as testament to the director’s dedication to disseminating the insights gained through experimentations at Butser Ancient Farm. Admittedly the site has a long active
history, over 30 years, from which to draw conclusions and write papers. On this point it is important to note that the publications begin in its early years of development (for example, Reynolds’ article on *The Butser Ancient Farm Project* printed in the Bulletin of the Birmingham Archaeological Society in 1975) and continue to this day (e.g. Reynolds 2006). In contrast the early findings of experiments at Howick remain unpublished. Secondly, the director’s attempts to educate the lay-person gained pace over the decades as the public’s demand for it grew. The site has adapted to the needs of the national school curriculum as well as appealing to a wider audience through popular television programmes. Thirdly, full-time staff and enthusiastic volunteers ensure that visitors to the site take away as much information as they wish concerning the houses, crafts, livestock, crops, and food of people living in prehistoric and historic Britain. These three points have focused on communicating with its audience. The fourth and final point to make is the importance of the experiments themselves. Both researchers and lay-persons want to witness and experience a part of the experimental process, especially one that is active and ongoing. A perpetual and valid programme of experiments is essential to inform archaeological research and captivate the wider public.

4.2.1. Summary of Failures

The main weaknesses of the experimental archaeology sites I visited during this study can be summarised as follows:

1. Ignoring the fundamentals of experimental archaeology, such as the use of modern technology to an extent where it interferes with the experiment (see Coles 1973).
2. Not publishing or disseminating the results of experiments conducted, and thus interrupting the cyclical nature of experiments as they continually feed back into research and new hypotheses are tested (see Reynolds 1978).
3. Inadequate management of visitors, their needs and the impact on the experiments.

4.2.2 Summary of Successes

The main strengths of the experimental archaeology sites can be summarised as the following:

1. An ongoing and active programme of research
2. Publications to appeal to a wide audience, including general guidebooks for visitors and more specialised reports for researchers
3. Providing a means by which visitors can interact with the experiments, ranging from full hands-on experience to access into experimental buildings
**Chapter Five**

**Experimental objectives**

5.1 **Introduction**

The rewards of using experimental archaeology to obtain a better understanding of archaeological remains were well highlighted by Coles:

…it has been stressed that those who fail to exploit the experimental approach do so in the knowledge that they neglect one of the very few mechanisms which can transform hypothesis into legitimate inference (1979:243).

Generally, the experiments at Beidha intend to expand our current comprehension of the early Neolithic, its architecture, culture and people.

The archaeological reconstructions at Beidha provide a series of *cognita comparanda* for field archaeologists to use when excavating early Neolithic sites in the Levant, as the Experimental Earthworks project has done for our understanding of ditch sections in lowland southern Britain (Bell *et al.* 1996). Ideally the experiments at Beidha should improve our understanding of the physical evidence used in developing archaeological interpretations of sites in southern Jordan, the Levant, and beyond; they were designed explicitly with this aim in mind.

The objectives of the experiments at Beidha are presented in this chapter. The evidence available was examined to develop hypotheses addressing various unanswered questions relating to the early Neolithic architecture at Beidha. Like Reynolds’ Pimperne building, the reconstructions are site specific. For example, the dimensions of an excavated structure accompanied by evidence of charred timber remains led to hypotheses concerning the form of superstructures. Hypotheses such as these were collated to form the objectives behind each experiment. Therefore the experiments are based on hypotheses developed after a thorough examination of the available archaeological evidence. At Beidha the evidence available for study took the form of:

- archive photographs,
- a recently published monograph based on the excavations (Byrd 2005b),
- *in situ* remains, and
- preliminary evidence obtained from specialists carrying out ongoing and/or unpublished analysis on archaeological evidence, such as plaster sampling (Rehoff-Kaliszan 1998).

Developing clear objectives before carrying out experiments is important for four main reasons. Firstly, they help establish a framework within which to work. In essence the framework of objectives establishes a logical sequence of questions that should provide answers in which to set further investigations. Secondly, unambiguous objectives help to clarify what is established knowledge, what is not known but knowable, and what is unknowable about a site or artefact. In the process of formulating hypotheses and objectives, details of the archaeological remains at Beidha were questioned and then reconsidered; this is undoubtedly a strength of the application of data from a single site. And thirdly, objectives help maintain focus on the research issues to ensure that the relevant information is gathered on site as the experiment is carried through. The more data considered and collected during the experimental stage, the more research opportunities available to explore and to review the analyses afterwards. For example, comments on the relative energy costs in the construction of circular versus rectangular structures can only be made if records of working hours are routinely kept on a daily basis. In this way a clear framework ensures that all relevant data is available for analysis at the end of the experiments. Problems and inconsistencies arise trying to fit models to inappropriate data or attempting to align data with altered research objectives. The fourth aim in developing clear objectives in these experiments was to ensure that a minimum of subjectivity and maximal objectivity were applied to each experiment; such procedures increase the future merits of the site, and ensure repeatability of the experiments by myself or another investigator.

Having established a number of research questions at Beidha, I developed a series of hypotheses that could be tested through experimentation. A framework of objectives (Table 5.1) ensures that any result, whether it confirms or contradicts a hypothesis, is observed and recorded. If need be further hypotheses and experiments can be carried out based on the observations.

A degree of flexibility was maintained in developing the list of objectives for the experiments at Beidha in order to accommodate additions and modifications resulting from issues and outcomes encountered while carrying out the experiments. Modifications to the list of objectives reflected changes in research agendas, technology available, techniques
employed, evidence made accessible, as well as the impacts of real world conditions such as restrictions imposed by government bodies, and variations in the make-up and skill level of the task force carrying out the experiments.

The majority of the objectives relate specifically to details of the structural form of early Neolithic architecture at Beidha. However, consideration of these inevitably leads to more complex issues such as social organisation, cultural evolution and transitions at Beidha and in the wider context of the southern Levant. For example, the change from circular to rectangular structures reflects not only innovations in local building techniques but shows changes in the use of space and perhaps reflects multiple cultural transitions in the village and region. This is what Odell and Cowan (1986) describe as taking data from lower-order research problems, using their example of questioning the correlation between the size of lithic points and the resulting damage, and implementing the data to address more complex issues, such as changes in prehistoric hunting practices and subsistence patterns.

At Beidha the experimental objectives address four main areas of investigation:
- details of PPN architecture,
- social implications relating to PPN villages,
- site formation processes, and
- presentation of prehistoric sites to the public.

The list below of experimental objectives (Table 5.1) is followed by a closer examination at the evidence available for each of the experimental constructions, followed by the hypotheses and unanswered questions that defined the objectives of the experiments. The methods and results of the experiments themselves are described in full in Chapter 6.

5.2 Experimental Objectives

Aim:
The primary aim of the reconstructions at Beidha is to use experimental archaeology to examine and interpret early Neolithic architecture. The aim is to use a series of experimental reconstructions to inform the debate concerning structural techniques used, size and organisation of early Neolithic settlements. This approach should further our understanding of the early Neolithic, its architecture, culture and people.
The experimental objectives are listed here beginning with simple practical estimations made in the field then progressing to analyses involving multiple observations in the field, more complex explanations relating to wider PPN issues, and finally, the Neolithic in the public eye. In the column to the right of each experimental objective is a brief description of the method used.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>To estimate the amount of time taken for the construction process</td>
</tr>
<tr>
<td>II</td>
<td>To estimate the labour expenditure needed</td>
</tr>
<tr>
<td>III</td>
<td>To assess the maintenance costs of a structure</td>
</tr>
<tr>
<td>IV</td>
<td>To analyse construction techniques</td>
</tr>
<tr>
<td>V</td>
<td>To analyse construction designs</td>
</tr>
<tr>
<td>VI</td>
<td>To analyse construction materials</td>
</tr>
<tr>
<td>VII</td>
<td>To evaluate the effectiveness of individual structures</td>
</tr>
<tr>
<td>VIII</td>
<td>To explain site location</td>
</tr>
<tr>
<td>IX</td>
<td>To evaluate the overall form of the structures</td>
</tr>
<tr>
<td>X</td>
<td>To determine function of individual buildings</td>
</tr>
<tr>
<td>XI</td>
<td>To analyse organisation of interior space</td>
</tr>
<tr>
<td>XII</td>
<td>To explain patterns of structural adaptations and re-use</td>
</tr>
<tr>
<td>XIII</td>
<td>To explain changes in architectural styles, from circular to rectilinear</td>
</tr>
<tr>
<td>XIV</td>
<td>To explain intrasite variability over time</td>
</tr>
<tr>
<td>XV</td>
<td>To analyse post-abandonment processes</td>
</tr>
<tr>
<td>XVI</td>
<td>To assess intentionality in prehistoric destructions</td>
</tr>
<tr>
<td>XVII</td>
<td>To evaluate the social organisation required for construction process</td>
</tr>
<tr>
<td>XVIII</td>
<td>To share with the public the intricacy of Neolithic life</td>
</tr>
</tbody>
</table>

Table 5.1 Experimental objectives developed at Beidha
5.3 Some notes on the objectives

Objectives I and II - To estimate the amount of time taken for the construction process; to estimate the labour expenditure needed

The records of the time and energy expended during the experimental reconstructions at Beidha represent approximations of the labour expenditure in building Neolithic structures. Other researchers have provided examples of experiments used to gain information “to estimate the amount of labour expenditure needed to accomplish certain tasks, to infer how many people such enterprises would require, and to explore the social implications behind the needed labour force, including the social and organisational requirements needed to mobilize a body of labourers” (Mathieu and Meyer 1997:333). Calculations of labour expenditure have been obtained through experimentation with varying degrees of success and accuracy. One such experiment involves recording readings in terms of calories burnt and minutes taken to complete a task. This can be achieved by gauging efficiency measured by oxygen intake and expenditure to calculate kilocalorie consumption with a Kofranyi-Michaelis meter (see Saraydar and Shimada 1971:216). I believe that the interpretation of the results of such experiments may be flawed in that they are constrained heavily by varying levels of skill, experience, fitness and ability in the labour force. And therefore such readings could only ever give approximate indications of energy expenditure. However, calculations of labour expenditure and time taken can be useful in determining the variables affecting the productivity of individuals within the labour force. A clear example would be calculations revealing that a healthy 20 year-old performs heavy labour better than a 70 year-old female, however some tasks may not depend so heavily on gender, fitness, or age. The calculations therefore provide a relative scale of labour costs.

Because of the limitations of methods such as the Kofranyi-Michaelis meter, a stringent recording system was not implemented at Beidha to record each calorie or every minute devoted to a particular reconstruction task. Instead the focus was placed on observations of the levels of skill, experience and ability needed during each stage of the construction process. Over the five years of experimentation an adequate assessment could thus be made of the average time and energy required for each task and the variables affecting the efficiency of the labour force. In other words, repeated observations on multiple experiments over an extended period provided an alternative to methods involving calorie consumption data collected during one isolated experiment.
The gathering of material, seen here as an integral step in the construction process, is also recorded through repeated observations.

**Objectives IV, V, VI and VII – To analyse construction techniques; to analyse construction designs; to analyse construction materials; to evaluate the effectiveness of individual structures.**

These objectives are interrelated and are seldom addressed in the experimental process without consideration to the other outlined objectives. In the same way that Mathieu and Meyer (1997) linked tool use to tool efficiency I set out to link construction techniques, design, and materials to a structure’s effectiveness. Mathieu and Meyer stated that “understanding the effectiveness of tools or a technological complex often requires a knowledge of how the tools were used and how efficiently they fulfilled their purpose” (1997:333). Similarly, examining use and efficiency of structures at Beidha has led to a better understanding of how the structures were built, what materials and technology were required, and how effective the finished structures were in providing shelter and protection.

**Objective VI – To analyse construction materials**

Through experiments we can understand the raw material, first hand. This understanding and knowledge of the material and its physical properties are essential when interpreting the behavioural characteristics suggested in the archaeological record (Odell and Cowan 1986). For example, pottery studies involve knowledge of interrelated variables such as temper and wall thickness –

…essential problem is to understand the nature of variables contributing to the observed phenomena and their interactions. This involves two aspects: the first concerns the exact physical characteristics depicted by variables, whereas the second reflects both the observer’s ability to extract relevant information and the fineness of the measurement system used (Odell and Cowan 1986:195).

As with production of artefacts, experiential knowledge of the exact physical characteristics of construction materials can best be gained through direct experimentation with the materials.

**Objective IX – To evaluate the overall form of the structures**

The form of the structures is here defined as their basic shape, in conjunction with the arrangement of their main features such as walls and doorways, and the visual aspect of their completed appearance. Identifying form in this sense from archaeological remains can reveal patterns that show distinctions between varying groups such as cultures, class and
gender. One such example in artefactual analysis is at Ain Ghazal where it is thought that the differences in form and technique identified within the lithic assemblage led to a division of artefacts in which one set related to the settled farmers in the village and the other to transhumant populations in the peripheral dry areas (Rollefson 1984). Arguably, identifying similar patterns in the overall form of structures, a method usually confined to artefact studies, could lead to a better understanding of the processes that gave rise to varying architectural forms. As with identification and classification of technological changes in lithic production during the PPN, patterns of change in the overall form of structures at Beidha may reflect cultural trends within the prehistoric community.

Objective X - To determine function of individual buildings

Identifying the function of individual buildings revealed through excavation often relies on data provided by ethnographic studies (e.g. Abrams 1994; Aurenche 1984; Bankoff and Winter 1979; Cameron and Tomka 1996; Clark 1989; Gilman 1987). To determine the function of a building using an experimental archaeology approach requires the building to be viewed as an artefact. Archaeological experiments on artefacts, such as tool production and use, predominantly address function and effectiveness. Carried out in conjunction with artefact studies these experiments help identify the range of uses of an artefact. However, it is important to remember that the results from an experiment do not conclusively determine an artefact’s main or only use. As Schiffer (1978:236) correctly illustrates, a stated primary function of a tool is certainly not its only use, even in our own modern society. A similar line of reasoning can be adopted in architectural studies and care needs be taken during all stages of experimentation and interpretation; for example, when defining spaces as domestic versus non-domestic, workshops versus storage, or sleeping platforms versus activity areas. Careful consideration must be given to spaces adapted for multiple uses. Additionally, the modern concept and interpretation of the division of space is unlikely to have been applied in a similar manner in the development of early architecture, as seen in the slow emergence of public and ceremonial buildings.

5.4 Description of Buildings and subsequent research objectives for Experimental Building 49

The numbering of the buildings in these experiments adopts a system applied by Kirkbride during the original excavations at Beidha (e.g. Palestine Exploration Quarterly 1966) and subsequently by Byrd (2005b). However, note that Kirkbride referred to the structures as
houses (e.g. House XLVIII) whereas Byrd uses the term building (e.g. Building 48). Here, the building number preceded by ‘ex’ refers to the experimental reconstruction of the structure excavated by Kirkbride (e.g. exB-48).

ExB-49 was the first experimental reconstruction at Beidha

<table>
<thead>
<tr>
<th>Building number</th>
<th>Building type</th>
<th>Occupation Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExB-49</td>
<td>Circular structure</td>
<td></td>
</tr>
<tr>
<td>ExB-48 and burning</td>
<td>Circular structure</td>
<td>Phase A</td>
</tr>
<tr>
<td>ExB-18 and exB-50</td>
<td>Pier structure</td>
<td>Phase C</td>
</tr>
</tbody>
</table>

Table 5.2 Summary of name and type of experimental reconstructions

5.4.1 Description of Building 49
(Figure 5.1)

In summarising Byrd’s description of the building I draw attention to his assumptions and speculations; extract the essential archaeological facts which can be taken as read (for a full description of Building 49 see Byrd 2005b:35-6) and highlight the elements to be tested through experimentation. According to Byrd’s account, based on the original excavator’s notes, Building 49 had the following characteristics:

The interior space of this semi-subterranean circular structure measures almost 4m in diameter. The structure consists of wall posts, stone walls, and a large central post hole (0.40m in diameter, 0.60m deep, and packed with stones). The wall posts, approximately 0.11m in diameter, are visible as slots in the interior face of the stone wall. Traces of unburnt wood were excavated from some of the post holes. The wall survives to a maximum height of 1.40m above the earliest interior floor level. The wall, slightly sloping outward in places, is built of quartzite, limestone and flint. Sandstone slabs were used only occasionally in the construction of the wall. Angled footing stones were seen wedged into the base of the interior walls. The building appears to have two entrances, opening respectively to the northwest and east. The eastern opening was blocked during occupation. A baulk obscures the details of the entrance to the northwest. Two floors were described for this structure during excavation. One floor was made of a layer of small stones covered with a layer of plaster. The other is not described fully. Considerable debris collected within the structure between these floors and subsequently after the final abandonment. A subsequent structure was built on top of the remains of this structure.
My own observations of the archaeological remains of Building 49 also indicate that large capstones sat on the head of the walls, thus marking the maximum height of the stone wall (figure 5.2). The wall posts described above in approximate terms, suggesting uniformity, were actually highly irregular in both diameter and shape, as well as in their distribution round the wall (see figure 5.1).

5.4.2  Experimental Building 49 (hereafter ex B-49): research objectives

As the first of the experimental structures to be erected at Beidha, exB49 aimed to primarily address objectives II, III, and IV and hence answer questions relating to how the early Neolithic structures were built. In essence, the primary question considered during this initial experiment was whether my proposed design for one of the earliest structures at Beidha was architecturally sound; in other words, would the building stand for any length of time?

The excerpts from Byrd’s monograph (2005b) listed below illustrate another scholar’s views on the gaps in our knowledge concerning the early circular semi-subterranean architecture of Beidha. The excerpts, which Byrd kindly gave me access to prior to its publication in 2005, also clearly differentiate established fact from assumption. These points were considered when developing the experimental hypotheses and are addressed in the objectives of this experiment.

Several posts appear to have been situated inside the line of the wall and probably were later additions to reinforce the superstructure. Alternatively, they could represent a variation in construction technique, where larger posts were set slightly inside the wall itself (Byrd 2005b:36).

Here two alternative explanations for the upright wall posts have been offered by Byrd – one focuses on the post possibly functioning as a roof support, and the other as a possible indication of a change in construction technique. Inserting upright timbers into the wall of exB-49 during its initial construction and during subsequent modifications to the structure addresses the following objectives:

- Objective IV: To analyse construction techniques
- Objective V: To analyse construction designs
- Objective XII: To explain patterns of structural adaptations and re-use
The narrow, eastern entrance was blocked at some point during the occupation (Byrd 2005b:36). Constructing an entrance during the initial construction phase, followed by a phase of monitoring, followed by the blocking of this entrance, and further monitoring helps reveal and explain patterns of structural adaptation.

- Objective XII: To explain patterns of structural adaptations and re-use

Almost all of the wall segments slope slightly outward, and occasionally there are angled footing stones wedged into the interior base of the walls. A portion of the upper exterior wall is exposed in a sounding on the south, revealing a similar style of construction (Byrd 2005b:36). No explanation was offered by Byrd in the description of B-49 for the sloping of the walls. My studies of the standing remains of the original structure indicate that entire portions of the wall, both internal and external faces, lean outwards. This contrasts with the slightly inward curvature of walls of the buildings in the prehistoric village at Tenta, southern Cyprus (Todd and McClellan 1985). At Tenta the curvature of the walls suggested that the buildings had domed roofs. At Beidha the outward batter may have been a functional or stylistic feature employed during the construction of the wall, or alternatively, the batter now seen on the walls may result from lateral thrust from the roof construction during the use life of the building. To test these two theories the walls of exB-49 incorporate areas of vertical and sloping walls. Monitoring these walls over an extended period will show any possible short-term or long-term effects of the sloping walls in comparison to the vertical walls.

- Objective IV: To analyse construction techniques

Remodeling and reuse were evident, including two separate floor levels (Byrd 2005b:35). The initial construction of exB-49 includes a floor level. Recording the nature of deposits on the floor and monitoring activities affecting the accumulation rate addresses the following objective:

- Objective XII: To explain patterns of structural adaptations and re-use

Moreover, the northwest entrance was located in the same area as building 18. The exact relationship between the exterior surface and the interior of the building was not elucidated. It is possible that it was constructed later than building 18, as it appears to have both utilized portions of building 18’s walls and also abutted building 18 (Byrd 2005b:35-6). Unfortunately there is a degree of uncertainty as to the exact location of this northwest entrance because a baulk obscured it during excavation (marked unexcavated in Byrd 2005b:250, figure 147). This has led to considerable speculation by Byrd built on the little evidence gathered by Kirkbride relating to the entrance and surrounding layers, and hence
further confusing the phasing of buildings 18 and 49. An investigation into the surface levels both inside and outside exB-49, and later exB-18 (see Chapter 5.6 for description), sheds light on the stratigraphic relationships and spatial organization which eluded the excavators in the 1960s. During the experimental period observations made on the relative heights of the deposits inside and outside the structure, including observations on the nature and rate of accumulation, elucidate the relationship between interior and exterior surface levels.

- Objective IX: To evaluate the overall form of the structures
- Objective XI: To analyse organisation of interior space

The floor was 50cm lower than building 18 to the north, perhaps because the original terrace surface was sloping southward near its eroded edge (Byrd 2005b:36). The experimental construction of exB-49 provides quantifiable data on the degree of terracing needed in the construction of a semi-subterranean structure built on a slope. The construction process addresses the possibility of aspects of structural design that may have resulted from topographic features such as sandy slopes. Comparative measurements of the floors and exterior ground levels of exB-49, and later the floors of neighbouring exB-18, show differences in surface levels. Subsequent monitoring offers data regarding the rate and nature of changes in surface levels through time.

- Objective V: To analyse construction designs
- Objective VIII: To explain site location
- Objective XII: To explain patterns of structural adaptations and re-use

Subsequently, ~22cm of fill (which included a number of stone slabs) accumulated within the building. Whether this indicated an abandonment of the building or whether the building was re-floored without an intervening hiatus is unknown (Byrd 2005b:36). Long-term monitoring of exB-49, initiated during the current programme of experiments, indicate the rate, depth, and origin of deposits accumulating within the structure. Simulations of phases of occupation, maintenance and abandonment, only partially fulfilled during this programme of experiments, sheds light on the different conditions in which these deposits accumulate.

- Objective XV: To analyse post-abandonment processes
- Objective XVI: To assess intentionality in prehistoric destructions

The debris that accumulated within the building after abandonment contained little trash, except for flint debitage in the upper rubble/wall-collapse deposit.
Substantial roof material, with stone slabs and strips of plaster (up to 34 cm by 2.5 cm in size), collapsed into the building. This roof debris was thicker along the southern edge of the building than elsewhere (Byrd 2005b:36).

In this instance I question whether the debris containing stone slabs and strips of plaster as reported by Byrd originated from the roof or from the walls. Once again, monitoring of exB-49 through various phases subsequent to its construction will illustrate physical conditions under which deposits accumulate, provide clearer descriptions of deposits and their origins, as well as help explain variations noted in the archaeological record.

- Objective XV: To analyse post-abandonment processes
- Objective XVI: To assess intentionality in prehistoric destructions

Experimental Building 49 can also be used to investigate broader issues of structural design such as the introduction of internal features in the early semi-subterranean structures excavated at Beidha. For example,

The initial Subphase A1 buildings lacked internal features, while almost half of the buildings had interior features in Subphase A2...no storage features occurred within (subphase A1) buildings, although a large carbonised basket of pistachios was recovered within the roof fall within a burned, medium-sized dwelling (Byrd 1994:647).

Building 49 is an example of a subphase A1 building. Using exB-49 as a control and placing interior features in subsequent experimental structure exB-48, as well as staging an experiment to burn that structure down will produce patterns similar to the presence and absence of features in subphase A1 and subphase A2 buildings (see Chapter 7 for a full description of the conflagration).

- Objective IX: To evaluate the overall form of the structures

The objectives detailed above are addressed in the experiments in Chapter 6; and discussed further in light of the results in Chapter 9.

5.5 The Description of Building 48 and subsequent research objectives for Experimental Building 48 (exB-48)

5.5.1 Building 48
(Figure 5.3)

Below is the basic structural information relating to Building 48 according to Byrd (for a full description of Building 48 see Byrd 2005b:33-4):
Building 48 is one of the largest circular structures in subphase A1 with an internal diameter of 4.20m. Twenty-three posts were each placed in post holes 0.20m deep. One of the 23 timber posts was located in the centre of the entrance to the structure, dividing the structure from the adjoining rectangular area, building 50. The postholes are relatively small (only 0.10 m in diameter) except for three measuring 0.20m in diameter. A large posthole of circa 0.50m in diameter was located just south of the centre of the structure. The base of this posthole was 0.70m below the floor level. The evidence indicated that oak was used for the wall posts, pistachio for the central post, and juniper for the roof beams. The wall was constructed of large irregular cobbles with little to no visible coursing. The remains of the wall were preserved to a height of 0.60m to 0.70m. The post sockets were set into the wall and small slabs covered the post-sockets at the base. The floor and walls were plastered. The building burned and this resulted in a number of artefacts being found in situ within the structure, including a wooden bowl, a bitumen basket with carbonised pistachios, three querns, large scapulas, and groundstone tools. Two stone blocks were located in the southwest of the structure, near the entrance, and some large stone slabs, possibly used as platforms for activities, where found in the southeast of the structure. The stones in the wall were reddened/oxidised by the fire.

The burning of the structure also provided evidence of the roof construction: reed impressions in mud plaster, burnt beams, and layers of debris totalling 0.50m to 0.80m in thickness (including a burnt beam of 0.15m to 0.20m in thickness), oxidised clay, and a number of small stone slabs.

See Chapter 7 for further details on the burning experiment.

In addition, my observations on site indicate that the wall construction was similar to Building 49, in that a rubble infill was placed between an inner and outer wall face.

5.5.2 Experimental Building 48: research objectives

Below are some of the assumptions and theories put forward by the excavators and more recently by Brian Byrd, followed by the relevant objectives addressed in this experiment:

The three larger posts that these postholes contained were evenly spaced around the building circumference and no doubt played a more critical role in supporting the superstructure (Byrd 2005b:34).

Byrd does not describe the positions of the three larger timber posts or how they could be spaced evenly within a sub-circular structure. Therefore, replicating their probable positions within exB-48, including the thought processes and levels of calculations and planning needed, addresses the possible levels of intentionality in the spacing of these timbers. Further observations of the effects of the positioning of the larger timbers on the construction
of the superstructure, followed by months of monitoring the benefits of their placement, may confirm Byrd’s suggestion that they were intentionally, if not evenly, spaced.

- Objective IV: To analyse construction techniques
- Objective V: To analyse construction designs
- Objective VI: To analyse construction material

The superstructure debris that accumulated within the building varied in thickness between 50cm and 80cm. It included several discrete layers and indicated that the superstructure collapsed in a series of episodes (Byrd 2005b:34).

In contrast to the slow natural collapse of the roof of exB-49, the roof of exB-48 was destroyed by fire. Observations of the accumulation of deposits within exB-48 over an extended period before the fire, as well as immediately after the roof collapse, helps to address both the nature of the deposits and a possible time frame for the series of episodes described by Byrd.

- Objective XV: To analyse post-abandonment processes
- Objective XVI: To assess intentionality in prehistoric destructions

Based on this evidence, it appears that the roof was constructed of a series of beams which were covered with reeds. Then clay was laid on top, with stone slabs either below or on top of the clay. The ceiling and walls were then plastered (Byrd 2005b:34).

The roof construction design suggested here by Byrd is reiterated for the majority of descriptions of roofs from this early phase at Beidha. However, here he introduces the use of stone slabs and notes some doubt over the positioning of them on the roof. This uncertainty suggests a lack of understanding as to their potential structural function. Replicating the use of stone slabs on the roof of exB-48 may address this. In this description Byrd also introduces for the first time the idea that the ceiling was plastered. ExB-48 includes attempts made to create at least a test patch of the ceiling with plaster on it. This brief description of the reeds, clay and stone slabs has also suggested a sequence of construction events, some of which are more obvious than others. The roof construction follows a natural progression of adding layers, however the reasoning for completing the roof construction prior to then plastering the walls is less obvious.

- Objective IV: To analyse construction techniques
- Objective V: To analyse construction designs
- Objective VI: To analyse construction material
The burnt Level VI group of post-houses (No. 18, 48 and 49) produced many finds which even at this period indicate some degree of specialization of crafts within the different rooms. House XLVIII contained a variety of heavy implements, grinders, polishers, axes or hoes, querns, and a whetstone (Kirkbride 1967:10).

Recreating the space, the use and positioning of the implements will address issues relating to the level of specialisation within the structure.

- Objective XI: To analyse the organisation of interior space

5.6 The Description of Building 18 and subsequent research objectives for Experimental Building 18 (exB-18)

5.6.1 Building 18
(Figure 5.4)

As with the previous experiments all the structural evidence was taken from interim reports (Kirkbride 1960, 1966a, 1966b, 1967, 1968, 1985), from personal observations of the archaeological remains as seen today, and from descriptions by Byrd. The summary of the available evidence is as follows (for a full description of Building 18 see Byrd 2005b:35):

Building 18 is an irregular oval-shaped semi-subterranean structure built between building 48 and 49. The interior space measures approximately 4.50m along the north-south axis and only 2.50m along the east-west axis, including the roughly square alcoves in the northeast and west. The wall has more formal courses than seen in Building 48. The building was formed by two stretches of wall interrupted by two entrances to the west and east. The southern wall was 1.20m at its widest whilst the north-western wall was 0.60m thick.

Two floor levels were identified, separated by about 0.30m of debris. A large posthole of 0.40m diameter was found southeast of the centre and thought to be associated with both floor levels. The material associated with the first floor included the remains of a wooden box containing 115 flints, two bitumen basket fragments, two basket fragments with plaster bases, colour pigment blocks, bone tools, shell beads, groundstone tools, querns, and stone blocks.

5.6.2 Experimental Building 18: research objectives

The evidence presented above focuses on the aspects that make B-18 different from its neighbouring structures B-48 and B-49. These differences include its irregular shape,
variations in the formation of its walls, and the degree to which it shares walls with neighbouring buildings (figure 5.5). ExB-18 also serves to further validate through repetition the observations noted from erecting exB-48 and exB-49. Below are some of the research questions relating to this structure.

The building witnessed considerable remodelling and reuse during its use life, including two distinct floor levels and the blocking of exterior entrances into the two alcoves (Byrd 2005b:35). The initial challenge when replicating the evidence for exB-18 is in the interpretation of the excavator’s description of the archaeological remains. For example, ‘alcove’ is a word commonly used to describe a small recess in a wall. However, in the description of Building 18 the word refers to an annexe, or an extension to the original enclosed space. The second challenge is in the location and form of the building’s walls because it shares walls with both exB-48 and exB-49. The archive describes its construction as complex because of the variations in wall thickness and form. An accurate reconstruction of this building from its initial form through its various phases of remodelling and reuse could indicate reasons for the modifications made as well as a possible time frame for the intervals between construction activity and the total lifespan of the building.

- Objective XI: To analyse organisation of interior space
- Objective XII: To explain patterns of structural adaptations and re-use

It was built at the same time as building 48, since the two structures shared a considerable length of the same wall (Byrd 2005b:35). The implication here is that buildings with shared walls are contemporary in their construction and in their use. However, the construction design and technique of these early structures, specifically the construction of inner and outer wall faces, allows for walls to be built in phases without leaving clear stratigraphic evidence such as abutting walls. Replicating the walls of exB-18, months after the initial construction of both exB-48 and exB-49, helps to indicate whether it is possible to build a structure that shares a wall with an extant building. Constructing the walls of exB-18, exB-48 and exB-49 in three separate and distinct construction events also helps identify where one building ends and the next begins, and further disentangle related structural features.

- Objective V: To analyse construction designs
- Objective XIV: To explain intrasite variability over time

There was only minimal evidence to indicate the building burned (a few partially carbonised posts), and if it did not, then the reason why these artefacts remained on the floor of the building is not clear (Byrd 2005b:35).
There is doubt as to whether or not B-18 was burnt down during its life. This doubt is because of the paucity of carbonised material excavated from within the structure in comparison to the heavily burnt remains of the adjacent building, B-48. It is possible that the paucity of carbonised remains resulted from wind swept material landing in B-18 whilst the neighbouring structure, B-48, burnt down. Observations and monitoring of exB-48 and exB-18 during and after the fire provide contrasting and comparative data to indicate whether this scenario is possible.

- **Objective XV: To analyse post-abandonment processes**

Eventually, the building was abandoned, and there was only limited evidence (consisting of carbonised wall posts and roof debris) to indicate that it burned (Byrd 2005b:35). Once again, the doubt implied by the scant evidence can be reinforced through experimentation by observing the build up of deposits within the structure.

- **Objective XV: To analyse post-abandonment processes**
- **Objective XVI: To assess intentionality in prehistoric destructions**

Collapsed roof and wall material appears to have dominated the fill of the building. This may have been levelled to facilitate the subsequent reuse of its upper wall remnants in the construction of subphase A2 building 74 directly overlying it (Byrd 2005b:35). Deposits accumulating within exB-18 form a contrast to events taking place within exB-49 and exB-48. The three structures provide examples of deposits collecting in a building that is maintained, in one that is abandoned, and in one that has been burnt down, respectively.

- **Objective V: To analyse construction designs**
- **Objective XII: To explain patterns of structural adaptations and re-use**
- **Objective XIV: To explain intrasite variability over time**

The accumulation of the fill between the first floor and the later floor suggests there may have been a period of abandonment or possibly reflooring. Although a considerable number of artefacts was recorded in the debris above the late floor, none were clearly associated with the upper floor (Byrd 2005b:35). ExB-18 was abandoned for short periods (four months maximum) between stages of experimental work on site. The rate of accumulation of material within the structure compared to exB-49 provides some indication of timescale for the ‘period of abandonment’ described above.

- **Objective XI: To analyse organisation of interior space**
- **Objective XV: To analyse post-abandonment processes**
Whilst constructing exB-48 and exB-49 several observations were made that needed further investigation and therefore the opportunity to further test hypotheses was taken in the construction of exB-18. This included questioning the evidence provided for the central postholes within the early circular structures of this phase. Challenging ideas arose concerning features of similar dimensions containing similar fills that were being excavated at the neighbouring PPNB site of Shkarat Msaied at the same time as experiments were carried out at Beidha. The pit-like features excavated in a sample of circular buildings at Shkarat Msaied were confidently interpreted by the excavators (Rehhoff Kaliszam et al. 2002) as hearths. The hearths were round or oval and measured approximately 0.30m to 0.40m in diameter. The fill was described as ashy. Based on the new interpretation that came to light in the excavations at Shkarat Msaied, the central feature of exB-18 was constructed as a hearth to form direct comparative data to the postholes constructed in exB-48 and exB-49.

Questions also still loomed about the design of the roofs of the early circular semi-subterranean structures. The roof of exB-18 was designed as a flat roof following the varied success of the pitched and slightly pitched roofs of exB-48 and exB-49. It is thought that flat roofs are easier to construct, with the ends of wooden beams resting on a wall plate, and are thought to be suitable in regions where precipitation levels are low, while the need to reduce surfaces exposed to solar heat are great (Oliver 1997). However, earth roofs are always built slightly sloped and are well-adapted to hot climates (Oliver 1997). Therefore the roof of exB-18 was designed to incorporate these architectural features.

Further questions that arose during the construction of exB-48 and exB-49 involved the structural issues related to the roof design of exB-18 sandwiched between two existing roofs. The details and logistics of constructing a building that was to share walls with adjacent structures had been relatively straightforward in comparison to the construction of roof sharing. There had been no mention in the published literature of how these structures met at roof height.

5.7 The Description of Building 10 and the subsequent research objectives for Experimental Building 10 (exB-10)

5.7.1 Building 10
(Figure 5.6)
Building 10 was one of the pier structures excavated in Phase C deposits at Beidha. The pier houses, tightly packed together, dominated the architectural design of this last phase of Pre-
Pottery Neolithic B occupation at Beidha. Typically these rectilinear structures were semi-subterranean with an entrance along one of the shorter sides. These structures were often plastered. It is argued by Byrd (2005b) that the pier structures were two-storied buildings and the remains seen today at Beidha are the lower, or basement, levels.

Unlike most examples of this type of structure excavated from the site, Building 10 only abutted one other structure and therefore made it an ideal example for studying the basic construction of a single architectural unit. However, the lack of adjoining walls did exclude potential experiments relating to the complexities of abutting walls, shared walls, and more complex problems that arise from creating structural networks.

The following is a description of the archaeological evidence available for the structure according to Byrd (for a full description of Building 10 see Byrd 2005b:62):

The structure was a well-preserved semi-subterranean building with only its southeast corner damaged by later Nabataean terrace walling. The building consisted of six cells, described by Byrd as rooms, opening off a central corridor. Each of these rooms was separated by a ‘pier’ bonded to the exterior wall. The structure consisted of inner and outer wall faces with a mud and rubble hearthing. The thickness of the walls varied from 0.85m to 1.10m. The walls survived to a maximum height of 0.90m. The southeast corner of Building 10 was bonded to the northeast corner of Building 11. A small passage was created between Building 10 and the nearest structure to the west, Building 12, which was 0.80m away. The doorway, in the northern face, was 1m wide, but was subsequently partially blocked. The floor of the structure was not confidently defined during excavation. It may have reused a plaster floor from an earlier construction phase. Above the floor was a series of deposits thought to have accumulated after the building was abandoned.

5.7.2 Experimental Building 10: research objectives

These so-called pier or corridor structures are described as consisting of:

…a large rectangle with an entrance typically on one of the shorter sides. Arranged symmetrically along the long axis of the rectangle are stone or brick piers, wooden posts, or both, to support the roof. Sometimes the piers abut the long sidewalls, to leave only a central passage… (Byrd and Banning 1988: 65).

Similar structures have been identified at Ain Ghazal (Kafafi & Rollefson 1995), Jericho (Kenyon and Holland 1981), Beisamoun (Lechevallier 1978) and Yiftahel (Garfinkel 1987). Those described at Beidha differ slightly because of the reduced interior space between the
piers, the very thick walls, and the absence of hearths (Byrd and Banning 1988). Therefore, the construction of exB-10 was first and foremost an experiment to define the construction materials, techniques, and design of this form of structure at Beidha.

Occasionally, builders subdivided the hall more completely by filling the space between piers with a high wall pierced by a window, or with a low wall, to create two small chambers flanking the longitudinal axis (e.g. Kenyon 1957: 119; 1981: 308b-c) (Byrd and Banning 1988: 66).

The shapes of these structures lend themselves easily to the opportunity to create obstacles to deny access, form divisions to compartmentalise materials, and segment areas for separate activities. The design of the pier buildings allows subdivided spaces to be created simply by building a thin wall between piers to form chambers. It has been argued that this form of compartmentalisation implies increasing socioeconomic complexity in small village communities (Byrd 1994; Gilman 1987). Replicating the simple action of building a wall in exB-10 followed by a programme of monitoring provides fresh data relating to the practicalities of these features and further fuels the debates relating to increasing complexity in Neolithic communities.

- Objective IV: To analyse construction techniques
- Objective V: To analyse construction designs
- Objective VI: To analyse construction materials
- Objective XIII: To explain changes in architectural styles, from circular to rectilinear

The entrance in the north was originally ~100cm wide and contained four steps that descended ~78cm in elevation down to the floor. The entrance width was reduced by half during the building’s use life when a wall was constructed blocking the west side of the steps (Byrd 2005b:62).

Byrd did not offer an explanation for the reduction in width of the entrance into B-10. Initially the experimental objectives for the construction of exB-10 included the partial blocking of the entrance into the structure. However, in the latter stages of the experiment it was noted that this modification would significantly hamper visitors’ access into the building, and therefore this aspect of the experiment was abandoned.

- Objective XII: To explain patterns of structural adaptations and re-use

The lower two or three courses of a probable exterior retaining wall were situated 120cm to the north. The slightly curved wall extended for ~ 3.5m and may have functioned to keep deposits from accruing on its north side away from the entrance or possibly as a wind break. Beyond it lay an open exterior courtyard area. It is possible that the upper step and the retaining
A series of deposits accumulated within the building after abandonment, many of which contained large amounts of trash and discarded artifactual material. The earliest trash deposit directly overlay the floor and sloped down from the steps into the northern portion of the building. This suggests that after the building was abandoned it was immediately used as a trash dumping area (Byrd 2005b:62).

It remains unclear how Byrd was able to suggest both immediacy and intentionality of dumping inside B-10. Monitoring the rate and form of the accumulations of deposits inside exB-10 provides a comparative model for gauging natural accumulations versus intentional dumps, as well as provide a time frame and possible variables under which these deposits accumulate.

Researchers have questioned the function of these structures for over 40 years. Kirkbride was herself puzzled by their form and contents in contrast to the circular buildings from the earlier phases at Beidha. The following excerpts from reports ask questions about function, form, and spatial organisation. These can not be directly tested through the experimental reconstruction of a wall or a roof design, but instead will be constantly questioned during the experimental process.

It is also possible that the small corridor rooms, or workshops were used to live in, and that the very wide stone platform-baulks were used as sleeping platforms (Kirkbride 1962:9).

It is unclear what feature Kirkbride was referring to when describing the ‘very wide stone baulk-platforms’. I suggest that she was referring to the piers. A very simple experiment involving lying on the baulks and in the rooms to assess the size and suitability of the features as beds, although extremely subjective, will help to assess their possible function.
Logical reasoning suggests that the confined space available in the rooms argues against any form of domestic use, such as living or sleeping space, or as working space.

- Objective X: To determine function of individual buildings

The extremely small size of the rooms together with a lack of domestic debris such as hearths poses the question as to whether these buildings served a domestic purpose. Their contents, where undisturbed, seem to suggest that they were workshops (Kirkbride 1962:8).

Are the rooms of exB-10 big enough to work in? How can size be judged? What may seem like confined space to one society can be considered wasted space by another. The practicalities of carrying out various activities within the rooms of exB-10 can be re-enacted and provide an insight into a possible function of the rooms. Additional data affecting work conditions, such as temperature and available natural light, can also indicate function.

- Objective X: To determine function of individual buildings

The corridor buildings...contained objects in varying proportions, which suggest a certain degree of specialization in the crafts. Presumably each of these building belonged to a certain family. One unit may show evidence for the practice of a specific craft or crafts, while the contents of others are more general (Kirkbride 1966a:203).

Once again the interpretations made here by Kirkbride can not be tested directly in the reconstruction experiments. However, the broader issues of spatial and social organisation can be considered during the experimental reconstruction process.

Observations relating to the creation and use of space were also made at Ain Ghazal:

The small alcove in the northwest corner of House 3083 is also intriguing as a possible source of evidence for activity areas. Since there were no artefacts on the floor in or near this alcove, however, it is not certain that it functioned as a storage area. It is possible, however, that the house’s last occupants cleaned it out upon abandonment or used it only to store perishables (Banning and Byrd 1983:19).

The similarity in architectural design, and specifically the chambers or alcoves created in pier houses, at Ain Ghazal and Beidha provide the opportunity to test contrasting hypotheses on related architectural issues. The sequence of events from Ain Ghazal quoted above reinforces the possibility that empty spaces, artefact- and ecofact- free, in the archaeological record may once have been filled with perishable goods. Whilst monitoring the use of space within the structure a proportion of chambers within exB-10 were used to store perishable goods in an attempt to reconstruct events at Ain Ghazal. During the experimental construction process a note was made of all perishable items used and stored in the structure.

- Objective X: To determine function of individual buildings
The pier buildings from Beidha and Ain Ghazal have been compared and contrasted for twenty years (Byrd and Banning 1988). Their similarities suggest strong cultural links between the two villages, despite the discrepancies in chronology. But their differences remind us that there is no set template for early villages and variations are frequent. The question is why do they differ? Why, for example did all of the structures excavated in Ain Ghazal have central, plastered hearths and those at Beidha, by contrast, have none? Experimenting with the placement of hearths at Beidha and recording their visibility in the archaeological record begins to address these differences.

Areas where a concentration of artefacts have been identified, for example a collection of polished limestone bracelets or circular pendants, led Rollefson to suggest that “this possibly reflects a specialized manufacturing locus analogous to the “shops” in Level II/III at Beidha (Kirkbride 1966)” (Rollefson 1984:9).

In the current experimental programme, general observations were made in the actual use of space within exB-10 to provide practical guidance on interpretations relating to its possible function. Further experimentation, beyond the current programme of study, could include the experimental reproduction of a multitude of specialised objects such as polished limestone bracelets and pendants accompanied by observations of associated tool manufacture, use of space, storage facilities, and eventual deposition of related artefacts and tools.

- Objective X: To determine function of individual buildings
- Objective XI: To analyse organisation of interior space
- Objective XVII: To evaluate the social organisation required for construction process

Many scholars have questioned the form, function and design of these structures, and specifically the evidence to indicate a second, or upper, storey. By the term second storey it is implied that the lower, semi-subterranean structure forms a basement level that supports a superstructure. The superstructure would, by definition of a second storey, comprise of a floor, walls and a roof. This contrasts with simply using a roof top for sleeping or for activities such as grinding. In such cases the roof of a single-storey house may have an installation, such as a parapet wall, to provide temporary shelter. Banning and Byrd are key figures in proposing that the pier buildings at Beidha may represent the basements which supported upper stories similar in plan to the pier houses seen at Ain Ghazal and Jericho. The implication is that the piers were introduced to help reduce the roof span of the structure,
perhaps in the absence of wood long enough to span roofs. Banning and Byrd suggest that the piers would be evenly spaced if used to bear the load of the superstructure (Byrd and Banning 1988).

In Level IV: In general these buildings - rectangular, undivided and supplied with a hearth – are in fact smaller editions of the large main house of level II and III. The latter may therefore represent an older tradition of architecture, while the corridor structures may have been an innovation introduced by a new element in the population (Kirkbride 1966a:204-205). The sequence of experimental reconstructions from exB-49, exB-48, and exB-18 through to exB-10 simulates the chronological phasing from the archaeological record. The sequence brings new insights into the transition from one form to another.

- Objective XIII: To explain changes in architectural styles, from circular to rectilinear
- Objective XIV: To explain intrasite variability over time

The function of the wide stone baulks separating the small rooms cannot be decided with certainty, but it seems most probable that they were interior buttresses upholding a lightly built upper storey…there is as yet no evidence for a second storey, but the nature of the fill found above the occupation levels in the workshops bears out the theory to some extent (Kirkbride 1966a:203). This theory can be tested through the construction of piers of varying size, shape and position. Each can be monitored for signs of strain before and after the construction of an upper floor in order to assess their function as buttresses.

- Objective V: To analyse construction designs
- Objective X: To determine function of individual buildings

The evidence for second storeys is equivocal, as even Banning and Byrd have shown:

It is even tempting to wonder if some of the walls and floors Kirkbride ultimately attributed to Level 1, found directly on top of those of a corridor complex of Level II, and whose plaster floor collapsed into a hidden cavity in the level II building below could be remnants of such a superstructure. In some cases, clearly, they are not (Byrd and Banning 1988: 68).

The results of experimental reconstruction of B-10 can begin to address the uncertainties in the design of pier buildings and attempt to determine the likelihood of second storeys on these structures.

These querns had mostly fallen from above, thus suggesting that grinding was carried out on the roofs, but one was in situ on the floor (Kirkbride 1962:8).
Experiments involving grinding were carried out on the roof of exB-10, and repeated again once the second storey was built on what would then be the floor of the upper storey. The practicalities of grinding on the roof can be assessed and illustrate the possible differences between the use of roof space and second storey space. Note here that Kirkbride has referred only to the use of roof space, and has not described the use of the floor of an upper storey.

- Objective X: To determine function of individual buildings
- Objective XI: To analyse organisation of interior space

Already in Level V there is strong evidence for architectural evolution, the chief of which betrays an increasing confidence in the building materials and perhaps reflects some changes within the social pattern of the settlement…Not only is this a great advance (grouped structures to free-standing ones), but in addition the shapes and traditional method of construction of the houses changed as the memory of the flimsy post and mud huts receded (Kirkbride 1967:8).

A direct comparison of building techniques, design and method can be made through the experimental reconstructions. The experimental reconstructions shed more light on hypotheses such as those stating that free-standing structures represent a more advanced construction than grouped structures.

- Objective XIII: To explain changes in architectural styles, from circular to rectilinear
- Objective V: To analyse construction designs

5.8 The description of the burning and subsequent research objectives for Experimental Burning

5.8.1 Description of burnt remains

In the 1960s and 1980s, excavations of the burnt remains of B-48 provided evidence that was to be used to describe the general construction technique and materials of all the circular semi-subterranean structures in the early Neolithic phase (Level VI or Phase A) at Beidha. B-48 was amongst 12 structures (57.1%) in Phase A to show evidence of burning, compared to only 2 (11.1%) in Phase B, and 1 (3.7%) in Phase C (Byrd 2005b:104, table 11). The following excerpt describes the burnt condition of Building 48 and illustrates the wealth of archaeological evidence available to be compared with the experimental results:
The burning of the building caused many of the wall stones to be oxidized reddened by the fire, and considerable roof fall accumulated within the building. The latter included reed impressions and burned beam fragments that provide insight into the nature of the superstructure. Radiocarbon dates were obtained on a *Juniperus* sp. roof beam, a *Quercus* sp. wall post, and the *Pistachia* sp. central post…The superstructure debris that accumulated within the building varied in thickness between 50cm and 80cm. It included several discrete layers and indicated that the superstructure collapsed in a series of episodes. The lower portion contained a considerable quantity of burned roof timbers (including a probable fragment, between 15cm and 20cm in width, of the central post) and slightly oxidized roof clay. Above this was more roof clay containing a number of large stone slabs (presumably from the roof); then more charcoal from roof beams and reeds; and finally highly oxidized clay containing numerous reed and beam impressions, and plaster fragments. Based on this evidence, it appears that the roof was constructed of a series of beams which were covered in reeds. Then clay was laid on top, with stone slabs either below or on top of the clay. The ceiling and walls were then plastered. After the building burned, a portion of the western wall was destroyed by pit digging perhaps for the construction of subphase A2 building 51 or for stone robbing purposes. No trash accumulated within the building (Byrd 2005b:34).

The fire in Building 48 also preserved artefacts *in situ*. In addition to the architectural features described by Byrd, Kirkbride found two dark, circular shadows on the floor. One was a wooden bowl 0.40m in diameter, the other a bitumen-coated basket 0.45m in diameter.

Building 48 contained heavy implements including: grinders, polishers, axes or hoes, querns and a whetstone. These deposits also contained two figurines of baked clay, “one a rough representation of a (?) female goat, the other a well-modelled ram’s head” (Kirkbride 1967:10). An earlier description of the burnt remains indicates that:

One of these houses was destroyed by a very fierce fire, and the resultant baking and solidifying of the mass of clay, mortar and plaster from roof and walls supplied a magnificent series of plant impressions. In addition, a heap of carbonized pistachio nuts which may originally have amounted to some five gallons, was found on the floor in perfect condition. They seem to have been lying in a basket; the resin released from the nuts by the heat has preserved imprints of the weave in a thin skin of tar (Kirkbride 1966a:205).

From this house – and baked hard in its destruction – came a section of a small, very primitive clay bowl as well as a lively representation of an ibex and modelled aurochs’ horns (Kirkbride 1966a:206).

5.8.2 Experimental Burning: research objectives

Many of the questions relating to the construction techniques, designs and materials were addressed in the experimental objectives tested in Experimental Buildings 18, 48, and 49.
As with the experimental reconstructions of these buildings, the destructive burning of exB-48 aimed to replicate architectural evidence recovered from Kirkbride’s excavations at Beidha. The evidence included the extent of burning noted on the timbers, on the stones of the inner wall, and the depth and content of collapsed roof debris. The two descriptions quoted above – that of the original excavator and of the site’s key interpreter - of the burnt remains from Building 48 pose many questions relating to the finer details of not only B-48 but also of other semi-subterranean circular structures at Beidha.

- Objective IV: To analyse construction techniques
- Objective V: To analyse construction designs
- Objective VI: To analyse construction material

Reproducing the forensic clues by experimentally replicating the outcome of the conflagration provides an insight into the nature of the fire that destroyed the building. The archaeological description of the burnt remains of B-49 led Kirkbride to conclude that the building was destroyed by a very fierce fire as indicated by the thick charred deposits, oxidised stones, and baked clay and mortar. This evidence would suggest a two-phase structural fire characterised by an initial slow-burning fire to produce the charred remains followed by a well-vented fire resulting in a combustion sufficiently intense so as to cause oxidisation of stones (Harrison pers comm.). Understanding how the fire consumed the structure and how it was fed will indicate the nature and possible origins of the fire (Drysdale 2000).

One important question not fully considered in the 1960s reports or in subsequent publications is the question of intentional, as opposed to accidental, burning. Ethnographic studies and archaeological experiments have previously demonstrated that construction materials greatly influences the degree to which a house will burn (Gordon 1953; Bankoff and Winter 1979; Wilshusen 1986; the observations made by Hansen 1966 are discounted here due to his use of petrol to ignite the fire):

> A house with mud and rubble walls and a flat mud covered roof has to be prepared for burning or it will not burn at all: the two essentials being extra fuel and a good draught (Gordon 1953:149).

This contrasts with the rapid rate of conflagration of thatched houses in dry conditions (Friede and Steel 1980; Waddington 2004 pers. comm). Therefore, based on this evidence,
Building 48 would need both extra fuel and a good draught to burn sufficiently to replicate the archaeological record.

- Objective XV: To analyse post-abandonment processes
- Objective XVI: To assess intentionality in prehistoric destructions

It seems significant that a serious fire in one part of the village should coincide with a change of architecture in the next phase (Kirkbride 1962:10).

Here Kirkbride seems to be suggesting that a large destructive fire effectively marked the end of occupation in Phase A at Beidha. The fire may have been accidental and simply provided a clean slate for starting afresh, or perhaps the village was deliberately torched to make way for a new architectural style and way of life. An intentional fire, or arson attack, would involve infilling the buildings with combustible material. Examining the evidence from the experimental conflagration may indicate intentional versus accidental burning.

- Objective XIII: To explain changes in architectural styles, from circular to rectilinear
- Objective XVI: To assess intentionality in prehistoric destructions

The lack of the latter [hearth]s in Levels V and VI must have been an ancient safety measure, for the post-houses were obviously inflammable enough without the added risk...It seems likely that these fires considerably hastened the evolution of buildings that were not only free-standing but free from the immense amount of internal wood (Kirkbride 1967:9).

Here Kirkbride suggests that the placement of hearths in courtyards between structures and complete absence of hearths inside the circular semi-subterranean structures, as tested in the experimentation of a central hearth in exB-18 (see Chapter 5.6.2, following fresh evidence from Shkarat Msaied), was a design characteristic to avert the risk of house fires. This led to the suggestion that the decrease in wood in the later pier houses was designed to further reduce the risk of fire. Her hypothesis is based on the observation that the houses were ‘obviously inflammable’ (Kirkbride 1967:9). However, based on the evidence for the small amount of flammable material (e.g. reeds and timbers) compared to the vast amount of non-flammable material (e.g. stones and earth-beaten floors) within a semi-subterranean structure, I suggest that these structures were actually for the most part non-combustible. Testing the combustibility of a circular semi-subterranean structure may answer questions relating to architectural design, such as the location of hearths; construction materials, such as the quantity of timber used; and provide further insight into the transition of architectural styles noted at Beidha.

- Objective V: To analyse construction designs
Objective XIII: To explain changes in architectural styles, from circular to rectilinear

These questions relating to the nature and extent of the fire are addressed more fully in Chapter 7.

5.8.3 Research questions relating to Artefacts

On the whole the experiments address questions relating directly to the architectural features of the early Neolithic structures at Beidha. However, questions relating to the artefacts are also addressed where possible. For example:

a. Was the basket lined with bitumen as described by Byrd (2995b:34), or was it the resin from the nuts as described by Kirkbride (1966a:205), that produced the impressions of the basket weave?

b. Were the clay objects baked or unbaked at the time of the conflagration?

Evidence from Ain Ghazal suggests accidental baking of clay figurines, “four of the figurines had been baked, perhaps accidentally, and therefore were well preserved” (Rollefson 1984:10). If borne out, this might suggest that unbaked clay figures were more common, though only appear in the archaeological record if accidentally burnt. Similarly, “…it is hypothesized that storage was typically within domestic dwellings. Storage may have been in baskets hung from the ceiling or set directly on arrays of stone slabs” (Byrd 1994:648). A sample of artefacts, including baked and unbaked clay objects, placed inside the structure before the conflagration may begin to address these questions.

A more comprehensive description of the artefacts in relation to the nature of the fire and the collapse of the structure is given in Chapter 7.

5.9 Further research questions

5.9.1 Research questions relating to social organisation

The experimental objectives outlined here have so far related directly to the archaeological evidence gathered from the excavations. But, over the years that the experimental reconstructions have been in existence, additional observations relating to the archaeological evidence have led to further more in-depth questions such as those focusing on spatial and social organisation. Although such complex issues do not lend themselves directly to
experimental archaeology, they have been behind many of the experimental objectives already listed and were therefore kept to mind when carrying out the experiments.

An example of such a complex issue emerges in Byrd’s interpretation of the structures in Phase A as domestic dwellings, based on in situ artefacts that suggest activities such as food processing and preparation, production and maintenance of tools, and storage and sleeping areas (Byrd 1994:648). In contrast, the largest building in Phase A, Building 37, had no in situ artefacts on the floor, and therefore he has interpreted it as a non-domestic building. The obvious question is whether it is really possible to infer structural use through the preservation of a handful of artefacts within a building. The interpretations based on the absence and presence of materials on a floor surface need to take into account the issues of cleaning, which are linked with emerging sedentism.

Comments have been made by previous authors relating to the social implications of architectural forms encountered at Beidha. For example, Phase A is thought to show signs of a developing community (Byrd 1994). This is illustrated by the effort needed to construct the village terrace wall and the large central non-domestic building (Building 37), but the community retained the interdependent domestic buildings characterised by simple internal structural organisation, wide doorways, and unlimited visibility and access (Byrd 1994). However, in Phase C the growing complexity of the community is represented by an increase in building size and elaboration of form: two-storey corridor buildings with restricted traffic flow and compartmentalised activities.

The structural elaboration and increased energy and labour investment in constructing a greatly expanded non-domestic building in Subphase C2 suggests the growing importance of the political institutions associated with these buildings (Byrd 1994:656).

- Objective XVII: To evaluate the social organisation required for construction process

The effects, both social and structural, of the various sizes and forms of the reconstructions at Beidha were recorded during the experiments. These are further discussed in Chapter 9 (for further discussions relating to the social implications of architectural forms encountered at Beidha see 9.1.13.)

5.9.2 Research questions relating to water catchment

Descriptions of Beidha given in reports written by the excavator in the 1960s also provide grounds for further investigation through experimentation. For example:
The nearest permanent water supply is now 1½ hours’ walk away would seem to argue for serious desiccation in the area since the village was built (Kirkbride 1962:7).

At the start of this period of experimental studies there were no present-day hints or suggestions of a permanent water source close to the Neolithic village, leading to thoughts of possible water catchment devices and wells at Beidha during the Neolithic period. Throughout the construction of exB-49 observations were made relating to the amount of water used in each stage of construction as well as the effort taken to transport the water to the construction site. Such data is essential when assessing the need of the original builders for a nearby water source. Without a nearby spring the Neolithic community may have relied on water catchment techniques, and/or were tied to the wet seasons for construction activity, or perhaps Beidha was only seasonally occupied.

- Objective I: To estimate the amount of time taken for the construction process
- Objective II: To estimate the labour expenditure needed
- Objective VIII: To explain site location

Since carrying out the experimental reconstructions at Beidha a palaeoenvironmental study of the environs revealed a palaeochannel adjacent to the site (for further details see Chapter 6.4.1 b).

5.9.3 Research questions from other PPN sites

In addition to focusing on the primary evidence unearthed at Beidha by Kirkbride and subsequently reported by Byrd, attention during the conduct of the experimentation was also directed at questions relating to the architectural changes noted at Beidha by excavators of other PPN sites, such as Rollefson at Ain Ghazal. He has suggested that:

…the crucial evidence for understanding the effects wrought across the southern Levant are best seen in the areas of animal husbandry and the culturally motivated requirements for lime plaster production” (Rollefson et al. 1992:468).

And further more, Rollefson suggests that the production of lime plaster caused:

…radical deforestation around settlements such as Beidha and Beisamoun, for example, exposed land useful for agriculture, but only on a temporary basis. The removal of trees, on the one hand, and the browsing habits of goats, on the other, maintained a constant exposure of the fragile farming soils to erosion by water and wind, reducing agricultural production in spring-tethered settlements to a point below the demands of the local, and often large, populations. Inhabitants of many settlements were thus forced to disperse to smaller permanent sources of water, and the necessarily smaller populations that could
Within this short excerpt Rollefson has suggested that the transition to farming and emergence of the use of lime plaster had a detrimental effect on the environment upon which they relied. The increasing pressures on their surroundings resulted, according to Rollefson, in a shortage of both timber and water. The question is whether the increasing pressure on the environment is archaeologically visible at Beidha. Perhaps environmental degradation can be seen in the changing form of the architecture as the people are forced to cope with changes in raw material available for construction. It can be hypothesised that the impact of environmental change on architecture may be observed in the change in architectural design, technique, and materials at Beidha. Records of the raw material used in the building of exB-49 compared to exB-10, a rectilinear structure from a later phase, may reveal a trend in the reduction of both water and timber consumption in the construction process.

- Objective IV: To analyse construction techniques
- Objective VI: To analyse construction materials
- Objective V: To analyse construction designs

Viewed from our new knowledge concerning the earlier stages at Beidha the corridor building of Level II and III are now seen to represent a tradition of architecture foreign to the uninterrupted native architectural evolution as shown in Levels VI-IV (Kirkbride 1967:5). Such questions relating to external influences on the form of architecture at Beidha can not be directly answered through experimental archaeology. However, observations during the construction process help to distinguish native from foreign techniques and methods not previous identified in the archaeological record.

- Objective XIII: To explain changes in architectural styles, from circular to rectilinear
- Objective V: To analyse construction designs
- Objective XIV: To explain intrasite variability over time

With the end of Level IV also comes the termination of the indigenous architectural evolution, for the multiple-roomed corridor buildings and general layout of Levels III and II are too complete and too different and must represent an importation reflecting a new element in the population. There is, however, a continuation of the indigenous architecture in the large meeting-houses of III and II, for they are enlarged versions of the curving rectilinear houses of Level IV (Kirkbride 1967:9). Through the act of building exB-10 the new individual elements of construction can be quantified in comparison to the so-called indigenous elements of the earlier structures at Beidha. Identifying which elements have changed, for example changes reflecting
availability of the construction materials, or change in technique due to the introduction of new tools, provide clues to the reason for the variability and suggest a source of change. For example, flatter stones are used in the walls of Phase C, but is the construction technique used still the same as observed in Phase A? Could the source of this change be influence from nearby settlements: Baja, Basta, or Shkarat Msaied?

- Objective XIV: To explain intrasite variability over time

5.9.4 Related experimental objectives

The experimental archaeology at Beidha focuses primarily on the architecture. When the experimental reconstructions were originally conceived it was hoped that they would form the basis for further experiments on all aspects of construction and provide opportunities for further research into PPNB architecture and technology. This opportunity was taken up by Chloe Brown (University of Reading) when she conducted experiments relating to lime plaster production in the early Neolithic (Brown 2006). The general consensus based on archaeological evidence is that “the preparation and use of plaster was a widely-practised, energy intensive, labour-intensive, skilled activity” (Kingery et al. 1988:236). It is proposed that at Beidha lime plaster was used in non-domestic structures in the final occupation phase: “approximately 2,250kg of quick lime was necessary for each of the five thick plastering episodes” and “9000kg of wood was required” for charcoal (Byrd 1994:657). This requirement for the conspicuous consumption of plaster is interpreted as creating an increase in the authority and influence of certain individuals and their ability to mobilise more labour and resources.

Brown’s objectives on site were to investigate the technology and methodology of producing lime plaster based on archaeological evidence from the Levant. The experiments she undertook addressed questions relating to the amount and type of fuel required for the fires, the form of the fire pits (whether they were open fires or closed pits), and an approximation of the time and energy invested in each stage of manufacture. The results of the experiments challenge current proposed estimations on the amount of fuel necessary and contribute to our understanding of the social and environmental implications of lime plaster production during the PPNB (Brown 2006).

The objectives described in this chapter are put to test in the next chapter (Chapter 6). Each experimental reconstruction incorporates a series of objectives described here in relation to its construction, maintenance and decay which are re-examined in Chapter 9.
Chapter Six
Experiments


This chapter presents the experiments carried out at Beidha from the spring 2001 to the spring of 2006. These include the construction of three circular semi-subterranean structures and one rectangular pier house; maintenance work to all the structures; rebuilds; and several small-scale experiments including the mixing of mud plasters. The methodology and results of the burning of one of the experimental circular semi-subterranean structure can be found in the next chapter (Chapter 7). Before describing each experiment in detail, the experimental parameters are outlined, followed by details of the constraints recognised as potentially affecting the results of the experiments, and then a summary of the general recording method.

6.1 Experimental parameters

Every stage of each experiment was conducted in accordance with the objectives of the experimental archaeology project outlined in Chapter 5, and correlated directly with the archaeological evidence from excavations carried out at Beidha in the 1960s and 1980s. This archaeological evidence formed the basis for developing the hypotheses. As with experiments such as the construction of Pimperne House at Butser Ancient Farm by Reynolds, this experiment is site-specific and is led primarily by archaeological data; it is not reliant on ethnographic examples or modern technology. Reynolds claimed that the Pimperne House “was, in fact, a three dimensional projection of the data built at a 1:1 scale” (Reynolds 1995b:11). Such a bold statement is not made for the experiments conducted at Beidha, instead I would claim that the available, and sometimes limited, archaeological evidence is used as far as possible to create a 1:1 scale replica of the structure but thereafter, where evidence is lacking, experimental procedures are implemented to test hypotheses. Here, I have adopted the use of the word ‘hypothesis’ instead of ‘interpretation’ because it is a term that allows multiple theories to be presented for examination and re-evaluation, as opposed to ‘interpretation’ which implies that testing, careful consideration, and a single interpretative model have all already been formulated.
Where archaeological evidence was limited, for example in the reconstruction of the roof, greater emphasis was placed on the experimental process. In other words, confidence in the experiments was increased through repetition (for further definitions of experimental archaeology see Section 2.1.2h). With each experiment lessons can be learnt and possibilities can be eliminated. At Beidha, a total of four roof experiments were conducted (including two successive roofs on exB-49) in order to experiment with variations on the available archaeological evidence which had suggested both the type and approximate quantities of raw materials used. The experiments addressed variations in the location of upright timbers, angle of slope of the roof, presence/absence of central post, and thickness of mud covering. The plans for the initial roof experiment (exB-49) drew influence from local analogies (see Section 2.2) and ethnographic examples (see figure 6.28, where the influence of American pueblo and African mud hut constructions are clear). The interpretations of the roof construction were dynamic and fluid, in which one experiment lead to another.

The experimental reconstructions are based directly on the archaeological evidence from individual structures at Beidha and are not an amalgamation of evidence from early Neolithic structures from other sites. However, evidence from neighbouring PPNB sites such as Shkarat Msaied and Ba’ja was used to challenge the evidence at Beidha and provide contrasting hypotheses to consider during the experiments. As far as possible evidence for each reconstruction is taken from only one structure at Beidha and not compiled piecemeal, though where evidence is inadequate, for example in the experiments relating to second storeys on pier houses, contemporary structures at the site were used to provide supporting evidence.

Initial analysis of the archaeological structures was undertaken to furnish the data for the reconstruction; this involved identifying renovations and building maintenance that may have taken place during the occupation of these structures. For example, timber posts were replaced and new post holes dug, door ways were blocked and walls added. The experimental structures, as far as possible, take into account recognised changes in the occupation history of the structure; in such cases the earliest phase of the structure is used as the template for the experiments. Thereafter, the reconstructions undergo, over time, similar changes as those encountered in the ancient buildings in accordance with the modifications noted in archaeological evidence relating to each building’s life history. The experiments are therefore intended not only to examine the construction of the buildings but also the
changes made to the buildings through time. The aim is to reconstruct the history of the building, and not simply the initial architecture.

6.2 Some experimental constraints and considerations

A careful evaluation of possible constraints imposed on the experiments at Beidha was considered before experimentation began. Such a considered approach was employed by Mathieu and Meyer in their experiments relating to stone, bronze and steel axes where they claimed to have carried out the experiments “in as complete a manner as possible, subject to constraints of time, expense, and ability. Where variables could not be controlled, they were noted and their effects were discussed” (Mathieu and Meyer 1997:334). The variables that could not be controlled at Beidha during the experiments included interference from visitors (especially from local children playing on the structures), variable weather (especially the unpredictable extreme flooding in the winter in contrast to the predictable droughts in the summer months), limitations resulting from raw material availability (for example using sawmill timber because of restrictions imposed by modern legislation and environmental constraints/climate change affecting forests), and the variations caused by a turnover of volunteers (and hence individuals building skills and habits).

To expand on the first constraint listed, the site is open to the public all year round. Visitors have unlimited access to the experimental structures and to the archaeological site itself. Although a guard was hired to watch over the site and signs were put up to advise visitors to respect the site and the experimental buildings, it is impossible to accurately monitor their activities or restrict their movement around the site. As a result, some visitors climb on the archaeological and experimental walls, and move and remove artefacts.

As with all experiments that attempt to replicate past human activity, the experiments at Beidha were constrained by the subjective and unquantifiable elements of past human behaviour. The action of building a house involves decisions and actions by individuals which can not be simply replicated through a scientific process. This limitation was recognised at Beidha and no pretence was made that the experimenters could simulate the thoughts and actions of Neolithic people. However, observations were made on the thought processes involved in constructing a building of Neolithic design, hence providing an insight
into the problems encountered and overcome by individuals in Beidha during the Neolithic period.

Similarly, no experiments were conducted to replicate actual occupation of the structures. Attempts by individuals to recreate daily activities of ancient societies have been criticised as being unscientific (Reynolds 1995b) and “it is increasingly being recognised that human actions are context specific rather than law-like…cannot replicate attitudes of past communities to time, materials or knowledge” (Bell et al. 1996:244). In contrast to Reynolds, I acknowledge the potential for further understanding, and even gaining scientific data, in spatial organisation through actual occupation of reconstructions, where there is sufficient surviving evidence in the archaeological record to focus such activities. However, at Beidha there is not enough evidence to recreate accurately the daily activities of the PPNB community. As a result, the monitoring of degradation and decay in and around the reconstructions focuses on non-human agencies.

As each experiment progressed a record was kept of the total number of hours invested into the construction process. These were recorded simply as an indication, and are not intended as an absolute record, of the exact hours it would have taken prehistoric individuals to build each structure. In each case a note is made in terms of hours and not days in order to allow for the variability that emerges in the length of a working day which is largely dependant on the strenuousness of the task being carried out. For example, a working day comprising of carrying heavy stones would be only five hours long compared to an eight-hour day of light work.

Other stochastic factors that arose during the experimental process included climatic conditions and geomorphological processes. In essence these factors challenge the assumption that the experiments are completely repeatable. The temperature and wind conditions on any given day at Beidha were unpredictable and uncontrollable and therefore experiments such as the rate at which plaster dries involved a nondeterministic element. As far as was possible, these elements were recorded, incorporated into the monitoring process, and factored into the hypotheses generated by, and interpretation of, the results.

The experiments at Beidha were only minimally impacted by time or budget. I was able to monitor changes that occurred at regular intervals throughout the experimental period. Visits to the site were usually made in fair weather ideal for conducting experiments, usually at the
start of spring, in mid-summer, and in the autumn. However, only occasional visits were made in mid-winter when rain prevented building work. On such occasions the primary aim of the visit was to observe the effects of adverse weather conditions on the experimental structures. A total of six months was spent on site in each of the initial two years of the experiments. The project was conducted on a low budget which overall did not impact detrimentally on the experiments with only one notable exception. In the case of using timber of species recognised in the archaeological record for the upright posts and roof rafters, the project was not in a position to consider meeting the cost of importing timber from trees that could not be sourced locally (e.g. juniper and pistachio).

Careful consideration has also been given to the pitfalls of using results from comparable experiments carried out by other researchers at other sites. For example, experiments involving axes have largely included data relating to tree felling which in turn fuels discussions relating to the construction of monuments and buildings (Mathieu and Meyer 1997). Data from these experiments has been used at Beidha to support reconstruction work so that the experiments at Beidha could focus primarily on construction methods, design and technology and less on the details of the tool manufacture and use. Therefore, experiments at Beidha did not involve multiple trials in tree felling, transport, sawing or chopping. This was a necessary step in order not to get diverted by issues relating to tool manufacture and use (e.g. flint knapping, hafting, grinding and polishing) which constitute whole experimental studies in themselves that have been carried out elsewhere (e.g. Smith 2005). Similarly, I have considered results from studies on harvesting raw materials, such as timber, to provide data on the time and effort needed for tree felling. For example, Mathieu and Meyer (1997:341) showed that hardwood took longer to fell than softwood and were able to quantify the difference in materials in terms of time and energy. This data was considered as a supplement when calculating the approximate cost, both in time and energy, involved in each stage of the construction process at Beidha. This was particularly relevant in relation to experiments involving harvesting and collecting timbers which could not be replicated at Beidha because of absolute constraints on timber supply.

At Beidha, observations were made on the types of tool required for each task in the construction process. Small experiments were carried out when necessary, and then comparative examples and datasets were sought from previous experiments (e.g. Ashbee and Cornwall 1961), or from ethnographic examples. Modern tools were used to facilitate the construction process only after considering whether it would compromise the results of the
experiment. It was thought that the experiment would still be valid if the hand-tools still functioned broadly comparably within the parameters of prehistoric tools. For example, the role of modern shovels is comparable to scapulas and digging sticks, both items are capable of digging a foundation pit.

6.3 The Recording Method

Digital photographs were taken daily. For each experimental structure a set number of photographs were taken from pre-allocated positions around the site (figure 6.1). This provided a consistent, comparative visual record of the construction process. Other photographs were taken from various different positions in order to highlight tasks undertaken on any given day.

Photographs were also taken in the months between construction phases to monitor the effects of weathering processes on the structures. These were taken on an opportunistic basis as and when possible.

A field notebook was kept for all working days on site. It includes daily notes on progress, field observations, ideas and thoughts from team members, and sketches of features (figure 6.3). All artefacts resulting from the experiments, for example mud plaster fragments with reed impressions and hand-tools used for ramming mud, were recorded in the field notebook and photographed. The majority of the artefacts, such as mud plaster with impressions, were not retained in the longer term due to their fragile nature and the lack of suitable storage facilities on site.

One experiment, the conflagration of one of the semi-subterranean circular structures, was recorded using a digital video camera. A total of 88 minutes was produced showing the preparations of the experiment followed by the burning of the structure until the moment that the last flame died down. A DVD of the footage was produced, and a limited number of copies were made to accompany this thesis.

In contrast to accepted contemporary good practice on excavations, a policy was taken not to sieve deposits and fills produced as a result of these experiments. This is based on the reasoning that during the original excavations at Beidha no sieving was carried out (except in
the Natufian layers excavated in 1983 where 50mm mesh was used). Formulating a sieve sampling strategy for experiments carried out on reproductions of structures from Phase A at Beidha would therefore produce data with no directly comparable precedent at the site. The one exception to this methodology is the material excavated from the burnt experimental structure; this was sieved in order to maximise the data available and to enhance the interpretation of the material excavated in the 1960s.

As yet, no microstratigraphic analysis has been conducted on the experimental structures. However, replicating the Neolithic structures at Beidha has provided an opportunity for future microstratigraphic sampling which was not incorporated into the relatively rudimentary excavation techniques that existed in the 1960s.

6.4 The Experiments

The area selected for the experiments is located within the area owned by the Department of Antiquities around the Pre-Pottery Neolithic B village at Beidha and is demarcated by a fence line. The experimental area is located approximately 27m east of the 1960s and 1980s archaeological trenches of the early Neolithic village (figure 6.2). Two exploratory slot trenches were dug in the selected experimental area to test the depth of any archaeological remains at this point. The slots were half a metre deep and showed no signs of in situ archaeological remains. Only a few sherds of Nabataean pottery were found in what appeared to be slope-washed and wind-blown sand. It was therefore concluded that the chosen site for the experimental area would not interfere directly with the archaeological remains. This is in accordance with Article 7 of the Charter for the Protection and Management of the Archaeological Heritage that states “reconstruction should not be built immediately on the archaeological remains” (Cleere 1990).

The principal experiments focused on the construction of four structures: Experimental Buildings 48, 49, 18 and 10 (figure 6.4), corresponding to the numbers of the source buildings. These buildings were chosen for reconstruction for the following reasons:

i) Clear archaeological plans of Buildings 10, 18, 48, 49 and 50 featured in the interim reports (e.g. Kirkbride 1967: fig 1);

ii) Kirkbride herself used Building 10 as the basis for her partial reconstruction drawing of Phase C (1966:12, fig 2);
iii) The archaeological remains of the selected buildings were partially visible on site and therefore could be viewed during the experimental period. These remains had not been destroyed by subsequent excavations;
iv) Buildings 18, 48, 49 and 50 was collectively the best preserved example of a clustered network of circular structures;
v) Collectively these buildings were representative of the architectural features identified for Phases A and C at Beidha.

Each one of these is described in detail below – including descriptions of all raw materials used, followed by details of each step in the construction process.

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<tbody>
<tr>
<td>Ex B49</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Ex B48</td>
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<td>Ex B10</td>
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<td></td>
<td>Ex B18 (and annex Ex B50)</td>
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<td>Burning Experiment</td>
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Table 6.1 Timetable of experiments carried out at Beidha

6.4.1 Experimental Building 49 (exB-49)

a) Summary of experimental objectives (as stated in Chapter 5)

The first experimental structure to be erected at Beidha was initially going to be based on the evidence that survives for Building 48. Once in the field and after a brief study of the existing structural remains I opted for a neighbouring structure, Building 49. B-49 measured only 5m in diameter compared to the 6.9m diameter of B-48, and it was therefore deemed a more manageable first experiment in the summer of 2002.

Primarily this experiment aimed to test the construction design, building technique and suitability of the materials used in an early Neolithic semi-subterranean circular structure. Confirmation that the structure erected was structurally sound would then lead to further investigation and experiments.
The construction method that was to be tested involved seven main steps (figure 6.6). First, a pit was dug for the foundations of the structure (figure 6.7). Then the timber posts were erected in a circle within the foundation pit (figure 6.8). Steps three and four were carried out simultaneously – they included building a wall between and connecting the circle of upright posts and subsequently packing rubble and mud behind the wall (figure 6.9). Step five, building the exterior wall, began once the inner wall construction reached the height of the natural ground level (figure 6.10). The wall was capped once it reached its full height, both internally and externally. The final step involved constructing the roof.

These seven main steps, summarised above, are described below in more detail in relation to the construction materials, technology and design aspects of relevance at each stage.

b) Raw materials

Timber uprights

Obtaining timber for the upright posts proved to be a very difficult task given modern circumstances in the area of Beidha. The majority of the thin oak woodland that survives in the vicinity of the site is diseased. The scarce woodland that survives elsewhere in the region stretches from Showbak south along the plateau and is protected by the government. Permission to fell any tree in Jordan has to come from the Ministry of Agriculture. After several unsuccessful attempts to obtain timbers from woodland with official support, I managed, with the help of local Bedouin, to scavenge enough wood from the modern village of Beidha for the first experimental structure to go ahead. As a result these timbers were not uniform, but instead were of different sizes and species, and varied from freshly cut to partially rotten. Each timber was measured, photographed and monitored over the experimental period (figure 6.11).

The evidence from the excavations of B-49 suggested that the wall posts were approximately 11cm in diameter. The results from experiments conducted by Mathieu and Meyers in Vermont suggest that the timbers of this size, whether of hard or softwood, were relatively easy to fell using a stone axe (Mathieu and Meyer 1997:348 and fig 7). Their results show that trees of an approximate diameter of 10cm were felled in less than 20 minutes. It can be
assumed that ovate celts, as found amongst the stone tool assemblage in Building 49 (Wright 2000:107), were used for felling trees at Beidha during the Neolithic.

Analysis of the data from this study led to an interesting insight. All the graphs that plot ‘time to fell in minutes’ against ‘tree diameter in cm’ show distinct convergence of the data around the 10cm diameter mark. The clumping of the results at and below this diameter suggests that small trees can be easily felled by any axe type and that the important variables may not be ones we controlled for in this study, but factors such as vegetation and topography which make up the ‘felling environment’ and which are difficult to control in experimental situations. Once a tree’s diameter reaches about 20cm, the tree’s species and size seem to play a larger role in the amount of time necessary to fell. Trees under 10cm in diameter will be felled quickly with any type of axe, and other factors such as walking out to the felling site and clearing vegetation probably contributed greater time costs to a project than the actual felling (Mathieu and Meyer 1997:347).

Based on the results from their experiments it can be reasoned that the majority of the investment in the timbers used at Beidha would therefore be in the time taken to reach and fell the trees and the effort to carry the timbers back to the village. The forest today crowns the hills approximately 5km to the east of the site, over two hours walk there and back. It would have taken approximately nine hours to fell the trees, but perhaps 16 to 48 hours to transport the load of timbers back to the village. These calculations are based on the current distribution of trees in the local area. The palaeoenvironmental studies carried out in the 1960s by Helbaek (1966) suggests a lusher environment surrounding the site during the Neolithic period, perhaps with trees growing in the wadi system. The approximate times taken to complete this task are stated here only to indicate the effort involved in transporting timber compared to the relatively brief task of felling the trees. Given the lengthy transportation time it would be reasonable to assume that proximity to a wooded area would be preferable when choosing a location for building a village and further supports the suggestion that the region was more wooded during the Neolithic.

A decrease in the diameter of timbers used in constructions was noted in the PPNB layers at Ain Ghazal suggesting that fewer and fewer mature trees were available (Rollefson and Kohler-Rollefson 1992). As a result, the decrease in the load bearing capacity of the thinner timbers available also decreased the structure size at Ain Ghazal. Such a dramatic decrease in diameter, from 50-60cm to 15-20cm, was not noted at Beidha. It seems that throughout the occupation of Beidha the timbers used in the constructions fall within Rollefson and Kohler-Rollefson’s description of thin immature trees. It is therefore possible that even in
the earliest phases of Neolithic occupation at Beidha that environmental constraints were placed on the availability of construction materials.

**Stones**

The stones for the wall of exB-49 were collected from Kirkbride’s old excavation spoil heaps that slope away to the west of the archaeological site (figure 6.12). Additional stones were collected from the nearby wadi bed to the south of the site and from the surrounding agricultural fields. These are marginal fields used by farmers from Wadi Musa to grow crops (figure 6.13). All this land is owned by the Department of Antiquities through the Petra National Park.

The stones collected for the construction of the internal and external wall faces averaged 30cm in length, 20cm wide, and 10cm thick. They were an admixture of sandstones, limestones and flint nodules which was in accordance with the archaeological evidence: the walls were built of quartzite, limestone and flint, with the occasional incorporation of stretches of sandstone slabs but only in small segments of walls (Byrd 2005). I was opportunistic when gathering the stones and left behind only those that showed signs of having been worked. The worked stones scattered through the fields date from the Nabataean occupation in the area and were therefore discarded for these experimental structures on the grounds that they involved relatively modern architectural innovations.

A few of the stones were carried by hand to the experimental area, each individual perhaps managing a load of two to three stones at a time. However, most of the stones were loaded into the back of a pickup truck and driven the few hundred metres around the perimeter of the fence line to the experimental area. A small team of three or four people was able to collect roughly 250 stones in one day (figure 6.14). Rubble-sized stones, ranging between 8cm and 20cm in length, used in the construction of the wall infill were collected at the same time and place as the large stones though occasionally special trips were made to collect more rubble. The present day abundance of limestone and flint in the area illustrates that the Neolithic structures were built with readily available raw material, and no special journeys were made elsewhere to collect stones for construction.

Early village settlements are usually located at the base of south-facing cliffs or slopes that offer natural shelter against adverse weather (McHenry 1980). These cliffs also provide
fallen stones that can be used as building material. The PPNB site at Beidha fits within this typical site location model, with a set of cliffs within 15m of the site on its north side.

As with the early Neolithic structures, the occasional broken quern stone was used in the construction of the experimental building. Three were incorporated into the wall of exB-49. Each was collected along with other stones from the ploughed fields surrounding the site.

**Mud**

The mud for the infill of the wall was made by mixing ten litres of water to four buckets of local soil, in an approximate ratio of 1:4 (litres of water to litres of soil). The soil was sourced from a spoil heap created when digging the foundations of exB-49. A ratio of approximately 1:3 (up to 40 % water) was used at Khirokitia, where straw was also mixed in. To speed up the production of mud we used wheelbarrows for measuring and mixing the mud (figure 6.15). The mud was mixed for about ten minutes, or until the soil had been sufficiently liquefied to present a malleable consistency.

No binding agents such as chaff were mixed in with the mud. The two main reasons for the omission of chaff were the lack of archaeological evidence for it and its current poor availability in the Beidha region. Firstly, plaster and mud samples from the archaeological remains of the early phase of the site lacked any suggestion of voids or direct evidence for vegetative matter (Kalizsan pers comm.). Secondly, straw is in short supply in the Beidha region even in good harvest years. Crops are laboriously collected by hand and all remnants are used as fodder for goats. Until recently straw from the fields was traditionally used in the construction of houses in the Beidha region. The experimental buildings at Beidha test the efficiency of mud without any binding agents and form a contrasting dataset to experiments carried out by Thomas at Lembia (1999), Reynolds at Butser (1995d), and Stevanovic at Çatal Hoyuk (1999). At Çatal Hoyuk it was shown that soil recovered from the spoil heaps re-used without the incorporation of a vegetation binding material added produced unsuccessful bricks (Stevanonic 1999).

Experiments with mud involved variations in the way the mud was mixed, including leaving some mixed mud overnight. Mud used in construction is often left to steep overnight, however this traditionally was done in mixes that include vegetative material. Steeping mud mixtures overnight allows binding agents to leach out of the vegetation into the mud. At
Beidha, the outcome appeared to show that there was no advantage in leaving the mix, without vegetative inclusions, to soak overnight except for reducing by a few minutes the time taken to mix the mud by hand to its final malleable consistency the next morning.

The experiment did involve making some mud without the aid of modern tools. This was done by heaping the soil on the ground, pouring water into a hollow at the top of the heap, and then treading the mixture by foot (figure 6.16). This process, although effective, was inefficient in that a significant percentage of water drained away into the ground below. This would not be a problem if a steady water supply was available, but during the experimental work at Beidha water had to be bought from the Bedouin in the village of Baida Hausing and transported to the site. This source was closer than the nearest permanent water supply identified by Kirkbride which was located one and half hours walk away up a steep hillside at Dibadiba (Kirkbride 1962). Water in the Bedouins’ village is limited, and despite the money we were able to offer in exchange for their water supply, we were essentially depriving a family of water. Common sense, respect, and an acknowledgment of the extreme arid environment of Beidha today altered my approach to water use during the experiments. Every effort was made to economise on water use including supplementing water supplies by bringing jerry cans from Amman, as well as using rainwater and non-drinking water wherever possible.

Approximately 900 litres of water were used in the construction of the wall. A similar amount was also used in the making of the mud to coat the roof material, and an additional, but comparatively marginal amount, was used for making mud plaster to coat the walls.

The annual rainfall during the occupation phases of Beidha is estimated to have been only 200mm (Raikes 1966). Without a permanent water supply in close proximity to the village the construction of the walls, plaster, and roof coating would have been an incredibly daunting and laborious task. A rough estimate of time taken to transport the water over 5km by foot suggests that between 11 and 23 long working days would be devoted to this task. Another possibility is that the Neolithic village in Beidha may have been sustained through the use of a well or water catchment system. Based on recent discoveries in Cyprus (Peltenburg et al. 2000) and Israel (Garfinkel et al. 2006) it is conceivable that such hydrological technology needed to harness water would have been available during the occupation of Beidha. Such great technological advances at Beidha during the PPNB would demonstrate the ability to control, or ‘domesticate’, water as well as plants and animals.
Similar notions for the early management of water, or sociohydrology, are being discussed by excavators at the neighbouring PPNB site of Ba’ja in connection with pre-sedentary communities adapting to seasonal variations in water supply and thus controlling ownership, access, hygiene and storage (Gebel pers. comm.). There is ample evidence for water management at Beidha in the Nabataean period including channels, dams and cisterns. However, there was no evidence at Beidha, either from excavation or survey, for any water installations such as wells, dams or channels dating from the Neolithic. The essential, basic requirement of a reliable water source for drinking, watering livestock, and, in this case, constructing shelter, was therefore still under-researched when the current project began.

The solution came in 2005 with the discovery of the remains of a spring within a hundred metres of PPNB Beidha (Black et al. 2008) (figure 6.17). The new findings from the recent analysis showed that a permanent supply of water was available during the occupation of the PPNB village, but that it seems to have run dry at about the same time as the site was abandoned. It is also thought that the landscape around Beidha during the PPNB was depositional rather than erosional. In such a case the wadi level would have been higher in the PPNB. The discovery of a reliable water supply close to the village at the time of its occupation means that the energy costs in fetching water for the original construction of the village were much reduced from the calculation offered above and indeed almost negligible by comparison.

Plaster

The technique of making and applying the plaster to the walls will be discussed below in relation to the construction method.

Roofing Material

Timbers for the construction of the roof of exB-49, including the large central post, were ordered and collected from a timber yard just north of Amman. They were of mixed species, though predominantly of pine. All were still covered in bark and were untreated.

We bought a truck-load of freshly cut reeds, Phragmites, from a lush wadi in the Wadi Shu’aib, running west of Amman (figure 6.18). The same species of reeds is present in smaller numbers in the region of Beidha today but what little grows is, once again, protected
by the Ministry of Agriculture. The reeds, with their foliage still attached, were approximately 3.5m in length and 0.02m in diameter. They were cut using a modern scythe. For exB-49 approximately 225 shoots were obtained; however only approximately 150 of these were required for the construction of the roof.

The mud for coating the roof was mixed using a wheelbarrow in the same proportions as the mud of the wall infill. However, the consistency of the mud was altered slightly depending on the portion of the roof under construction and also varied from layer to layer. The first layer to be applied was thicker in order to fill the gaps between the reeds (figure 6.19). The last layer was more liquid in consistency and was spread evenly to form a smooth, sealing layer on the roof.

Summary of raw material used in Experimental Building 49

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Quantity</th>
<th>Person hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Procurement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>manufacture</td>
</tr>
<tr>
<td>Timbers</td>
<td>30</td>
<td>*Max. 9 hr 40 minutes to fell</td>
</tr>
<tr>
<td></td>
<td></td>
<td>†Max 48 hours transport</td>
</tr>
<tr>
<td>Stones</td>
<td>More than 900</td>
<td>96 hours</td>
</tr>
<tr>
<td>Mud</td>
<td>5 m³</td>
<td>66 hours</td>
</tr>
<tr>
<td>Water</td>
<td>1800 litres</td>
<td>N/A</td>
</tr>
<tr>
<td>Reeds</td>
<td>150 shoots</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 6.2 Summary of raw material used in ExB-49 * Based on figures produced by Mathieu and Meyer (1997:348 and fig 7); † Based on location of ancient woodland today

c) Construction method

The construction of exB-49 began in May 2002 (figure 6.4 and 6.5).

Foundation pit

It took four people, using modern tools, one day to dig the foundation pit. The pit was 5m in diameter and approximately half a meter deep (figure 6.7). The depth of the original semi-subterranean structure is uncertain. The relationship between sequences of interior and exterior deposits was not satisfactorily correlated during the 1960s excavation, with the
exception of burnt structural remains, such as Building 48. This evidence suggests that the foundations pits of Phase A buildings were at least 0.30m deep.

The depth of the foundation pit varied in accordance with the angle of the slope into which it was cut. In other words, to create a level foundation the pit had to compensate for slope and was therefore deeper in the northern upslope portion. The base of the pit was levelled by eye, without the aid of spirit levels. The fill was a grey-brown sandy silt. It was easy to dig - so much so that the pit edges naturally crumbled regularly. Modern shovels were used for the experiment (spades are rarely used locally because of the very loose sandy soil typical of southern Jordan). Experiments on exB-49 using an ovicaprid scapula, without a fitted handle, showed that it would have been effective as a digging tool. With practice in modern hands a scapula may easily have been as effective in the loose sandy soil at Beidha. This is in marked contrast to the difficulty encountered by previous experimenters on the chalky soil at Overton Down, Wiltshire (Ashbee and Cornwall 1961). However, in the opening stages of this experimental reconstruction we eagerly returned to modern shovels as a familiar and preferable tool.

The spoil from the foundation pit was placed just five metres to the west of the pit and would be used for mixing the mud for the wall infill, wall plaster, and roof coating.

*Timber posts*

The post holes were all dug approximately 0.50m to 0.65m apart and 0.50m from the circumference of the foundation pit (figure 6.20). The postholes were dug using trowels and tailored to the size of the individual timbers, allowing for a tight fit with minimal packing material (figure 6.8). The holes were approximately 0.10m in depth, though larger holes were dug for the larger timbers: 1, 2, 5 and 6.

Care was taken to place the post holes, including those set in the wall, as accurately as possible according to the excavation plan (see figure 5.1). This, at times, meant removing obstructions such as buried stones. It is possible that the seemingly random placement of the timbers in the original construction reflects similar attempts by the original builders to avoid such obstacles.

Each timber was photographed and measured before being inserted in the ground.
Stone walls

The construction of the wall did not start as smoothly as anticipated. The difficulty in obtaining timbers meant that they were delivered in small batches over a period of six weeks - first six timbers, then another six, then two more were delivered making a total of 14 timbers. The delay in getting these timbers and our impatience to begin building meant that the construction of the stone wall began before all the timbers had arrived (figure 6.21). Care had to be taken to bond the wall construction to ensure a smooth join all the way around. The delay in getting timber also meant that the edge of the foundation pit began to collapse under foot before the wall of the structure could be completed.

The stone wall consists of three main parts: inner face; rubble and mud infill; and outer face (figure 6.22). To form the internal wall face we placed stones between the timbers, as well as placing stones tightly up against the back of the timbers to secure the post all three sides. Initially only three to four courses of the wall face were built in this fashion before pausing (figure 6.23). At this point wall building stopped to allow the mud infill to dry between courses so as to form a solid base upon which to continue constructing the wall. In fine weather three to four layers of mud infill would dry in approximately three hours. The infill consisted of rubble-sized stones ranging from small (0.05m to 0.10m) to medium (0.10m to 0.20m) stones packed behind the inner wall with mud poured over the top of the rubble (figure 6.24). The mud was pressed by hand into the gaps between stones. Each mud layer was approximately 0.05m thick. Another layer of stones was placed in the mud whilst still wet. This process of laying the inner stones and then filling behind them continued for several cycles around the structure until we reached the height of the surface level surrounding the foundation pit (0.50m). At this stage the external wall face was started. Large stones were laid on the edge of the pit, sloping inwards. Stretchers were inserted from time to time in order to spread the load across the breadth of the wall and to bind the three wall components together (figure 6.25).

Only basic drystone walling techniques were used in the experiment such as the use of stretchers, avoiding running joins, and using pinning stones (Callander 1982). A stretcher is a long flat stone extending from the inner to the outer face and thus tying the wall together. There is, as yet, no sign of the use of stretchers in the archaeological record at Beidha, and in fact my studies of fallen segments of wall suggest that they were not used (figure 6.26). Stretchers are traditionally incorporated into a wall only every metre or more, depending on
the type of building stones used, and may therefore as yet be undetected in the archaeological record at Beidha. In a study I carried out of the PPNB walls at Beidha there appeared to be some evidence that effort had been made to avoid creating running joins between stone courses. Running joins weaken the wall by preventing an even load distribution and not creating a lock between stones. Minimal chinking or pinning stones were used despite every volunteer’s instinct to use them. The decision to minimise their use was based on the lack of evidence for pinning stones in the archaeological record of the earlier phases at Beidha. Their absence from the available evidence may of course be a result of differential preservation, for example if they have all been washed out of the wall during the post-abandonment phase and before archaeological recording.

Once the wall reached a height of 1.20m, equalling approximately twelve courses of stone, it was capped using large boulders (see Byrd 2005:259 figure 160). These boulders were sizeable enough to cover the majority of the mud and stone infill and are thought to tie in the inner and outer walls as well as protect the infill from the rain (figure 6.27). Thirty boulders were needed around the perimeter of the structure.

*Roof*

The construction of the roof was a much-debated topic leading up to the experiment, and will no doubt be discussed for many years to come. This is simply due to the poor evidence available on which to base its reconstruction and the multiple hypotheses that have already been put forward for the design over the past years. Plans were drawn up and a design chosen based on the available evidence and deductive reasoning (figure 6.28). The design selected provides standing room to the height of approximately 1.80m at the centre of the structure and create a pitched roof to deflect rain. The pitch of the roof was based on previous experimental reconstructions of thatched conical roofs on Iron Age roundhouses in Britain, such as those at Flag Fen, which indicated that the optimum slope of the roof is 45°. This allows for rainwater to be shed quickly and efficiently.

A large central post measuring 2.80m long with a diameter of 0.12m was placed into a posthole measuring 0.20m in diameter and 0.30m deep in the approximate centre of the structure. Small stone wedges were used to secure the position of the timber post in the hole and soil was pushed down between the wedges until it was tightly packed. The upright timbers in the wall, despite being placed in shallow post holes, were well stabilised by the
wall built around them. The framework of the roof was based on 14 rafters sloping from the central post at an angle of 40° to 45°, and resting individually on the 14 upright timbers that had been built into the wall.

The timber roof frame was built in stages. First we secured, using rope, four main rafters to the top of the central post and tied them to upright timbers T1, T5, T9 and T14 (figure 6.29). A second group of four rafters were then placed from the central post to T2, T4, T8, and T13 (figure 6.30). The resting position of the rafters at the junction with the wall depended on the angle and strength of the timber uprights. Some rested directly on the capstones of the stone wall whilst others were tied to the uprights. Arrangements for securing each had to be assessed individually. Most of the timbers were tied at the central post, though the occasional rafter was jammed into the network of rafters converging on the central post and did not require tying down. After the last set of rafters was in place a piece of rope was used simply to bind the network of rafters together at the apex.

Reeds were then attached to the rafters. First we attempted to lash the reeds roughly horizontally from rafter to rafter. This method proved ineffective as each reed had to be tied separately to prevent them from slipping and gathering in a bundle at the base. The second method adopted was tying the reeds vertically, or parallel with the direction of the rafters. A few of these were tied to a ring of reeds that was itself tied to the rafters around the base of the roof (figure 6.31). These reeds were spaced approximately 10cm to 20cm apart. Some reeds were split by hammering them with a stone on a flat stone slab and then the thin reed splinters were woven between reeds to bind them together. They split easily. The entire roof was covered in this fashion until only specks of sunlight shone into the structure. Care was taken to avoid creating a thick springy mat of reeds on the roof. Experiments at Lemba in Cyprus had shown that the thick mat of vegetation subsided over time causing the roof soil to crack and thus allowing water to penetrate (Thomas 1999).

A thin layer of mud was spread over the reeds; however, a portion at the apex of the roof was left bare because we simply could not physically reach it. A ladder, or scaffolding, would have been needed to safely reach the apex. Ultimately it was concluded that the apex of the roof was adequately waterproofed by the mass of converging rafters and reeds, and did not require a layer of mud after all.
Construction work stopped for the winter at this point and large sheets of plastic were tied to the rafters to form a canopy over the structure to protect it from the winter rain. Work resumed the next spring after the rainy season. More layers of mud were placed on the roof in May 2003 (figure 6.5 d). The steep angle of the roof (40°) and the uneven nature of the junction of the rafters with the upright posts created a precarious platform for work on the roof and necessitated the use of a ladder. Fairly substantial handfuls of mud were slapped on all the way round the roof except where the supports of the ladder poked through the roof (figure 6.32). A runny mix of mud was then spread over the roof once the first layer had dried. The holes from the ladder supports were then filled and then a final thin layer of mud was spread over the entire roof and especially on cracks that had started to appear during the two-day long process of covering the roof.

This roof was monitored for three years (see monitoring details below). In April 2006 a new roof was put on exB-49 based on the results of the monitoring exercise and also drawing on data collected from observations of the roofs of exB-48 and exB-18. The slope of the new roof was reduced by shortening the central post. The upright posts (T7, T12, T14 and T8) were reinforced by adding another timber alongside them (figure 6.33). This was done by digging an additional post hole approximately 8cm to 12cm from the existing timber. Unlike the archaeological evidence for the construction of Pimperne House (Harding et al. 1993), there was no evidence at Beidha of disturbance around post holes to indicate that old rotting posts had been levered out before the insertion nearby of replacements. Neither was there evidence from excavations at Beidha of modifications made to existing post holes. This contrasts with observations from excavations of British later prehistoric roundhouses showing additional post packing material and a sequence of post fills (Charles 1982; Reynolds 1982, 1995b). Based on the evidence available at Beidha the old timbers were left in situ and instead new timbers were inserted alongside existing timbers. The remaining ten timbers appeared to be in good condition and were reused unchanged to support the new roof.

New reeds were placed on the rafters. More care was taken in the placement of these reeds in comparison to the first design (figure 6.34). These were tied together in mats/rafts which, once lifted onto the roof, served to create a solid platform. The platform eliminated the need for a ladder and provided a surface strong enough to hold the weight of two adults who spread on the mud coating.
Several experiments in the making and application of mud plaster to vertical walls were conducted during the construction of exB-49. The archaeological evidence from Beidha indicated that the walls, both interior and exterior were plastered, at least in parts. The term plaster is used here to indicate a mixture used for spreading mud on walls to form a smooth surface, and not a mixture involving lime, nor the use of pyrotechnology. Plaster made from mud is weatherproof, bonds with itself, and should only need renewing every ten to fifteen years which is within the useful life expectancy of most residential buildings (McHenry 1980). The general consensus is that walls built predominantly of mud, such as terre pisé or wattle-and-daub, will last up to six or seven years before needing repair work if covered, but only two to three years if left uncovered and exposed to rain (McIntosh 1974; Reynolds 1995b). A mud structure can survive twenty years without major repair work and have a life expectancy of approximately 70 years if roofed. These estimates rely heavily on four main factors: the type of soil used in the construction; the orientation of the walls and position in relation to the prevailing wind and rain; the technique used to apply mud layers; and the quantity and type of maintenance work carried out each season. These factors were considered in monitoring the test patches of mud-plaster applied to exB-49.

Half of the interior and half of the exterior walls of exB-49 were plastered in the summer of 2003 (figure 6.35). The positioning of these test patches provided every possible combination of plastered and unplastered walls in a single structure: both interior and exterior faces plastered; just interior face; just exterior face; and bare, unplastered walls.

Areas for test patches were set aside for different mixtures and application techniques (figure 6.36). Mixture A consisted of soil taken from the spoil heap created when excavating the foundation pit for the structure. This soil was a loose grey brown sandy silt that has been interpreted as slpwash. Mixture B was made using an orange brown sandy clay gathered from the remnants of the 1960s spoil heaps. A silt mixture is thought to improve workability but detracts from the durability of the resulting facings, whereas clay in a mix acts as a plasticizer, retards setting time, and increases water retention (Hendry and Khalaf 2001). Including clay in the plaster mixture is traditionally more effective in forming a long lasting, adhering, waterproof plaster. A pure source of clay was not available in the immediate surroundings of Beidha. The nearest source visible today is in the road sections 1km east of
the site. As a result impure clay, possibly washed down the wadi from the clay source in the east, was used in this experiment as Mixture C.

Both the silt and the clay were simply mixed with water in an approximate ratio of 4:1, soil to water, until they reached a wet and malleable state. The mixtures were applied to the stone walls starting at the base and working up towards the capstones (figure 6.37). This was done using bare hands in a manner that mimics modern plasterers use of a trowel, leaf, and hawk, in that the mixture was handled for a few minutes to bring out the moisture then, when it reached a tacky consistency, it was pressed on to the wall in handfuls. Mixture A was easy to apply in smooth handfuls and only occasionally cracked whilst drying. In contrast, Mixture B was heavy and claggy, could only be applied in lumps, and began cracking within an hour of application. This may have been due to the unseasonally hot day (35°C outside) on which the experiment was carried out.

The mixtures were applied in two coats. The first sealed the wall by filling gaps between stones but left an uneven surface; whilst the second, applied in the final stages of the first drying, formed a smooth layer. A rough surface was left on the first coat for the second layer of mud plaster to adhere to. Whilst the second layer was still slightly wet, patches of this plaster where beaten back, literally pounded, and burnished using stones. These stones were selected from amongst the pile of building stones as looking like ideal hand tools. The two separate coats of plaster were identifiable in exposed sections in November 2005 as the plaster eroded and weathered. A similar plaster finish was discovered at Ain Ghazal where the “completed walls received an interior coating of mud plaster and were finished by a thinner layer of white plaster” (Banning and Byrd 1984:17).

In the experiment the plaster was not of a uniform thickness when applied to the wall simply because it had to compensate for the uneven pre-existing surface created by the different sizes of stones employed in the construction of the wall. The thickness of the plaster was recorded at a set of points and an attempt was made thereafter to monitor the thickness of the wall and the rate of erosion. Unfortunately, the markers placed in the plaster as control points for the experiment were tampered with by visitors, and were ultimately useless for recording accurate measurements of mud thickness and rates of erosion. Therefore the monitoring process had to be based on less controlled observations and on the use of comparative photographs.
The exterior plaster was manufactured using sandy-clay collected from the 1960s spoil heap and was applied in a similar fashion to the interior plaster. At this stage the decision to use a mud plaster made of a clay mix was based purely on aesthetics. Its hue matched that of the standing archaeological remains visible immediately beyond the experimental site and was therefore judged to be in keeping with the overall aesthetics of the site (figure 6.38). The monitoring of the external wall showed that substantial erosion of the external mud plaster only occurred once the roof began to deteriorate. It illustrates how much protection the projecting eaves of the roof offered the wall.

The archaeological record indicated that some plaster was pale pink in colour. I was able to reproduce this colour of plaster by grinding a piece of red sandstone, commonly occurring in the area, with a cup of water poured onto a large pale sandstone block (figure 6.39). It was then applied as a finish to the dried wall plaster by hand, in an attempt to replicate the ‘finger-painting’ identified on PPNB structures elsewhere. In the MPPNB levels in Ain Ghazal “every floor with paint shows that a ‘finger-painting’ approach was used” (Rollefson et al. 1992:449), compared to the ‘broad brush’ technique used in later phases. The majority of the paint applied to exB-49 was added at the base of the wall and was washed away in the first floods, though remnants did survive, albeit very faded, on the upper parts of the wall for at least 30 months. This indicates that the painted plaster can withstand months of general weathering, such as desert winds and rain dripping from the roof, but will not survive in severe floods.

Floors

The floor of exB-49 was left unplastered, and consisted essentially of an unbeaten earth surface. During the construction of the building it was noted that a compact floor surface formed simply through general activity and foot traffic in the area. It was decided that this surface should be monitored over a two-year period to offer a comparison with the plaster floor of exB-18.

Other features related to construction activity

The spoil heap created by digging the foundation pit was placed approximately 5m to the west of the experimental building site. This is where the mud for the wall, roof and plaster was occasionally mixed, usually in addition to mixing mud directly in a wheelbarrow. A
small hollow was dug into the top of the spoil heap into which water was poured, and then
the soil was gradually mixed in to form mud. Once the mud was mixed to the right
consistency it was scooped out and carried to the construction site. The remnants of mud at
the mixing site dried rather rapidly during the summer months to form an irregular mud-
lined pit that was still readily visible two years after the initial construction (figure 6.40).

d) Monitoring and Maintenance

Timbers

Monitoring of the upright timber posts over a four-year period indicated that the posts
remained structurally stable despite some showing signs of rot (figure 6.41). Rot from insect
infestation became prevalent after three years at which point a decision was made to replace
a sample of the affected upright timbers. This insect infestation does not, however, reflect
the life expectancy of timbers in a Neolithic structure because these timbers were not
sourced new for the reconstruction but were instead recycled. ExB-18 and exB-48
incorporated freshly cut timbers and provided more meaningful data on the life expectancy
of timbers, as discussed below (Chapter 6.4.2 d). The premature rot observed in the timbers
of exB-49 provided the opportunity to experiment with replacing timbers within the
structure, as had been noted in the archaeological record (Byrd 2005b:36).

Data from experiments on timber posts suggests that rot begins at the ground interface where
the microbial activity is at its highest (Reynolds 1995b). This is due to the variability in
levels of humidity that exists at ground level. At Butser, the porch posts of the Pimperne
House experiment were replaced after ten years. Reynolds’ experiment indicated that the
inner ring of timbers, despite being protected from the damp by the roof, had completely
rotted below ground level after 15 years. The post packing stones, similar in function to the
stones walls at Beidha, continued to secure the upper, rot-free posts in place. This illustrates
that timber rot below ground level does not necessarily affect the efficiency, longevity, or
load-bearing capacity of posts and hence does not necessitate the immediate replacement of
rotten timbers.

An excavation slot carried out in April 2006 through the floor of exB-49, four years after the
initial construction, partially revealed the base of timber 5 (T5), *in situ* (figure 6.42).
Although this timber looked in a sound condition above ground, below ground it had begun to rot, turning dark brown and taking on a burnt carbonised appearance. Despite the rot below ground the upright post was still securely in position, locked in by the stone wall, and continued to support the roof timbers. This observation suggests that the stone wall played a major role in supporting the timbers even after the base of the timber had rotted, and hence the wall extended the use life of the posts. It was also noted at this stage of the experiment that the roof timbers were unaffected by rot, possibly because they were not subjected to the fluctuations experienced at the earth interface.

*Mud*

Experiments using various mud mixes were carried out, including the construction of mud walls of approximately 0.50m in length, 0.10m deep, and 0.25m high. However, these additional experiments were unfortunately destroyed after just two years of monitoring by an over zealous film crew working on site at Beidha. This illustrates how susceptible to damage experiments at this largely unpolic ed location are to the actions of visitors in an open-air laboratory. The film crew wished to use the reconstructions at Beidha as background scenery for a documentary on early farming communities (figure 6.43). Unfortunately, whilst left unsupervised on the site, they attempted to enhance cosmetically their view of the experimental structures by levelling to the ground all smaller features around the main structures, including the area designated for testing mud mixes.

*Plaster*

The plaster on the interior and exterior wall faces was monitored for signs of decay.
The first signs of the decay of the mud plaster, both interior and exterior, were hairline cracks in the outer mud layer. Analyses of where these occurred indicated that they resulted from insufficient care taken when beating back the freshly applied mud layers; hence residual water pooled within the mud creating cracks during its evaporation. Investing more time in beating back, pounding and burnishing the mud brings the water to the surface, thus minimising cracking. Within twelve months these cracks increased in both length and width. The worst affected area was locally around and over the timber posts notably where the mud

<table>
<thead>
<tr>
<th>Test patch</th>
<th>Soil type – Mixture A or B</th>
<th>Further description of initial construction</th>
<th>Condition after 18 months *</th>
<th>Condition after 30 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; T1</td>
<td>Silt - A</td>
<td></td>
<td>good</td>
<td>Poor – mud peeling off, esp. along edge of timber</td>
</tr>
<tr>
<td>T1 &gt; T2</td>
<td>Silt - A</td>
<td>Filled occasion cracks after second coat, and beaten back</td>
<td>good</td>
<td>good</td>
</tr>
<tr>
<td>T2 &gt; T3</td>
<td>Clay - B</td>
<td></td>
<td>Poor – many cracks</td>
<td>Poor – mud washed off &amp; exposing stone wall</td>
</tr>
<tr>
<td>T3 &gt; T4</td>
<td>Silt - A</td>
<td></td>
<td>good</td>
<td>Poor – mud washed off &amp; exposing stone wall</td>
</tr>
<tr>
<td>T4 &gt; T5</td>
<td>Silt - A</td>
<td>Beaten back when set but not completely dry</td>
<td>good</td>
<td>Fair – less signs of weathering</td>
</tr>
<tr>
<td>T5 &gt; T6</td>
<td>Clay - B</td>
<td>Beaten back whilst applying second coat</td>
<td>good</td>
<td>Good – substantial cracking but remains intact</td>
</tr>
<tr>
<td>T6 &gt; T7</td>
<td>Clay - B</td>
<td>Beaten back when set but not dry; applied red pigment to base</td>
<td>good</td>
<td>Fair – substantial cracking and partially peeling off</td>
</tr>
</tbody>
</table>

Table 6.3 The variables in each test patch. T1>T2 refers to the stretch of stone wall between timber 1 and timber 2, and so on. * Note: all test patches suffered equal damage from a flood in the winter months, six months after the wall were initially plastered.
layers had adhered poorly to the posts and thus created further points of weakness (figure 6.44).

The second signs of decay were small ripples and gullies running down the plaster on the interior wall face. These channels resulted from rain trickling through small holes at the base of the roof and running down the wall, rather than being cast off by the projecting eaves. In the case of test patches T2>T3 and T3>T4, where the mud had not been beaten back during the application process, the small gullies spread and in due course removed a thin layer of mud revealing the stone wall below. The material removed was deposited at the base of the wall tapering outward in a fan shape (figure 6.45) and forming a lip between the base of the wall and floor.

Undercutting at the base of the walls resulting from the splash-back effect of rain, as noted in a comparative study on stages of decay of mud walls carried out by McIntosh (1974) in Western Africa, was not observed on exB-49 test patches. However, a flooding event in the winter of 2003, less than twelve months after the walls were initially covered in mud, washed away the lowest 25cm to 30cm of mud plaster on all the interior test patches. A thin layer of organic material was deposited on and between the stones at approximately 25cm to 30cm above the floor level forming a ‘high tide mark’. Subsequent erosion of the mud plaster faces deposited new material at the base (figures 6.46 and 6.47). The taphonomic sequence observed here may be equivalent to the gradual undercutting noted by McIntosh (1974:167, figure 14). Comparative experiments in Western Africa (McIntosh 1974) indicate that extra stones placed up against the plaster at the foot of the walls prevent undercutting and protect the walls from erosion. This construction detail was also noted in the reconstructions at Khirokitia.

Historically, dados (the lower portion of the walls of a room that is decorated differently from the upper sections through the use of panels) were used to protect the lower and most vulnerable portion of the walls and to retard the rate of deterioration. The mud plaster on walls at Beidha served to protect the core of the walls at its most vulnerable point. The adverse effects of flooding, undercutting and subsequent erosion may also account for the unexplained angled footing stones described within the excavation report as being wedged into the base of interior walls (Byrd 2005:36). These stones may have been inserted secondarily after the original footings were dislodged during catastrophic flooding or after gradual long-term weathering.
Two and a half years after the initial application of mud to the walls of exB-49 sufficient layers of material, up to 100mm thick in places, had washed off the walls to reveal artefacts, such as fragments of pottery, that had been accidentally incorporated into the mud and plaster mixes made from the deposits from the 1960s spoil heap. The larger artefacts fell separately to the base of the wall whilst the smaller fragments were washed down along with the lighter material spreading from the base of the wall.

The technique for applying the mud plaster involved working from the base of the walls up to the capstones, and creating a slight curved lip at the base. A more pronounced lip on the plaster was described at Ain Ghazal “where a floor met the base of a wall, invariably the floor curved upward to a height of approximately 10cm, giving the corners of rooms a distinctly bathtub-shaped appearance…” (Banning and Byrd 1984:17). Another explanation for the bathtub-shaped appearance of the interior of these structures could be in the build up of debris resulting from the gradual decay of the wall. It was noted during the experiments on exB-49 that a significant amount of mud was slowly washed out of the walls during the winter and collected at the base; this process affected even interior walls. The mud formed fans where it washed out around the base of the timbers. An excavation to reveal the nature and formation of these deposits of mud at the base of the walls showed that they were indistinguishable from deliberate lips expressly created during the initial plastering.

In summary, the application of the mud plaster, and especially the clay mixture, involved a great investment of time and energy. The results, seen in Table 6.3, indicate that the time investment in applying this material carefully and carrying through finishing touches does pay off over as short a period as three years, since much less time is needed in the initial construction than is spent in subsequent maintenance of less adequately applied plaster. The treatment to the plaster during the drying phase, such as beating back and pounding using hand tools, affected the durability of the plaster more than the choice of soil matrix. At the three-year monitoring stage the results indicated that the traditional preference for a clay mixture does not hold true; it does not appear to be the superior material for manufacturing plaster for walls. The experiment has demonstrated that just because a practice was widespread does not validate it as an analogy and, as indicated by Stahl, there is still the tendency to “treat traditions as timeless” (1993:247). This is seen in practice at the experimental reconstruction village in Khirokitia (Cyprus) where local traditional builders were employed to construct the Neolithic houses because they were thought to have all the
answers to the building issues. As a result, the reconstructions at Khirokitia are well-finished structures displaying the developed skills of modern traditional craftsmen.

Stone walls

The lack of small pinning stones between stone courses did not appear to weaken the wall of exB-49, and in 2006, four years after its construction, the wall was still stable and intact. The strength of the construction was in the support offered by the rubble infill rather than the strategic placement of pinning stones and stretchers running transversely across the thickness of the wall.

The exact location of the entrance to B-49 is uncertain because a section baulk was left unexcavated in the northwest portion of the structure in the 1960s. It is thought that the entrance was located within this sector, facing in the same direction as the examined entrances to B-18 and B-48. Observations relating to the intrasite planning and spatial organisation of this structure in relation to its neighbouring structures, exB-18 and exB-48, are however only speculative.

Roof

The results from the programme of monitoring for the roof of exB-49 further informed the ongoing debate concerning the construction design of roofs in Phase A at Beidha (Table 6.4). For example, despite, or because of, the steep angle of the roof, the latter did not perform well in rain of any severity. Gradually the mud on the roof washed away in the heavy winter rain leaving the reeds and timbers bare after just three years. Also the extra cost of working at such a steep angle, both in terms of materials and time invested in building a ladder, did not have an immediate or long-term return in maintenance costs.

The monitoring programme also added to the lively debate concerning roofs by providing material for comparative analysis. Fragments of mud plaster that fell from the roof contained impressions of reeds (figure 6.48). These fragments, recovered from interior and exterior ground surfaces of exB-49 provide the only evidence of the nature of the superstructure. These fragments may be compared to reed impressions recovered during excavations at Beidha in the 1960s and more recently from Shkarat Msaied, although both
sets are currently under analysis and were not available for examination during this programme of experimental studies.

<table>
<thead>
<tr>
<th>Date</th>
<th>Condition of the roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 2002</td>
<td>Under construction – timber and reeds covered with plastic for protection from winter rain</td>
</tr>
<tr>
<td>May 2003</td>
<td>Completed construction by adding more layers of mud; 100% mud covering</td>
</tr>
<tr>
<td>Dec 2004</td>
<td>25% mud covering</td>
</tr>
<tr>
<td>Nov 2005</td>
<td>1–2% mud covering, and reeds falling off</td>
</tr>
<tr>
<td></td>
<td>50% of reed coverage surviving</td>
</tr>
<tr>
<td>April 2006</td>
<td>Roof repaired – including change of slope, occasional new upright posts, new reeds, and new coating of mud</td>
</tr>
</tbody>
</table>

Table 6.4 Observations of mud and reed coverage on the roof over a three and half year monitoring period

Observations on peoples’ behaviour inside the roofed structure led to insights into spatial organisation. The focus within the structure was on the floor space for setting down, and use of the timbers for hanging, produce and tools, not as space for standing up in. A study of our use of the interior space of exB-49 was carried out when it was used as a base during the construction of the neighbouring structure, exB-48 (figure 6.49). Food was hung in bags suspended from the rafters to keep it safe from crawling insects as well as the occasional stray goat. Water and tools used in the construction of exB-48 were stored on the floor on the west side. The team of workers and volunteers, seeking shelter from the sun and occasional sand storms, sat on the floor and rested up against the walls on the south east side, though they would move to the west side when the wind changed direction. Shortening the central post, and hence lowering the roof at the apex from 2.44m to 1.90m, during the repairs in April 2006, did not noticeably alter peoples’ behaviour inside the structure.

Casual observations made during the experimental reconstructions included spotting several birds regularly perching on the roof and on the tops of the walls to feed on the insects. Their presence would presumably have kept insect infestation under control, and may have been a feature of the original buildings too.

**Floor**

The unbeaten earth floor created during the construction of exB-49 in May 2002 was monitored over a four-year period.
<table>
<thead>
<tr>
<th>Monitoring interval</th>
<th>Description of floor</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2002</td>
<td>Construction of exB-49</td>
</tr>
<tr>
<td>Nov 2002</td>
<td>Construction debris accumulated on the floor including reeds falling from the roof. The reeds were blown to the base of the wall in the southern half of the structure by the wind entering the building through the northwest entrance. The majority of the debris was cleaned up, though small leaves were left.</td>
</tr>
<tr>
<td>May 2003</td>
<td>Wet mud falls through whilst coating the roof. The mud was cleared off the floor and recycled. Soil deposits washed out of the wall collect around the base of the wall. These deposits are fan-shaped radiating 18cm from the wall and tapering from a height of 5cm up the wall. A path leading into the structure and either side of the central post is worn by visitors. Unlike the surrounding ground, the path is free of wind-blown debris.</td>
</tr>
<tr>
<td>July 2003</td>
<td>Discovered fragments of dried mud with impressions of reeds from the roof in the centre of the floor and at the base of the wall.</td>
</tr>
<tr>
<td>Nov 2004</td>
<td>Deposits consisting of silt, reeds and modern rubbish built up at the base of the internal walls to an average depth of 0.20m and covered the groundstone tools placed near the central post (figure 6.50).</td>
</tr>
<tr>
<td>Dec 2004</td>
<td>Pigment on internal walls still visible even in patches affected by rain</td>
</tr>
<tr>
<td>April 2005</td>
<td>Deposits washed in during winter flooding formed thick compact surfaces sealing wind-blown deposits.</td>
</tr>
<tr>
<td>April 2006</td>
<td>Excavated slot trench through floor to illustrate sequence of deposition</td>
</tr>
</tbody>
</table>

Table 6.5 Observations made during the four-year monitoring period of exB-49

The depth of deposits recorded on the floor of exB-49 after the rainy seasons indicate a possible reason for realigning a structure’s entranceway. The positioning of exB-49’s entranceway on the northwest side of the structure placed it in danger of flooding. The rain water collected from the cliffs immediately to the north and gushed down the main path that had been worn leading to and into the structure (figure 6.51). The semi-subterranean nature of this structure worsened the flooding problem and created pools of water inside. The water collecting inside was recorded to a maximum depth of 25cm (figure 6.52). Although not built in exactly the same position as the original B-49 its general surroundings were comparable. The flooding risk for exB-49 was only slightly alleviated by the subsequent construction of neighbouring structures exB-18, exB-48 and exB-50, which formed partial barriers and deflected some of the surface water from the entrance of exB-49.
The successive interior floor surfaces identified in exB-49 over a four-year period suggest that, if a structure is left unattended and without a door, the majority of deposition occurs in the initial two years. The deposits of 20cm depth recorded in November 2004, two and half years after construction began, were only 2cm less than the fills in B-49 as described by Byrd (2005:36). Byrd has suggested that these deposits represented either a re-flooring event or post-abandonment accumulations. This experiment supports the latter suggestion and suggests a time frame as short as two years for the formation of the fill. This period could be even briefer if the fact that deposits may accumulate more quickly is taken into account, for example had the structure been completely abandoned and not open to visitors. Subsequent deposits in exB-49 are thinner than the initial 20cm deep layer and therefore suggest that material was deposited in a series of events in the early stages of abandonment and does not accumulate in gradual or steady increments, representing seasonal or annual events. The investigation of the stratification of the floor layers in exB-49 also illustrates the possible creation of pseudo-floors through the natural accumulation of deposits. A sequence of deposits introduced through the flooding, followed by baking heat, creates a compact floor surface similar to a man-made mud plaster floor.

The investigation into the accumulation of debris within the structure addresses an issue raised by Byrd. His description of the debris in B-49 states that it “was thicker along the southern edge of the building than elsewhere” (2005:36). This can be explained by aeolian and alluvial action resulting in the appearance of fine materials which accessed the structure through an entrance up slope, in this case from the northwest, and depositing debris down slope against the far southern wall.

Exterior surface levels were investigated and monitored, albeit to a lesser degree than the interior floor levels. Records were kept of the distribution, density, type and size of vegetation growing around the structure. External features, such as drip gulleys, were not recorded in the excavations at Beidha during the 1960s or 1980s. The reconstruction of Pimperne House at Butser confirmed Reynolds’ theory that drip gulleys do not form under the eaves of roundhouses but instead the reverse is true (Reynolds 1995c). The eaves form a protected habitat for vegetation. At Beidha, the area protected by the eaves contained accumulations of deposits that extended 62cm to 80cm from the base of the wall. The occasional clump of crumbled roof mud, no bigger than 10cm wide, had also accumulated under the eaves (figure 6.53). Unfortunately the results of this survey were compromised by the actions of a film crew in May 2004. Without permission, the crew stripped and raked the
area approximately 5m radius around the structure. Some vegetation recolonised the area after six months; however the harsh dry summer prevented any substantial regeneration until the next spring.

e) Summary of experimental results from exB-49

<table>
<thead>
<tr>
<th>Task</th>
<th>Person hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digging foundation pit</td>
<td>14</td>
</tr>
<tr>
<td>Building wall</td>
<td>132</td>
</tr>
<tr>
<td>Building roof 1</td>
<td>142</td>
</tr>
<tr>
<td>Building roof 2</td>
<td>96</td>
</tr>
</tbody>
</table>

Table 6.6 Summary of person hours involved in the construction of exB-49

The inferences to be drawn from this experiment are clear:
- The timber posts that carry the weight of the roof are secured and locked in by the stone wall even after the base of the posts begins to rot.
- Careful application of mud plaster, including beating back and burnishing, is more important in the production of a durable and effective coat of plaster than the choice between a silt or clay mixture.
- A roof of this design (using timbers, reeds and mud) will not withstand heavy rain even if pitched at 40° or more, and so a less steeply pitched roof may be preferable (see the roof of exB-48, Chapter 6.4.2 c, for further investigations into roof designs)
- A layer 20cm deep, described in archaeological contexts as post-occupation deposits, will accumulate on the floor inside the structure within short timescales, i.e. about two and half years. This assumes the absence of a door, and minimal cleaning out of the internal floor area.

6.4.2 Experimental Building 48 (exB-48)

a) Summary of experimental objectives (as stated in Chapter 5)

Following the successful construction of exB-49, exB-48 was built to further investigate building techniques by using a different task force, and by improving on the roof design. This structure was eventually used to stage a burning experiment.
b) Raw materials

Timbers

The timbers for the wall and roof were ordered from a timber yard just north of Amman. The length of the timbers required made it impossible to obtain them from southern Jordan. Even in the north of Jordan it proved difficult; the employee at the timber yard claimed that the timbers came from over 200km away. Whether this is true or not is hard to say but it does highlight how difficult it is to get good wood for construction. All the timbers still had bark on them but had been stripped of small branches. They were all cut to size at the timber yard using a saw, but leaving the ends exposed and untreated. The timbers are not oak, pistachio or juniper as described in the archaeological record, but instead are a type of pine (Aleppo pine) and white poplar. To be true to the archaeological evidence on this point would require timbers to be imported into the country at great expense and beyond financial means. Therefore these experiments cannot be used to assess the quality and suitability of oak, pistachio or juniper. Instead the experiment focuses on construction techniques.

The range of measurements for these timbers was more uniform than those used in exB-49, which had been scavenged from the local environs. The uniform size of the timbers (Table 6.7) facilitated the construction of the roof.

<table>
<thead>
<tr>
<th>Length (m)</th>
<th>Diameter (cm)</th>
<th>Quantity</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00 – 3.08</td>
<td>6 – 9.5</td>
<td>23</td>
<td>Roof beams</td>
</tr>
<tr>
<td>2.00 – 2.05</td>
<td>8 – 12</td>
<td>10</td>
<td>Wall posts / roof support</td>
</tr>
<tr>
<td>2.00 – 2.05</td>
<td>6 – 8</td>
<td>13</td>
<td>Wall posts / roof support</td>
</tr>
<tr>
<td>2.61</td>
<td>12</td>
<td>1</td>
<td>Central post</td>
</tr>
</tbody>
</table>

Table 6.7 Timber measurements for exB-48
<table>
<thead>
<tr>
<th>Timber</th>
<th>Diameter of timber (cm)</th>
<th>Diameter of post hole (cm)</th>
<th>Depth of post hole (cm)</th>
<th>Length of timber (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>12</td>
<td>15</td>
<td>21</td>
<td>202</td>
</tr>
<tr>
<td>T2</td>
<td>9</td>
<td>12</td>
<td>20</td>
<td>204</td>
</tr>
<tr>
<td>T3</td>
<td>10</td>
<td>12</td>
<td>19</td>
<td>201</td>
</tr>
<tr>
<td>T4</td>
<td>9.5</td>
<td>12</td>
<td>20</td>
<td>205</td>
</tr>
<tr>
<td>T5</td>
<td>10</td>
<td>12</td>
<td>20</td>
<td>200</td>
</tr>
<tr>
<td>T6</td>
<td>6</td>
<td>12</td>
<td>19</td>
<td>202</td>
</tr>
<tr>
<td>T7</td>
<td>9</td>
<td>12</td>
<td>21</td>
<td>200</td>
</tr>
<tr>
<td>T8</td>
<td>8</td>
<td>13</td>
<td>20</td>
<td>203</td>
</tr>
<tr>
<td>T9</td>
<td>9</td>
<td>12</td>
<td>20</td>
<td>203</td>
</tr>
<tr>
<td>T10</td>
<td>8</td>
<td>10</td>
<td>19</td>
<td>202</td>
</tr>
<tr>
<td>T11</td>
<td>9</td>
<td>12</td>
<td>20</td>
<td>202</td>
</tr>
<tr>
<td>T12</td>
<td>11</td>
<td>13</td>
<td>19</td>
<td>205</td>
</tr>
<tr>
<td>T13</td>
<td>12</td>
<td>14</td>
<td>20</td>
<td>208</td>
</tr>
<tr>
<td>T14</td>
<td>7</td>
<td>10</td>
<td>19</td>
<td>202</td>
</tr>
<tr>
<td>T15</td>
<td>8</td>
<td>13</td>
<td>19</td>
<td>202</td>
</tr>
<tr>
<td>T16</td>
<td>9</td>
<td>10</td>
<td>20</td>
<td>203</td>
</tr>
<tr>
<td>T17</td>
<td>7</td>
<td>11</td>
<td>20</td>
<td>203</td>
</tr>
<tr>
<td>T18</td>
<td>7</td>
<td>11</td>
<td>21</td>
<td>203</td>
</tr>
<tr>
<td>T19</td>
<td>8</td>
<td>12</td>
<td>20</td>
<td>206</td>
</tr>
<tr>
<td>T20</td>
<td>5.5</td>
<td>11</td>
<td>20</td>
<td>206</td>
</tr>
<tr>
<td>T21</td>
<td>7</td>
<td>10</td>
<td>19</td>
<td>205</td>
</tr>
<tr>
<td>T22</td>
<td>11.5</td>
<td>15</td>
<td>20.5</td>
<td>208</td>
</tr>
<tr>
<td>T23</td>
<td>7</td>
<td>11</td>
<td>20</td>
<td>205</td>
</tr>
</tbody>
</table>

Table 6.8 Timber measurements and corresponding post holes

Archaeological evidence from prehistoric sites in Europe has suggested that the ends of post were charred before being placed in the ground to help preserve them (Jewell 1963; Bell et al. 1996). The charring, usually to a depth of 0.3175 cm, creates a seal to prevent decay. An experiment was carried out to replicate this scenario in the arid environment surrounding Beidha where rotting caused by damp conditions are not thought to be a problem for the majority of the year.

The ends of two timbers, T20 and T23, were charred in a Bedouin camp fire for one hour before being erected in the ground (figure 6.54). For the first half hour each timber was placed directly in the flames and then simply placed in the hot ashes of the fire for the next
30 minutes. T20, a timber of pine wood, was charred to a depth of 1.5cm around the base and 19 to 21cm up the length of the timber. The timber reduced approximately 30mm in diameter during the charring process. T23, a timber of poplar, measured 70mm in diameter, and was charred 0.32m up the timber to a depth of less than one centimetre.

Stones

To collect stones for the construction of exB-48 we had to go slightly further than when gathering for exB-49. Previous procurement had virtually stripped the fields of appropriate sized stones (much to the satisfaction of the local farmers). The extra distance was on average only 200 to 300 metres further, however this would have equated to a sizeable increase in energy cost for the original builders. Only a handful of stones were collected on foot during the construction of exB-48 whilst the majority were transported by a vehicle. Even with the use of a vehicle the procurement of stones created a bottleneck in the construction process. It was a hard and slow task.

The main stones used in the construction were of the same types and approximate size as used in exB-49.

Mud

No alterations were made to the technique of making mud as that used in the construction of exB-49.

Plaster

A small portion, one sixth, of the interior wall was plastered. The test patch was located between T8 and T12 with the primary aim of monitoring the effects of the fire on the plaster (figure 6.55). The results are presented in Chapter 7.

Roofing material

As with exB-49, roof timbers and layers of Phragmites reeds were covered in layers of mud starting with thick layers and progressing to a thin spread.
Summary of raw materials used in Experimental Building 48

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Quantity</th>
<th>Person hours Procurement</th>
<th>Manufacture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timbers</td>
<td>47</td>
<td>*Max. 15 hrs 40 mins to fell</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>† Max 78 hrs to transport</td>
<td></td>
</tr>
<tr>
<td>Stones</td>
<td>Over 1200</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>Mud</td>
<td>6.5 m³</td>
<td></td>
<td>Quarter of total</td>
</tr>
<tr>
<td>water</td>
<td>2000 litres</td>
<td></td>
<td>Not applicable</td>
</tr>
<tr>
<td>Reeds</td>
<td>200</td>
<td></td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

Table 6.9 Summary of raw material used in Experimental Building 48
*Based on figures produced by Mathieu and Meyer (1997:348 and fig 7) for felling trees with a diameter of 10 cm or less, using a stone axe. † Based on location of ancient woodland today

c) Construction method

Construction of experimental building 48 (figure 6.56) started at the beginning of September 2003.

Foundation pit

The foundation pit of exB-48 was more complex than that of exB-49 because of the more steeply sloping terrain. It sloped a total of 35 cm, from north to south, over the five metre diameter of the foundation pit. As a result the northern end of the foundation was 65 cm below the external surface level whilst the southern half was approximately only 30 cm below the exterior surface level. The varying depths of the foundation pit were judged by eye during construction and then recorded using a dumpy level.

The pit measured approximately 4.70 m in diameter north to south and 5.20 m from east to west (figure 6.57). These measurements are approximately 10 cm short of the total diameter recorded on excavation plans of building 48. This error margin was created deliberately to allow for the edges of the pit to crumble during the construction of the wall, as they had done in exB-49. The entrance way was not dug out for the same reason.
The finds retrieved during the digging included the occasional fragment of Nabataean pottery, undiagnostic lithics, some plastic and metal, and one incised stone bracelet probably of recent Bedouin origin. The entire fill was of disturbed slopewash material. The pit took four people two days to dig. It was a hot day when we started digging the pit, dust blew into our eyes, and all four members of the task force rapidly became unmotivated and subsequently efficiency levels dropped.

*Timber posts*

Twenty-three timbers served as upright posts in exB-48. The timbers are of pine and poplar. The positioning of these posts was based on the evidence provided by the 1966 plan of B48 and subsequently in plans published in Byrd’s monograph (2005:244 figure 139). The distance between posts varied from 0.40m to 0.80m.

<table>
<thead>
<tr>
<th>Timber ref #</th>
<th>Distance to next timber (cm)</th>
<th>Timber ref #</th>
<th>Distance to next timber (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>72</td>
<td>T13</td>
<td>83</td>
</tr>
<tr>
<td>T2</td>
<td>54</td>
<td>T14</td>
<td>64</td>
</tr>
<tr>
<td>T3</td>
<td>61</td>
<td>T15</td>
<td>51</td>
</tr>
<tr>
<td>T4</td>
<td>58</td>
<td>T16</td>
<td>64</td>
</tr>
<tr>
<td>T5</td>
<td>58</td>
<td>T17</td>
<td>47</td>
</tr>
<tr>
<td>T6</td>
<td>42</td>
<td>T18</td>
<td>78</td>
</tr>
<tr>
<td>T7</td>
<td>80</td>
<td>T19</td>
<td>54</td>
</tr>
<tr>
<td>T8</td>
<td>76</td>
<td>T20</td>
<td>41</td>
</tr>
<tr>
<td>T9</td>
<td>38</td>
<td>T21</td>
<td>40</td>
</tr>
<tr>
<td>T10</td>
<td>66</td>
<td>T22</td>
<td>52</td>
</tr>
<tr>
<td>T11</td>
<td>78</td>
<td>T23</td>
<td>70</td>
</tr>
<tr>
<td>T12</td>
<td>77</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6.10 Measurements between upright timbers in exB-48

All of the timbers in this experiment were numbered using small metal discs (2.5cm in diameter) hammered into the trunk of the timber at a height of 1.50m (figure 6.58). Slightly larger discs were used on the roof timbers and the position of the disc was recorded relative to the junction of the roof timber with the upright post. The tags were designed to help identify the remnants of the posts after the burning experiment (see also Hansen 1966). The central post, T24, was tagged at a height of 1.51m.
Two of the larger timbers, those with a diameter over 10cm, were placed either side of the entrance way: T1 and T22. The other larger timbers, T12 and T13, were placed on the far side, opposite the entrance way. The placement of these larger timbers was based on the size of the post holes illustrated in the excavation plans of B-48. It is thought that they were strategically placed to take a greater proportion of the load of the superstructure (Byrd 2005). There is no statistical evidence resulting from the experiment to support this theory but observations during the construction of the roof indicated that the load was distributed unevenly and therefore would benefit from the occasional larger support timber. This uneven distribution of weight was due to the irregular nature of the structure in plan including the different measurements of the spaces between upright posts, the off-centre central post, and the distances between the central post and upright posts.

According to the excavation plan of B-48, a post hole was located in the middle of the entranceway. Presumably this held a timber of comparable size. T23 was therefore placed in the middle of the entrance way (figure 6.59). The entrance way is still wide enough to enter the structure by walking either side of the timber but access when carrying large loads, such as fully-laden baskets, was inconvenient if not impossible. Concerns were voiced about T23 in that it would not have a stone wall either side to support it. Similar concerns arose for T1 and T22, either side of the entrance way, which would only have a stone wall on two out of four sides. During the construction of exB-49 it was noted that the upright timbers only became fully secure once the wall enveloped them on at least three sides (figure 6.60). T1, T22 and T23 of exB-48 would illustrate whether a wall support on either one, two or indeed no sides would be enough to take the outward thrust of the roof. Alternatively the post holes for these three uprights may have been deeper than the others, however there is no evidence from the archaeological record to support the change in post hole depth.

The central posthole was positioned in accordance with the 1966 excavation plan for B-48. This posthole, located slightly off-centre, was dug to a depth of 0.65m and 0.50m wide. The posthole was filled with a mixture of ash from a Bedouin hearth mixed with some water to form a paste, and then packed with rubble (figure 6.61). More water was poured down into the hole once the timber was in place to form a cement-like mixture. The inclusion of ash in the posthole was twofold: firstly, evidence from experiments conducted at Lemba in Cyprus indicated that extra strength was gained in mixing clay and ash together so that the particles form an interlocking mass (Thomas 1999:116); and secondly, central features excavated at the neighbouring PPNB site, Shkarat Msaied, were filled with ashy deposits.
Stone wall

The construction method of the stone wall was similar to that of exB-49. In other words, it began with the construction of an inner stone wall face with a rubble and mud infill behind it.

We were unsure of how to build up the wall as it progressively reached the outer surface level because of the large difference in surface levels around the circumference of the structure (figure 6.62). The most obvious solution was to gradually step the wall up the gradient following the outer surface level. The foundations of the external wall would therefore be built into the sloping terrain and counterbalance the angle of the ground to form a level surface for each new course of stones. Other suggestions included levelling the surrounding area and building small terrace walls to hold back the slopewashed sand as seen in excavations at Basta; or digging footings into the surface level for each individual stone; or building a double wall on the upslope presumably to reinforce the wall and prevent it leaning outwards, as seen in excavations at Ba’ja. A study of the archaeological remains at Beidha showed that the first suggestion, stepping the wall gradually, would present the most accurate replication of the evidence available.

Four stretchers were introduced into the wall at a height of 0.35m to 0.40m, measured from the internal surface level. One large slab of stone, 0.85m long, was placed between T16 and T17. Fewer stretchers were used in this structure than in exB-49, mainly because we had depleted the immediate surroundings of sizeable stone slabs. Instead of using stretchers a course of stones was occasionally placed at right angles to the course below (figure 6.63). There is no archaeological evidence to support this technique, however, it was the overwhelming feeling amongst the task force that it was a reasonable and easy technique to adopt in order to stabilise the wall during construction. A step was placed in the entrance way to support T23 and to help prevent the entrance way from crumbling too much.

The stone wall, measured from the interior floor level, was 1.10m to 1.20m high. On top of this, capstones were placed taking the wall up to an average height of 1.30m (figure 6.64). Thirty-five capstones were used, each averaging 0.25m to 0.40m wide (figure 6.65).

As a result of the increasing demand for stones we had to go further afield to find appropriate stones in order to maintain some consistency in stone size used in the construction of the
wall. From this experience it is interesting to note that observations made during archaeological excavations relating to the differences in size and shape of stones may simply be a reflection of the immediate availability of raw material during the original construction. Additionally, small changes in the use of raw materials may reflect the unquantifiable effect of fluctuating energy and motivation levels of the builders on a particular day. For example, as energy levels ebbed so did our motivation to source the appropriate building material; we collected odd-shaped stones simply because they were lying closer to the reconstruction site.

On average, we, a team of five, managed to build one course of the wall per hour. This included mixing the mud, building up the inner face, pouring in the mud, and placing the rubble in it. On an average day we managed to build up approximately two courses of the wall and the rest of the working day involved collecting stones, rubble and water. It took eight days to build the wall.

The team consisted of myself, two volunteering European archaeologists, and two local Bedouin men. The division of labour developed after just three days of working together. The two Bedouin, obliging and hard working, were driven by economic gain, whereas myself and the volunteers were motivated simply by the experimental process and our incentive was research-based. Taking on the supervisory role I attempted to rotate the tasks so as to evenly distribute the harder tasks, but without any strict formal division of labour the Bedouin men tended to collect stones and make the mud infill whilst we built the interior and exterior wall faces. This division between collecting raw material and the building tasks suggests ancient trends of labour division between labourers and specialists (Abrams and Bolland 1999). It is also important to note that the Bedouin do not have a tradition of building walls. One elder in the local village proudly claimed to know how to build stone walls similar to the terrace walls seen in the fields of the sloping land around Beidha, but on the whole the tradition of building, even tents, has died and been replaced by breeze-block houses constructed under the auspice of government housing schemes.

The building material available in the Beidha region guided the technique used to build the stone wall. When faced with a pile of stones a builder will first look for the largest most regular shaped stone and then fill the gaps either side. A stretch of wall consisting of predominantly irregular and ill-fitting stones indicated that all the good building stones had been used up and that it was time to head out to collect more stones.
Attempts to build a flat radiating roof failed (figure 6.66). The design of the roof of exB-48 intended to test the hypothesis that a semi-circular structure at Beidha may have had a flat roof radiating from a central post. The roof was to be approximately 2m high at the centre of the structure and radiate at that height to the upright posts in the walls. This would leave a gap of approximately 0.70m between the eaves of the roof and the tops of the walls, which had been built to a height of 1.30m. First, a central post, measuring 2.61m in length and 0.12m in diameter, was placed in a posthole 0.65m deep and 0.50m in diameter. The posthole was filled with a mixture of ash from the Bedouin hearth and water, and then packed with rubble. More water was then poured down into the hole and compacted.

The problem with the roof design was the arrangement of twenty-three radiating roof timbers meeting at the same central post. The timbers converged and stacked up gradually causing each timber to slope more than the previous and ultimately creating an uneven and sloping roof. To build a perfectly flat roof using radial timbers each upright timber would have to be approximately 0.09m taller than the previous upright to allow for the extra height added to the central post with each new rafter. This would be a relatively simple calculation if the rafters were added starting at T1 and progressing round to T23, but, if as Byrd suggests, four thicker uprights were placed strategically into the wall of the structure to take the strain of the superstructure then the order of the placement of rafters would be more complex. In sum, the construction of a flat roof using wood of irregular sizes would require careful planning early on in the construction process, in other words before commencement of wall building at which point each upright timber would have to be carefully selected, trimmed to size and no doubt labelled according to a finalised plan.

The resulting radiating roof design for exB-48 was very unstable. We struggled to cover the uneven surface in reeds because of the large steps and holes that had developed between radial timbers (figure 6.67), and so several mats of reeds had to be woven and placed at converging angles to create 100% coverage. It was then difficult to cover the reeds with mud. The mud at the centre of the roof was very thin (maximum 0.03m thick) compared to the outer perimeter which averaged 0.05m thick.

Flat stones were placed in the wet mud in a test patch along the northern edge of the roof (figure 6.68) following the evidence presented by Byrd that suggests that there were “stone
slabs either below or on top of the clay” on the roof (Byrd 2005:34). The purpose of these stones in the original construction is uncertain and was not elucidated in the short monitoring period of this feature. However, the placement of stones within the mud coating on the roof was repeated during the construction of exB-18 and was further monitored to reveal their possible function within the design of the roof (see exB-18, Section 6.4.3, for further details). In the experiment conducted on exB-48 the focus was on observing the position of the stone slabs relative to the sequence of collapsed roof material. Therefore, each individual stone slab was numbered using chalk and its position recorded through photography as well as on a 1:20 scale drawing (figure 6.69). Their positions were recorded again following the collapse of the roof during the burning experiment (figure 6.70).

Evidence from the excavation of B-48 led Byrd to suggest that the ceiling, as well as the walls, were plastered after the roof construction was completed (Byrd 2005). Attempts were made to replicate the ceiling plaster, however the mud would not adhere to the underside of the roof timbers and reeds. Various consistencies of mud were trialled as well as elaborate techniques for throwing, coating and holding the mud in place. All attempts were very messy and ultimately failed.

**d) Monitoring and Maintenance**

**Timbers**

An exploratory trench was dug at the base of upright timber posts 2, 18 and 23 sixteen months after their initial interment. Two of these, T2 and T23, were excavated to a depth of 0.18m, and T18 to a depth of 0.16m (figure 6.71). The results were inconclusive with respect to the possible benefit of charring timbers to protect them from rotting and infestation from insects. Neither the charred T23 nor uncharred T2 showed any sign of either rotting or woodworm, however uncharred T18 showed signs of slight woodworm activity up to 0.08m below the ground surface level. The experiment needs to be repeated using a larger sample of charred and uncharred timbers.

The central posthole was sectioned two years after the burning of the structure (figure 6.72). From the surface the remaining stub of a charred timber, measuring 0.102m in diameter, was visible and thus indicating a shrinkage *in situ* of 180mm from the fire. The posthole was
revealed in plan once the burnt roof debris and occupation deposits were removed. The compact cemented ash material and post packing was clearly visible radiating a maximum of 0.18m from the charred central post. The post itself was only burnt to a depth of 250mm which corresponds to the depth of the debris accumulated during the fire. In other words, the central timber did not burn below ground level.

*Roof*

Only 60% of the stone slabs on the roof were recovered after the collapse. The remaining 40% were presumably moved by visitors or accidentally picked up and reused by experimenters. Signs of burning, in the form of blackening, were only visible on 10% of the stones. Mud from the roof construction adhered to 5% of the stone slabs. The majority fell either on the wall or onto the floor of the structure, 25% and 30% respectively, whilst only 5% fell on the ground outside. A line demarcated by the ring of posts at the junction of the roof dictated the region in which the slabs fell. The slabs that were set near the perimeter of the roof fell either on the wall or outside. Those set further in fell onto the floor. This indicates that the slabs fell straight to the surface below and their fall was only minimally affected by the slight slope of the roof. From the point of view of assisting archaeologists in interpreting house fills this experiment illustrates that only a portion of the slabs or tiles on a roof, those placed directly over the interior of the structure, will be recovered within the fill.

Within the stratigraphic sequence of roof collapse debris excavated from within exB-48 the slabs were located above a thin layer of ash and burnt reeds representing the burning of the fine foliage and reeds; but the slabs were mixed in with mud from the roof, and were covered by more burnt roof debris that had fallen in the final stages of the roof collapse. The interpretation on the stratigraphic sequences of this material relative to the evidence noted during the excavation of B-48 is commented on further in the next section on the events and results of the burning experiment (Chapter 7).

The difficulty in replicating the position of the posts and the roof construction indicates that irregular posts were used in the original construction. It suggests that the framework of the roof construction (i.e. the timber rafters) were set out in position before the upright posts could be established. In other words, the irregularities in the timbers called for more planning than would be seen when using standardised timbers. No two branches are the same therefore making exact replication impossible.
e) **Summary of Experimental Results from exB-48**

<table>
<thead>
<tr>
<th>Task</th>
<th>Person hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digging foundation pit</td>
<td>60</td>
</tr>
<tr>
<td>Building wall</td>
<td>80</td>
</tr>
<tr>
<td>Building roof</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 6.11 Summary of person hours in the construction of exB-48

The results of exB-48 indicate that:
- Charring the base of upright timbers does not appear to alter the likelihood of insect infestation in a timber.
- Considerably planning is needed in the construction of a flat roof.

6.4.3 **Experimental Building 18 (exB-18)**

a) **Summary of experimental objectives (as stated in Chapter 5)**

During the construction of exB-49 and exB-48 the fundamental building techniques and materials had been investigated and were undergoing monitoring. ExB-18 intended to experiment further with variations of the building techniques, however its primary role was to form the third structure in the complex. It shared walls with exB-48 to the north and exB-49 to the south.

b) **Raw Materials**

**Timbers**

Timbers for the roof were, once again, ordered from a timber yard just north of Amman. The majority of them were pine, though an occasional telegraph pole was slipped into the pile (complete with nails and strips of cable). Some of the timbers were freshly cut so much so that one grew shoots after being incorporated into the roof of exB-18 (figure 6.73).

<table>
<thead>
<tr>
<th>Length (m)</th>
<th>Diameter (cm)</th>
<th>Quantities</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.80</td>
<td>10</td>
<td>15</td>
<td>Uprights</td>
</tr>
<tr>
<td>1.50 – 2.00</td>
<td>10</td>
<td>13</td>
<td>Roof timbers</td>
</tr>
</tbody>
</table>

Table 6.12 The measurements of timbers used in construction of exB-18

**Stones**

The fields around the site were almost completely depleted of stones because of the intensive collecting for the construction of exB-49, 48 and 10. Therefore stones were collected from
the wadi bed and were predominantly round in shape. It was not worthwhile stopping to
collect the few stones that had resurfaced in the fields during the winter (since building exB-
10). The majority of stones were collected from the corner of the trackway, just before
turning into the Seyl Aqlat. Stones were also collected from the large pile that had been
dredged from the base of the wadi by a mechanical digger the previous year.

We collected stones for two mornings, and occasionally stocked up as the week went on.
We collected buckets full of rubble from the same locations. Flat slabs for the roof were
collected from the 1960s spoil heaps that slope away to the west of the archaeological site.

*Water*

We filled roughly seven jerry cans a day, totalling 140 litres, from a house in the Baida
Hausing village. The water was from the mains piped in from the spring at Dibadiba, the
ancient spring mentioned in Kirkbride’s interim reports. On the last day of building
(beginning of June) the village ran dry, and so I was taken to a recently restored Nabataean
cistern along the road to Little Petra and Beidha. The cistern is used by locals only in times
of drought to water their livestock and was in no way suitable for drinking.

*Reeds*

The reeds were stripped by the suppliers and delivered to Beidha (Siq el-Barid). Of the total
189 shoots, each measuring about 3.50m long, approximately 75% were used in the
construction of the roof of exB-18. The rest were used to complete the roof of exB-48.

*Mud*

Soil for the wall infill and the roof came from the excavated foundation pit.

*Summary of raw material used in the construction of exB-18:*

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timbers</td>
<td>28</td>
</tr>
<tr>
<td>Stones &lt; 700</td>
<td></td>
</tr>
<tr>
<td>Mud</td>
<td>4 m³</td>
</tr>
<tr>
<td>Water</td>
<td>1200 litres</td>
</tr>
<tr>
<td>Reeds</td>
<td>100 shoots</td>
</tr>
</tbody>
</table>

Table 6.13 Summary of raw materials used in the construction of exB-18
c) Construction method

Construction of exB-18 began on April 25th 2004, and lasted two weeks. The core construction crew consisted of myself and two local Bedouins (Mohammad Ibrahim and Musa Abdul Aziz), who both took part in the construction of exB-49, 48 and 10. We were all now experienced in the construction of semi-subterranean buildings having built two previously.

The floor plan of B-18 is irregular (figure 5.4) and a replica of the shape was attempted. This was complicated by having to fit the irregular shape between the existing two structures, exB-48 and 49 (figure 6.74). The plan of exB-18 is a satisfactory representation of the original structure though does not represent an exact replica.

Foundation pit

The foundation pit for the structure is half a metre deep to match the depth of both ex-B 48 and 49. It took three people one morning to dig the foundation – totalling 12 hours work using modern tools (spades and wheelbarrow). We were lucky to have a cool but not windy day.

There were no archaeological artefacts in the soil removed.

Timber posts

From the experiences, observations and results gathered whilst constructing the roofs of exB-48 and exB-49 a second attempt was made at building a flat roof. However, this time there was no central post. The key to the construction of the roof was obtaining an even, level surface upon which to rest the roof timbers. This process began by ensuring that the upright timbers reached two separate heights: one height for the main supporting rafters and another, slightly higher, for the cross beams. The four uprights for supporting the two main rafters were placed either side of the main entrance way with corresponding uprights at the back (in the east wall) of the structure.
These four timbers measured:

<table>
<thead>
<tr>
<th>Timber</th>
<th>Diameter at base (cm)</th>
<th>Diameter at top (cm)</th>
<th>Length (cm)</th>
<th>Depth of posthole (cm)</th>
<th>Diameter of posthole (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12</td>
<td>10</td>
<td>180</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>13</td>
<td>11</td>
<td>180</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>C</td>
<td>15</td>
<td>10</td>
<td>180</td>
<td>20</td>
<td>20*</td>
</tr>
<tr>
<td>D</td>
<td>12</td>
<td>10</td>
<td>185</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 6.14 The measurements of the four main upright timbers. * the post hole for timber C had to be re-dug once we discovered that the timber first selected for C was only 178 cm in length.

The height of all four main upright timbers was 1.64m above interior ground level. The upright timbers either side of the back entrance (entrance to the north-east) were also 1.64m above interior ground level. We used several techniques to ensure that the timbers reached the same height. One method included measuring the timber and then subtracting 1.64m, the result equated to the depth of posthole needed (this could be done without a tape measure by simply placing timber B up against timber A which was already in the ground and marking off the desired length). Another method was digging a posthole of about 0.20m and then finding a timber that would fit best. This latter method was based on a lot of trial and error, and eyeing in the height.

The other 11 timbers reached a height of 1.72m above interior ground level (figure 6.75). We dug different depths of postholes to accommodate the differences in timber lengths.

*Stone wall*

The construction technique for exB-18 was generally the same as that used for exB-48 and 49 though it differed in two main aspects. Firstly, the stone wall was interrupted by two entrances, one to the west and the other to the north-east. Secondly, the exterior faces of exB-48 and 49 constituted the exterior face of the wall for exB-18 (figure 6.76). In other words, the wall on the building’s northern and southern side was built with just an inner face and rubble/mud infill, using the neighbouring structures for their exterior wall faces. Elsewhere, to the east and west, the wall was double skinned as seen in the construction of the previous two experimental buildings. According to Byrd, B-18 and B-48 were built at the same time based on the fact that the “two structures shared a considerable length of the same wall” (2005:35). This experiment has shown that sharing walls in itself is not enough
evidence on which to build a stratigraphic sequence of construction. A closer look at the character of the wall, however, may provide better indications of phases of construction.

The stones were of less desirable shapes than those used in previous structures because they were collected from the wadi bed. As a result construction was done with less attention to aesthetics. Basic construction techniques were still applied, such as locking in the timbers by building tightly up against the post as well as placing larger rubble behind each upright timber, and strengthening the wall by introducing stretchers. The wall, built to a height of approximately 1.25m, was completed in just four days! The speed of construction was aided by two main factors. One was the experience gained through the two previous constructions, but more significantly were the existent shared walls. Sharing walls more than halved the stones needed and hence cut down on time needed for collecting stones for the construction.

In places, the wall is very thin at the base. The timber uprights were placed very close to the outer perimeter of the foundation pit, almost directly up against the sides of the pit itself, allowing for less room to build the wall. This was a direct result of exB-18’s proximity to neighbouring structures in that the walls of exB-48 and 49 gently sloped inwards thus creating an outward lean on the walls of exB-18. The wall thickened as the height increased. In other words, the exterior walls of exB-48 and 49 slope inwards and therefore the exterior wall of exB-18 had to slightly slope outwards in order to abut them (figure 6.77).

<table>
<thead>
<tr>
<th>Wall @</th>
<th>Wall @</th>
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<th>Wall @</th>
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<th>Wall @</th>
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</thead>
<tbody>
<tr>
<td>G</td>
<td>H</td>
<td>I</td>
<td>E</td>
<td>F</td>
<td>B</td>
<td>C</td>
<td>J</td>
<td>K</td>
<td>L</td>
<td>M</td>
<td>M2</td>
<td>N</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.67</td>
<td>0.82</td>
<td>0.66</td>
<td>0.70</td>
<td>0.37</td>
<td>0.40</td>
<td>0.45</td>
<td>0.30</td>
<td>0.32</td>
<td>0.42</td>
<td>0.64</td>
<td>0.56</td>
<td>0.58</td>
<td>0.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6.15 showing the varying thicknesses of walls

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of wall (m)</td>
<td>1.12</td>
<td>1.08</td>
<td>1.09</td>
<td>1.06</td>
<td>1.09</td>
<td>1.08</td>
<td>1.07</td>
<td>1.15</td>
<td>1.08</td>
<td>1.10</td>
<td>1.10</td>
<td>1.08</td>
<td>1.06</td>
</tr>
<tr>
<td>Plus capstones (m)</td>
<td>1.27</td>
<td>1.21</td>
<td>1.31</td>
<td>1.29</td>
<td>1.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of courses</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 6.16 showing the height of walls
The ever-depleting source of good stones in the surrounding fields meant that the capstones were a combination of horonzing rubble plus large capstone boulders. The final rubble-mud layer, in which the rubble averaged 0.15m in length, was arranged in horonzing pattern along the tops of the wall. Approximately 45 stones were used on top of the southern wall, and approximately 70 stones on the northern wall. The boulders were placed on top of the crazy-paving towards the exterior or in the middle of the wall. Large rubble/small boulders were placed in between the capstones to close the gaps.

The reeds from the roof of adjoining building exB-49 were trimmed *in situ* using a saw to make room for the wall of exB-18 as it grew upwards (figure 6.78).

**Roof**

The roof design for exB-18 incorporated fourteen rafters resting on fourteen upright timbers built into the wall. Unlike exB-48 and 49 the design did not involve a central post. The decision to experiment with this design stemmed from recent evidence from the neighbouring PPNB site at Shkarat Msaied in which large ash-filled pits in the centre of the circular semi-subterranean structures had been interpreted as hearths, and not burnt post holes. The dimensions and description of the hearth closely matched that of postholes described at Beidha. Therefore exB-18 provides an alternative interpretation on these central features and also forms a direct comparison to the features constructed in exB-48 and 49.

The placing of the upright timbers and the selection of the roof timbers was a complex task that involved considerable planning. The care taken in achieving the correct heights for the upright timbers was explained above in relation to raw material. For the roof construction the focus was on the secure positioning of upright timbers A, B, C, and D which were to take the majority of the load. The two big rafters stretching from timbers A to B and C to D would not sit comfortably on top of the uprights so notches were sawn into the top of the uprights. Just enough was notched to cradle the rafter (figure 6.79). Then the rafters were tied to the uprights (finding a knot to secure them was not easy and the result was not 100% satisfactory). The rope was not seen as crucial for securing the rafters but merely helpful in holding them in place during the construction process. Several pairs of hands would have served the same purpose. Notches and knots were also used to secure a beam across the north-east entrance. The other ten beams were placed to stretch from the remaining uprights to rest on at least one of the main two rafters running from A/B and C/D (figure 6.80).
These beams were then tied to the rafters to further secure them. One upright was too short to be of any use in supporting the roof and was left unused. The beams projected over the thickness of the wall to form a small eave.

Reed mats for the roof were made at ground level and then raised to the roof. For the mats the reeds were laid out parallel to each other and tied to three cross beam reeds measuring 0.10m longer than the width of the mats (figure 6.81). Two mats were made measuring:

<table>
<thead>
<tr>
<th>Mat</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Number of reeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mat 1</td>
<td>3.50</td>
<td>1.60</td>
<td>50</td>
</tr>
<tr>
<td>Mat 2</td>
<td>3.5</td>
<td>0.80</td>
<td>25</td>
</tr>
</tbody>
</table>

A third small mat of reeds was inserted at the northern edge of the roof to bridge the gap to the roof of exB-48. A layer of mud was then placed over the reed mats. The mud mixture was thick enough not to slip through the few holes in these mats. Two layers of mud were applied, both approximately 20mm thick. A ring of small flat slabs, averaging 0.10m in length with a maximum thickness of 0.05m, was placed in wet mud around the perimeter of the roof in a crazy-paving style. The placement of the stones on the roof expanded upon a similar experiment carried out on exB-48. The effect of the stones was monitored (see below in monitoring and maintenance).

**Floor**

This was the first experiment at Beidha in laying a floor in one of the structures, and further included the construction of a simple hearth. Mud, mixed to the same consistency as the wall infill and the roof coating, was spread on the ground using hands and a trowel to a thickness of 10 to 20mm (figure 6.82). The mud was pressed up against the stone walls and
forced to slightly lip up against the bottom stones of the wall (figure 6.83). A central hearth was made by digging a shallow pit, 0.50m in diameter, in the approximate centre of the structure. This was also lined with mud plaster. The mud dried for just a few minutes before we brushed the surface with a brush made of twigs from a nearby shrub. This process simulated beating back the mud surface and brought the moisture to the surface. This is, according to the local Bedouin Mohammad Ibrahim, how they now lay the concrete floors in their houses in their modern village.

\[d\) Monitoring and Maintenance\]

**Stone walls**

B-18 is described as having “witnessed considerable remodelling and reuse during its use life” (Byrd 2005:35). To replicate the changes it underwent in the history of its occupation, the north-east entranceway of exB-18 was blocked in November 2005, 18 months after the initial construction was completed. Monitoring of exB-18 over the 18-month period provided a possible indication as to why the entrance of B-18 had been blocked. The monitoring suggested that the prevailing winds created a through-draught, either from the west or east, making it very difficult to keep a fire lit.

The monitoring of exB-18 did not indicate that the position of the entrance made the structure prone to flooding. However, based on the results from both exB-48 and 49, the blocked entrance in exB-18 may have been an attempt to control flooding problems. The entrance was facing north-east and upslope, and with the slight variations in the neighbouring topography, may have been prone to flooding.

The wall ends at the entrances were prone to collapse, and both were repaired eighteen months after their initially construction (figure 6.84 and 6.85). The weaknesses were due to the odd angles of the wall as they abutted exB-48 and 49.

**Floors**

Fires were lit in the hearth of exB-18 periodically throughout the course of the experiments at Beidha. These were generally difficult to light because of the wind and draught entering
the structure through the west and northeast entrances. This was a problem even with temporary doors constructed out of reeds and cloth set in both doorways. This is because the prevailing wind at Beidha is from the east in the morning and swings round from the west in the afternoon as the thermals rise up the valley. Therefore one or the other entrance would always let in a draught.

The mud plaster lining of the hearth reddened from the heat of the fires, especially on the eastern rim as the wind blew in predominantly from the west. Ash deposits did accumulate in the hearth over the two-year monitoring programme of exB-18. However, these deposits were rarely more than 0.02m deep because the majority of the ash had been blown across the floor of the structure and accumulated in the cracks between stones at the base of the walls. Therefore the hearth did not simulate the great depth of deposits noted during excavations at Shkarat Msaied.

The deposits on the floor of the structure, including fragments of reeds, goat dung, and modern rubbish, were 0.05m thick after eighteen months (figure 6.86). The deposits were up to 0.10m thick in the western entrance to the extent where the steps had been completely buried.

**Roof**

The stone slabs placed in the uppermost layer of mud on the roof acted as an additional waterproof layer. The slabs channelled water off the roof and prevented water from pooling (figure 6.87). In sections without stone slabs rain water would collect, soften the mud plaster, and gradually start seeping through the layers of mud and eventually form a hole in the roof. The holes rapidly grew with every rainfall and more of the roof washed away.

e) **Summary of Experimental Results of exB-18**

<table>
<thead>
<tr>
<th>Task</th>
<th>Person hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digging foundation pit</td>
<td>12</td>
</tr>
<tr>
<td>Building wall</td>
<td>72</td>
</tr>
<tr>
<td>Building roof</td>
<td>48</td>
</tr>
</tbody>
</table>

Table 6.19 Summary of person hours involved in the construction of exB-18
In summary, the results of exB-18 indicated that:

- A small stone structure can be built in just four days.
- The wind can clean out a hearth, leaving little more than shallow pit of reddened plaster.
- Stone slabs placed in the mud on a roof prevented water pooling and extended the use life of the roof.
- Small structures built in the spaces between existing buildings are quick to build, but the structural stability is compromised.

ExB-50

According to the excavation site plans there is a small, enclosed space between B-48, 49, and 18 called B-50 (Byrd 2005:244 figure 139). There is no evidence of B-50 surviving on the archaeological site today. However, it has been described by Byrd as an alcove providing access to B-48 and B-18. This space was created by two stone walls. To replicate this space one wall was built extending south from the western wall of exB-48 and incorporated two upright timbers along the eastern side of the wall (figure 6.88). These upright timbers may have supported a roof. This could be easily achieved by creating a canopy of reeds and mud stretching over to the existent roofs of exB-18 and 48. However the space was left open during the experiments. The second wall protruded west from the wall shared by exB-49 and 18. No foundation pits were dug for either of these walls. These were built in an attempt to replicate the spatial organization of the small complex of structures (B-48, 49 and 18) and not as a further experiment into the construction technique and methods of wall building.

The construction of exB-50 altered the course of surface water around the complex of structures. Its western wall served to deflect the water from entering the courtyard space, and thus also shielded all three entrances to the structures.

These two walls were built by four people in just two hours.

6.4.4 Experimental Building 10 (exB-10)

a) Summary of experimental objectives (as stated in Chapter 5)
This structure aimed to address aspects of the construction materials and techniques used in the construction of a semi-subterranean rectilinear, or pier, building. The observations and data collected was directly compared with data collected during the construction of the semi-subterranean circular buildings, exB-18, 48 and 49.

Unfortunately, compromises had to be made during the construction of exB-10 early on in the construction process because of an unexpected archaeological feature appearing during the excavation of its foundation pit. The north-south walls of exB-10 had to be shortened by up to one metre to avoid disturbing the archaeological feature.

b) Raw materials

Timber

No timber was used in the construction of the walls of exB-10. However, four short timbers were used in the construction of the roof.

Stones

Stones were collected from the wadi and surrounding fields as they had been for the previous experimental structures. This time we had to go further afield to get hold of large blocks suitable for the foundation of the structure. Unlike the construction of the early buildings pinnings, small wedge-shaped stones, were used in the construction of the wall to stabilise the larger stones. These smaller stones were gathered from the same location.

Mud

The same methodology for making mud was followed as in previous experiments. Mud was mixed using the soil excavated from the foundation pit. Approximately half of the excavated soil was used for the wall infill, the other half was used in the roof construction. Water was collected in jerry cans from Petra. We used approximately 180 litres a day.

Plaster

The walls were coated with test patches of plaster twenty-four and thirty months after the initial construction phase was completed. This corresponded to the time of the construction of the second storey and lime plaster experiments, respectively.
Roofing Material

Approximately 250 reeds were used to cover the roof of exB-10.

Summary of raw material used in the construction of exB-10:

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Quantity (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large stones</td>
<td>2352</td>
</tr>
<tr>
<td>Small stones / rubble</td>
<td>6400</td>
</tr>
<tr>
<td>Water</td>
<td>2400 litres</td>
</tr>
<tr>
<td>Reeds</td>
<td>250 shoots</td>
</tr>
<tr>
<td>Soil for mud wall infill</td>
<td>6.36 m³</td>
</tr>
<tr>
<td>timber</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 6.20 Summary of raw materials used in the construction of exB-10

c) Construction method

The construction of exB-10, a rectangular pier house, began in October 2003 (figure 6.4 d).

Foundation pit

A task force of four people dug a rectangular foundation pit, approximately 5m by 6m, following the plans drawn up in 1966. The shape of the foundation pit was irregular. It was more complex to dig a rectangular pit than a circular one; the right-angle corners were difficult to judge by eye. Unfortunately the shape of the pit had to be slightly altered to fit into the space allocated for the experiments. Furthermore, we moved the pit 1 metre north after digging to a depth of 0.05m and discovering a buried terrace wall, and further shortened the length of the foundation pit when we discovered more traces of the wall at a depth of 0.50m. As a result the pit measured 4.80m by 5.30m (figure 6.89). Fortunately there is only a relatively small gradient in the slope of the terrain around the site of exB-10 and therefore it did not create any difficulties when trying to dig a level foundation for the structure. The relatively flat surface was a direct result of the buried terrace wall that had truncated the plan of the experimental structure.
Stone wall

The plan of the southern wall and piers of exB-10 was distorted by the discovery of an earlier possible terrace wall whilst digging the foundation pit. Therefore the space between the last pier and the southern wall measured only 0.50m rather than 1.20m (figure 6.90).

The construction of the walls was similar to that of the circular semi-subterranean experimental structures. They consisted of an inner face, a rubble mud infill, and an outer face. The outer wall face simply followed the rectangular shape defined by the edge of the foundation pit. However the inner face was more complex in that it undulated in and out to reflect the shape of the piers (figure 6.91). The piers were incorporated into the main construction of the walls rather than abutting as later additions to the structure. The piers differed in size and their shape was dictated by the measurements given on the excavation plan. They were not of a uniform size, nor were they mirrored along a central axis. An infill of mud and rubble bonded the inner and outer walls together, including the piers.

The largest boulders were used as the foundation stones, and then the wall was built up using the usual method up to the level of the exterior ground surface. Two methods of wall construction were adopted once the walls reached the height of the exterior surface level. To the east of the entrance the wall was banked up against the baulk of the foundation pit and stepped out over the edge of the pit once it reached the exterior surface level. To the west of the entrance the wall did not lean on the sides of the foundation pit and instead initially stood free and was then supported by an infill of mud and rubble to the exterior, before adding a second wall that started at the exterior surface level (figure 6.92). Essentially, the difference in construction technique meant that to the east the wall was built leaning against the solid sides of the foundation pit, however to the west the wall was free standing and the sides of the foundation pit were extended using mud infill in order to contour the shape of the wall.

The monitoring of these two segments of wall indicated that the construction technique used on the eastern wall was weaker than on the western side. Within six months of construction, and after a very wet winter, a large gulley formed along the eastern wall up to 0.25m deep (figure 6.93 and 6.94).

The construction of the piers is similar to the wall construction technique in that it uses large stones with mud and rubble infill, except at the base of the piers in the southern part of the structure (figure 6.95). Here, the first course was solely of large stones and mud with no
rubble infill. This was largely due to a misinterpretation by the local workmen though appears to have resulted in a very solid foundation. At foundation level the stone walls are only one course wide with a mud and rubble infill up against the bank of the foundation pit and broaden to double thickness to include an outer skin with rubble infill once they reach the exterior surface level.

Whilst building the walls there was a natural tendency to step them in slightly with each course added. A conscious effort had to be made to keep the walls as vertical as possible to avoid creating precariously thin towering walls (figure 6.96).

The back, or southern, wall of exB-10 was only 0.30m to 0.40m thick because the floor plan was altered to avoid archaeological deposits. This allowed for a maximum of 0.10m of mud and rubble between inner and outer courses. To compensate for the thinness of the wall, frequent stretchers were placed across the wall to tie in the exterior and interior courses. The thinness of this wall does not however compromise the experiment, in that it still corresponds with the excavation plan. The plan of B10 does not show a complete southern wall, nor is there any archaeological evidence for this wall surviving on site today. According to Byrd, “the south wall, particularly the exterior, is poorly preserved” (2005:62). The lack of evidence for this part of the structure allowed for some flexibility in experimentation.

The construction of the walls of exB-10 began on the eastern side of the entrance and each stone and handful of mud was added working clockwise around the building. As a result the eastern side of the building was higher, more solid and contained larger stones. By the end of a round we were left with less desirable working material. The variability in the quality of stones and mud reflected this availability. We collected stones first thing in the morning, usually for an hour, which would last approximately three courses.

The size and shape of the stones dictated the building technique used. The best stones in the immediate surroundings were used in the construction of exB-48 and exB-49. As a result more pinnings were needed to stabilise the less favourable stones used in the construction of exB-10. The pinnings were placed in the exterior face and also wedged behind the stones before the mud infill was added. More pinnings and medium-sized rubble were further added to support the awkward shaped stones. More medium-sized, irregular stones were used in the upper courses, once again because of the lack of good building stones. These
were much harder to build with because of their irregular shape. The tops of the walls therefore became uneven and exasperated the difficulty in building.

A small niche was built into the interior face of the eastern wall along the back of the bay (figure 6.97). A niche was not described in the original excavation details of B-10, however they were common features of pier structures, such as B-5 (Byrd 2005:348 figure 302). The niche was constructed using flat stones collected specifically for the feature (figure 6.98). The standard construction technique had to be interrupted to allow for the recess to be built into the wall. The selection of a space for the niche, as well as the selection of special flat stones for its construction, implies planning beyond the repetitive nature of the wall construction.

The final course of stones served to cap the wall ready for the roofing material (figure 6.99). The stones were slightly stepped into the wall in order to cover the majority of the mud infill. Spaces between the caps were filled with large rubble stones, creating a crazy paving pattern.

*Further experiments in stone walls*

Two small partition walls, a single course deep and three to four courses high, were built inside exB-10 in December 2004. Byrd and Banning have suggested that “occasionally, builders subdivided the hall more completely by filling the space between piers with a high wall pierced by a window, or with a low wall, to create two small chambers flanking the longitudinal axis” (1988:66). Walls such as these, although not recorded in B-10, were a common internal feature during Phase C at Beidha. Because only one experimental pier structure was be built at Beidha it was decided to assimilate architectural details such as these into the present experiment. The walls were replicated according to the details provided in the description of B-3 (Byrd 2005:373 figure 336), and were placed either side of the central axis of exB-10.

According the site records from the 1960s excavations at Beidha, a retaining wall was located just over a metre north of the entrance to the structure. This slightly curved wall was replicated in an attempt to explain its original location and function. In November 2005 a wall segment two courses high, one course wide, and 3m long was constructed by one person in less than one hour (figure 6.100). The dimensions of the wall replicated those on the
excavation site plan, except along its westernmost end where the wall was shortened by approximately 0.30m so as not to form an obstacle to tourists visiting the structure.

The original experimental objectives included narrowing the entrance to exB-10 from its original 1m width down to approximately 0.50m wide. This experiment may have helped explain aspects of the structures re-use, maintenance and architectural adaptations. However, this step of the experiment was not carried out because of the adverse effect it would have on visitors to the site. Narrowing the door would prevent the majority of tourists from venturing into the structure, and would also reduce the light entering the structure. Therefore, for the sake of visitors’ experience of the Neolithic structure, this aspect of the experiment was abandoned.

**Roof**

Minimal timber was used in the construction of the roof for exB-10. The piers considerably narrowed the span of the roof. Therefore only three timbers were needed to stretch from east to west across each of the pairs of piers (figure 6.101). The timbers were salvaged from previous experiments and measured 2.30m, 2m and 1.5m. The ends of the timbers were jammed under the capstones and more mud and stones were added where needed to secure them in place.

Several mats of *Phragmites* reeds were woven and placed to bridge the gap between timbers (figure 6.102). A thick bed of *Phragmites* leaves were placed on top of the reeds before the mud was thrown on. The reeds did not always stretch across the wall line and as a result the mud from the roof slipped directly on to the wall in places (figure 6.103). Mud was placed on the roof in several stages over several months. The first instalment used 300 litres of water, and took three people three hours. More reeds were placed on the roof before a second layer of mud was added. This helped to even out the surface of the roof. The mud thickness totalled 0.05m.

**Floor**

The floor of the lower structure was left as an earth beaten floor and was not plastered.
The evidence for second storeys on rectilinear buildings in Phase C at Beidha is controversial and is based primarily on the interpretations provided by both Kirkbride and Byrd. In order to test these theories an upper storey was attempted on exB-10 in November 2005 (figure 6.4 i) after two years of monitoring the structural features of the initial single storey construction. Here, an upper storey is defined not simply as a structure in which the roof space is used for daily activities, but includes an upper wall enclosing a floor surface that was, at least partially, roofed.

Kirkbride’s theory suggests that the wide stone baulks, or piers, separating the small rooms may have been constructed as interior buttresses to support a lightly built upper storey (Kirkbride 1966a:203). To test her theory the upper storey of exB-10 was built to rest primarily on the piers of the southern two-thirds of exB-10 (figure 6.104 and 6.105). As preparation, the roof was levelled off using handfuls of reeds and mud to provide an even ground for the wall construction. This was deemed necessary after noting the substantial sagging that had occurred since the construction of the roof two years earlier (figure 6.106). Once the roof had been reinforced the construction of the second storey began. The wall followed the same technique as that used in the other experiments though it had to be slightly modified to accommodate the narrowness of the walls upon which it was built. The second storey walls could not project further than the tops of the walls of the structure below. Therefore these upper walls consisted of an inner and outer face with little or no inner rubble and mud infill. The narrowness of the wall was more striking, and alarming, along the southern wall where the wall head of the lower exB-10 had only been 0.30m to 0.40m wide. The width of the upper wall was 0.35m at its widest and only 0.20m at its narrowest.

Buttress-like features were occasionally added to the interior face of the wall to provide added support (figure 6.107). Additionally, mud was plastered on the outer face of the southern upper wall in an attempt to fill the holes and secure the stones in position (figure 6.108). The role of these two new building techniques was fulfilled in previous experiments at Beidha by the rubble and mud infill.

The upper wall was only built to a maximum height of 0.75m, totalling 2.10m from the base of wall of exB-10 at exterior ground level (figure 6.104). At this height the wall began to feel precarious and unstable.
A hearth was constructed on the floor of the upper storey (figure 6.109). Minimal evidence was available for the construction of the hearth. The excavations at Beidha did not reveal the elaborate hearths as uncovered at Ain Ghazal. In Ain Ghazal the hearths were shallow pits up to 0.90m in diameter with evidence of repeated plastering with red paint along the raised clay border. The basic structure of this hearth, without the red paint, was replicated on the roof of exB-10.

d) Monitoring and Maintenance

Stone walls

Kirkbride suggested that the small corridor rooms were used to live in, or perhaps used as workshops, based on the collection of artefacts found relating to specialised activity areas. However, my personal experiences of the space created by the walls and piers of exB-10 suggest that the small rooms were not constructed with either sleep or work in mind. The space between piers is not large enough even when taking into account the prejudices of modern living. There is not enough elbow-room for activities such as using a grinding stone or knapping flint. These rooms were more likely to have been constructed with storage in mind.

This theory was tested by carrying out a series of temperature checks on the interior and exterior of the structure throughout the year. In the spring the interior was approximately 4°C cooler than the outside temperature, and maintained an average temperature range between 17.4°C to 24.3°C compared to the average exterior temperature range from 20°C to 31°C. In the winter the temperature inside ranged from 15°C to 22°C whilst the outside temperature ranged from 9°C to 25°C. The results showed that the mean temperature in the basement of exB-10 maintained a steady core temperature throughout the year and therefore proved to be ideal for storage.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time of reading</th>
<th>Interior reading (°C)</th>
<th>Exterior reading (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 April</td>
<td>12:40</td>
<td>23°</td>
<td>21°</td>
</tr>
<tr>
<td>3 May</td>
<td>16:57</td>
<td>24°</td>
<td>28°</td>
</tr>
<tr>
<td>11 May</td>
<td>16:58</td>
<td>26°</td>
<td>31°</td>
</tr>
<tr>
<td>25 Nov</td>
<td>15:20</td>
<td>21°</td>
<td>20°</td>
</tr>
<tr>
<td>2 Dec</td>
<td>02:00</td>
<td>20°</td>
<td>9°</td>
</tr>
</tbody>
</table>

Table 6.21 Examples of temperature readings taken during experimental programme
The monitoring of the partition walls suggests that they provided extra protection for material stored in the rooms of exB-10. Raw material, including wood and reeds, stored behind the partition walls was predominantly protected from the damp caused by flood waters and shielded the material from general trampling by visitors to the site. The construction of the partition walls created an easy solution for compartmentalising the storage of materials. As such, a deliberate step was taken to create a space for setting aside materials for later use. However, the partition walls of exB-10 collapsed within twelve months. It is likely that the walls fell as local children played in the structure, and, unlike the thick walls of the structure, these walls crumbled easily. The ease with which these features were built (less than one person hour) and fell (within twelve months) suggests that these were temporary features, perhaps creating storage spaces for a single season.

It was noted that within six months wind-blown sand, to a depth of 0.06 m, had gathered on the northern side of the small retaining wall built just north of the entrance to exB-10 (figure 6.110). These observations during the experiment support Byrd’s suggestion that the wall may have “functioned to keep deposits from accruing on its north side away from the entrance” (2005:62). The retaining wall is not thought to have been built as part of the original construction of B-10, but instead “added later after deposits accumulated directly north of the building” (Byrd 2005:62). In addition to the interpretations offered by Byrd from the archaeological evidence, the observations from the experiments also suggest that the wall alleviated the damage done to the structure by deflecting the flow of ground water during heavy rain. The gulley that formed to the immediate north of exB-10 in the first winter was protected from further eroding in the second winter.

**Roof**

Substantial sagging took place between the piers in the northern part of the experimental building over a two-week period. A timber, running north to south, was wedged in below the reeds to help support the sagging roof. Further significant sagging, up to 0.31m drop, was recorded two years after the initial construction of the roof and thus reducing the interior height from 1.56m to 1.25m.

**Floor**

Deposits of wind-blown sand up to 10mm thick were recorded in the northern two bays/rooms, closest to the entrance, six months after the initial construction of exB-10 was
completed. Lighter debris, such as vegetation and plastic rubbish, was blown into the building and deposited in the southern two bays at the rear of the structure (figure 6.111). As with the deposits described by Byrd for B-10, the deposits in exB-10 sloped from the entrance steps down into the structure. The observations from this aspect of the experiment suggest that deposits would accumulate within the structure immediately after abandonment. However, contrary to Byrd’s suggestion, these deposits could naturally accumulate and do not necessarily imply deliberate dumping.

**Second Storey**

Querns were placed on the floor of the second storey to replicate one of Kirkbride’s early interpretations which suggested that querns had fallen from above and “thus suggesting that grinding was carried out on the roofs” (Kirkbride 1962:8). Until the roof of exB-10 collapses there is no direct evidence from the experiments to support this interpretation. However, observations and experiences of the experimenters’ use of these space suggested that there was inadequate space in the basement of exB-10 for activities, but ample on the second storey.

A portion of the upper wall of the second storey collapsed six months after its completion. The collapse was at the wall end by the entrance to the upper storey (figure 6.112). As with the wall collapses of exB-18, the weakness was due to the exposed wall end.

e) **Summary of Experimental Results of exB-10**

<table>
<thead>
<tr>
<th>Task</th>
<th>Person hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digging foundation pit</td>
<td>48</td>
</tr>
<tr>
<td>Building wall</td>
<td>288</td>
</tr>
<tr>
<td>Building roof</td>
<td>72</td>
</tr>
<tr>
<td>Building 2nd storey (partial height)</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 6.22 Summary of person hours involved in the construction of exB-10

In summary, the results of this experiment indicated:

- Thick exterior walls and thin partition walls create a space suitable for storage, and not an activity area for specialised crafts
- Constructing a small retaining wall north of the entrance minimises damage caused to the building by surface water
- The basic construction technique used in the earlier circular structures was employed in structures of later phases

6.4.5 Other related experiments

Lime plaster production

…we have proposed that the crucial evidence for understanding the effects wrought across the southern Levant are best seen in the areas of animal husbandry and the culturally motivated requirements for lime plaster production (Rollefson et al. 1992:468).

Archaeological experiments into the production of lime plaster were conducted by Chloe Brown at Beidha in the spring of 2006 (figure 6.113; for full details of the experiments and results see Brown 2006). Three fires were built within the experimental zone at Beidha to investigate types of fire installations (open fire, open-pit fire, and closed-fire pit), the amount and type of fuel (wood versus dung), and technology involved in extracting lime (e.g. slacking).

Her results suggest that the amount of fuel needed has been over-estimated in the past (Rollefson et al. 1992) and hence the environmental impact may not have been as dramatic as has been first suggested by Rollefson and Köhler-Rollefson (1989). Production of lime plaster has been suggested to cause:

…radical deforestation around settlements such as Beidha and Beisamoun, for example, exposed land useful for agriculture, but only on a temporary basis…Inhabitants of many settlements were thus forced to disperse to smaller permanent sources of water, and the necessarily smaller populations that could be supported escaped ‘archaeological visibility’ for subsequent investigation (Rollefson et al. 1992: 468).

Brown’s investigations indicate that the production of lime plaster was likely to have required specialised knowledge, however manufacture could have been carried out at a domestic level in open fires, and hence may leave little to no trace in the archaeological record (Brown 2006).
Chapter Seven
The experimental destruction of exB-48 by fire

On the 3rd November 2004 an experiment was carried out to burn down experimental building, exB-48. This chapter presents observations from similar experiments carried out at other sites, before considering the objectives, events, results and conclusions from the conflagration experiment conducted at Beidha. The key aim of the deliberate destruction of this building was to establish a sequence of events to explain the archaeological remains found on site.

7.1.1 Summary of similar experiments

Documented conflagration experiments have primarily focused on wattle-and-daub structures or grass huts (e.g. Bankoff 1979; Friede 1980). These experiments have demonstrated that the initial burning of the roof material and wattle lasts approximately twenty minutes, up to which point someone could enter the burning building to rescue artefacts and belongings. The fire then enters into a second stage in which it smouldered for up to six hours and produced structural damage, ultimately resulting in outcomes such as timbers burnt to leave just postholes filled with ash.

The evidence gathered from the accidental burning of two experimental LBK houses (Stein 29 and JK 13) at Archeon provided insights into the interpretation of burnt architectural remains in the archaeological record (Flamman 2004). Investigations were carried out on the two burnt buildings immediately after the accident in 1995 and again two years later. The timber structures were almost completely destroyed within one and a half hours after ignition at which point, at the request of the experimenters, the remains were extinguished by firemen using a fine hose in order to preserve what remained of the burnt timbers. The observations made during this procedure indicated that the thatched roof material burnt quickly, and that laths of thatch slipped down the rafters, which further exposed the walls to raging fire as straw fell beside the walls. However, loam plaster exposed to severe heat for 45 minutes was only fired to a depth 2 to 3mm. Some laths of thatch fell inside the building and some, depending primarily on the direction of the wind, fell outside.
The life history of a building prior to it burning down can affect the interpretation of burnt remains. An example is from retrospective observations, rather than through experiments, made by Gordon in war-torn Waziristan, which led him to suggest that “all levels containing an ash layer cannot be due to destruction by burning; very many must represent dirty ash-impregnated floors” (1953:152). His observations of archaeological evidence of burnt/raided villages from the second millennium suggests that “the interior of a Wazir house where fires have burned for many years on an open hearth with no chimney and very little ventilation, presents a floor thickly coated with a fine grey dust hopping with fleas and a brushwood ceiling kippered black with smoke” (Gordon 1953:151).

Structures covered in mud present a different scenario when burnt. This was noted by Wilshusen in his observations of the burning of a Pueblo pit-structure in America, similar in form to the semi-subterranean structures of Phase A in Beidha:

…rate of burning is proportional to both the amount of inflammable substance exposed to oxygen and to the temperature of the fire which is applied to the substance….To create a quick and massive burning of a pit-structure it is necessary to either supply a substantial source of external heat to the roof or to confine the fire in one section of the roof and thereby accumulate heat (Wilshusen 1986:247).

These observations of the burning of mud, timber and thatch buildings from a range of environments can be compared and contrasted with the observations made at Beidha, as illustrated below.

7.1.2 Summary of experimental objectives

The primary objective of the burning experiment at Beidha was to replicate another stage in the history of B-48 by observing and monitoring the effects of events that may have led to the formation of burnt and carbonised remains discovered during the original excavation of Building 48. The excavation of the burnt remains of B48 revealed preserved construction materials of the circular semi-subterranean structures typical of Phase A. The interpretation of this data provided the main body of evidence for the experimental construction of exB-48. The next stage in the experiment was therefore to test the nature of this source material by staging a fire in the reconstructed building to examine the remains that were produced. Details of the conflagration were teased out of the evidence quoted below, including evidence such as the oxidisation of the stone walls and stratigraphic sequencing of burnt deposits, to provide forensic clues of the sequence of events that took place.
7.1.3 Evidence from Building 48

Detailed descriptions of the remains of B-48 included these observations:

The burning of the building caused many of the wall stones to be oxidized-reddened by the fire, and considerable roof fall accumulated within the building. The latter included reed impressions and burned beam fragments that provided insight into the nature of the superstructure. Radiocarbon dates were obtained on a *Juniperus* sp. roof beam, a *Quercus* sp. wall post, and the *Pistacia* sp. central post. The superstructure debris that accumulated within the building varied in thickness between 50cm and 80cm. It included several discrete layers and indicated that the superstructure collapsed in a series of episodes. The lower portion contained a considerable quantity of burned roof timbers (including a probable fragment, between 15cm and 20cm in width, of the central post) and slightly oxidized roof clay. Above this was more roof clay containing a number of large stone slabs (presumably from the roof); then more charcoal from roof beams and reeds; and finally highly oxidized clay containing numerous reed and beam impressions, and plaster fragments. Based on this evidence, it appears that the roof was constructed of a series of beams which were covered in reeds. Then clay was laid on top, with stone slabs either below or on top of the clay. The ceiling and walls were then plastered.

After the building burned, a portion of the western wall was destroyed by pit digging perhaps for the construction of subphase A2 building 51 or for stone robbing purposes. No trash accumulated within the building (Byrd 2005:34).

The fire in Building 48 also resulted in the preservation of artefacts *in situ*. Building 48 contained heavy implements including: grinders, polishers, axes or hoes, querns and a whetstone (Kirkbride 1967:10). This level also contained two figurines of baked clay, circular ‘shadows’ from a wooden bowl, and details of baskets.

One of these houses was destroyed by a very fierce fire, and the resultant baking and solidifying of the mass of clay, mortar and plaster from roof and walls supplied a magnificent series of plant impressions. In addition, a heap of carbonized pistachio nuts which may originally have amounted to some five gallons, was found on the floor in perfect condition. They seem to have been lying in a basket; the resin released from the nuts by the heat has preserved imprints of the weave in a thin skin of tar. (Kirkbride 1966a:205).

From this house – and baked hard in its destruction – came a section of a small, very primitive clay bowl as well as a lively representation of an ibex and modelled aurochs’ horns (Kirkbride 1966a:206).
7.1.4 Preparations for the experiment

First and foremost, an assessment of the potential dangers of setting alight a structure was considered and the necessary safety precautions were executed. The possibility that the fire could get out of control was taken into account. Preparations therefore included ensuring that an ample supply of buckets of water and sand were readily available, as well as stationing a fire extinguisher within easy reach of the experimental area.

The scene was then staged, incorporating as many experimental objectives and variables as possible into this one experiment. It was appreciated that staging a repeat experiment could only be achieved at the expense of destroying another experimental structure, so that it was important to anticipate and record all potential outcomes. A series of preliminaries were undertaken in order to make the recording of the destroyed building as meaningful as possible. These included: tagging the timbers with fireproof markers (figure 6.58); plastering portions of the interior wall face in order to observe the baking effects on plaster (figure 6.55), as well as oxidisation on the stone wall faces; and photographing the walls just before the firing took place (see Chapter 6 for details). All elements of the roof construction were completed, including roof timbers, reeds, thick layers of mud, and flat stone slabs placed on the roof. The condition of the structure was recorded and all areas indicating signs of decay were noted. For example, a portion of the mud coating on the roof had eroded, exposing reeds in the roof above RT16 (roof timber 16) round to RT19 (roof timber 19). The mud coating on this part of the roof was patchy and had decayed to a mere 20mm thickness after the last wet season; no maintenance work had been carried out on this portion of the roof.

Objects including baskets, a grinding stone, clay pots, figurines, and bundles of reeds were arranged on the floor of exB-48 according to the excavation plan of B-48 (Byrd 2005:247 figure 143) (figure 7.1), in addition baskets were suspended from the roof timbers (figure 7.2). Hanging baskets from the roof was suggested by Byrd: “storage may have been in baskets hung from the ceiling or set directly on arrays of stone slabs” (Byrd 1994:648). A total of six modern straw baskets bought from a Jordanian street market were placed within exB-48.

The contents of the baskets were as follows:

a) a flat open basket covered in 150 grams of salted pistachio shells,
b) a large basket coated on the interior with bitumen and filled with 1375 grams of salted pistachio shells,
c) a small bitumen-lined basket containing 50 grams of mixed seeds,
d) small basket containing 50 grams of mixed seed,
e) a medium flat basket containing 112 grams of fresh pistachios, and
f) a medium basket containing dried reeds and foliage.

It was decided to coat the interior of two of the baskets with bitumen, in accordance with the archaeological evidence as presented by Byrd (2005b:34). These baskets were first lined with leaves, then coated with a thin layer of mud before applying thick handfuls of bitumen (figure 7.3). The two baskets were then hung from the roof timbers of exB-48 to dry. They dripped down the wall by T14 and on the floor by T9 for up to 4.5 hours. The bitumen used was a modern mixture; however during the Neolithic period bitumen could have been collected from the Dead Sea shore in the valley to the west of the site.

The grinding stones were collected from the 1960s spoil heaps and surrounding fields and placed within the structure. A total of six clay pots and two figurines (figure 7.4) were made from local deposits, including clay selected from natural horizons in the wadi complex. One pot was placed in a Bedouin camp fire to bake, whilst the others dried gradually in the sun. The exact location of each of all these objects within the experimental building was planned and photographed (figure 7.5).

Outdoor and indoor temperature readings were taken before lighting the fire and a note made of the wind direction and weather conditions.

<table>
<thead>
<tr>
<th>Inside temperature</th>
<th>24° C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside temperature</td>
<td>31° C</td>
</tr>
<tr>
<td>Wind</td>
<td>Moderate to strong easterly</td>
</tr>
<tr>
<td>General weather conditions</td>
<td>Mild, sunny</td>
</tr>
</tbody>
</table>

Table 7.1 Summary of weather conditions on the day of the fire

A static digital video camera was set up at a vantage point on the roof of the neighbouring structure, exB-10 (figure 7.6). From this point the camera could record the whole of the roof of exB-48 and a portion of the interior as seen through the gap between the wall head and edge of the roof. Aspects of the fire were also recorded by three individuals with digital

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camera observing the fire from various standpoints both inside and outside the burning structure and thus captured an array of views.

Initially attempts were made to simulate the possibility of an accidental fire. This is represented by Plans A and B described below. Plan C represented arson, or a deliberate conflagration.

- **Plan A**: In the first instance a cooking fire was lit inside the structure. The addition of fresh green twigs and bitumen-coated baskets was intended to create enough sparks to threaten the reeds in the roof construction that were left exposed in the ceiling. This cooking fire was deliberately allowed to burn out of control. This simply caused some charring of a small area around the hearth and was not enough to burn the structure to the point of destruction.

- **Plan B**: A second cooking fire was lit on the roof. The thick layer of mud on the roof protected the reeds from catching light.

- **Plan C**: After Plan A and B, the structure was still standing intact so a more deliberate method of conflagration was adopted. Brushwood was stacked along the walls inside the structure and on the roof. The dry foliage was ignited from various points simultaneously.

As earlier experiments and observations suggested would be the case (e.g. Wilshusen 1986), an attempt to start an accidental fire following Plan A did not succeed. Indeed a neglected fire in exB-48 without ample combustible material would simply die down, forming no threat to the structure (Harrison pers. comm.). Similarly, a small fire on the roof, simulating the possibility of an activity area on the roof that included a hearth, would not burn down the structure if neglected. However, creating the opportunity for the fire to spread to the reeds below the mud plaster layer did provide the chance for a small campfire to ignite part of the roof construction material. The fire spread quickly once the dry roof material had caught light. Other failed attempts at starting a fire large enough to burn down the structure included igniting two adjacent baskets within the building, one lined with bitumen containing dried reeds, foliage, and nuts (figure 7.7).
Sequence of events on the day of the conflagration - November 3rd 2004 are summarised in Table 7.2. The full sequence of events can be viewed on the accompanying DVD (limited copies).

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00</td>
<td>A small fire was lit inside the structure adjacent to the central post (plan A). Flames persisted for seven minutes but the fire died out after 20 minutes (figure 7.8).</td>
</tr>
<tr>
<td>10:16</td>
<td>A small fire was lit on the roof above T11 approximately 20 cm from the edge of the roof (plan B). The fire smouldered and finally died after 8 minutes (figure 7.9).</td>
</tr>
<tr>
<td>10:17</td>
<td>A small fire was lit below two baskets and a pile of reeds that were placed adjacent to T8 inside the structure (plan C). One basket caught light immediately and was reduced to ashes within 2 minutes. The other basket, bitumen-coated, was alight in 3 minutes. Simultaneous flames rose the full height of the walls, approximately 1.20m. The bitumen basket continued to burn for 13 minutes; however by 10:36 the fire was smouldering, and four minutes later it was just smoking. (figure 7.10)</td>
</tr>
<tr>
<td>10:28</td>
<td>A second small fire was ignited on the roof in the same place as the fire lit at 10:16. This time the fire was encouraged by fanning and blowing the flames towards the reeds that were exposed in a small hole in the mud coating. After four minutes the reeds below began to burn, and at 10:35, after the small fire had been refuelled, the roof was alight. Burning reeds fell to the floor inside the structure as the fire was sucked along the underside of the roof. Smoke was drawn out through the apex of the roof where the mud covering was the thinnest (figure 7.11).</td>
</tr>
<tr>
<td>10:37</td>
<td>The first portion of mud falls from the roof into the building</td>
</tr>
<tr>
<td>10:41</td>
<td>The first upright timber, T11, catches fire at the top thirteen minutes after the fire was lit.</td>
</tr>
<tr>
<td>10:44</td>
<td>The roof is on fire at several points.</td>
</tr>
<tr>
<td>10:46</td>
<td>A portion of the roof, between T10 and T11, collapses onto the floor of the structure creating a further small fire inside. One minute later a basket placed on the floor inside the building is alight. Meanwhile reeds from the roof fall both within and outside the structure walls.</td>
</tr>
<tr>
<td>10:48</td>
<td>As the flames grow and the wind continues to blow from the east, and as a precaution a bucket of water is thrown on the roof of exB-18 to reduce the risk of the fire spreading to another of the experimental structures.</td>
</tr>
<tr>
<td>10:49</td>
<td>The tops of T9 and T10 are alight, after the ropes at the junction between the upright posts and the roof timbers begin to burn (figure 7.12).</td>
</tr>
<tr>
<td>10:50</td>
<td>T12 is alight, 22 minutes after the fire was lit.</td>
</tr>
<tr>
<td>10:56</td>
<td>The stone slabs placed above T8 and T9 fall.</td>
</tr>
<tr>
<td>11:03</td>
<td>A small basket lined with bitumen that had been suspended from the roof timbers with a piece of rope falls to the ground but is not burning.</td>
</tr>
</tbody>
</table>
Approximately half of the roof is consumed by fire, leaving some material burning on the floor, and further exposing the remaining roof to the wind.

West portion of the roof is now well alight, and within three minutes T1 is burning.

More water and sand is thrown on the adjacent roof of exB-18 as the fire in the roof of exB-48 spreads to the reeds adjoining the roof of exB-18.

The wind dies away noticeably and abruptly.

The wind begins to gently blow from the west. Meanwhile, the central upright post has caught fire at its base, being ignited from fallen debris in its vicinity.

The fire has died down and the smouldering structure is now more readily approachable.

The wind picks up to a moderate to strong wind. Three roof timbers could be salvaged at this point. RT8, RT10 and RT14 had fallen off the central post and were resting on the wall heads with the points resting on the interior floor. These three timbers displayed only superficial charring.

More timbers were salvaged from the building. RT4, RT5 and RT6 fell onto the exterior ground surface. This was due to the counter lever effect of the unburnt heavy mud layer around the perimeter of the roof relative to the thin roof material that had already collapsed into the structure. A large ring of white ash material was noted encircling the base of the central post.

An attempt was made to reignite material in the western portion of the roof. Once the wind had changed direction the flames returned to the centre of the roof leaving material in the west unburnt.

The central timber was still burning (figure 7.13).

The central timber collapsed having burnt through a little above ground level and the stump remaining in the ground was extinguished.

<table>
<thead>
<tr>
<th>Growth rate</th>
<th>Range of α (kW s²)</th>
<th>Time to reach 1055 kW (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very slow</td>
<td>&lt; 0.0000412</td>
<td>&gt; 1600</td>
</tr>
<tr>
<td>Slow</td>
<td>0.000412 – 0.006594</td>
<td>400 - 1600</td>
</tr>
<tr>
<td>Medium</td>
<td>0.006594 – 0.026375</td>
<td>200 – 400</td>
</tr>
<tr>
<td>Fast</td>
<td>0.026375 – 0.1055</td>
<td>100 – 200</td>
</tr>
<tr>
<td>Very fast</td>
<td>&gt; 0.1055</td>
<td>&lt; 100</td>
</tr>
</tbody>
</table>

Table 7.2 A description of the sequence of events during the conflagration

The rate at which the fire spread can be calculated using the observations noted in Table 7.2 and, based on the heat release rate (Table 7.3), the fire at Beidha would be classified as a very slow fire.

Table 7.3 Calculations of the rate of burning using the formula Q = αt² where Q is the heat release rate of the fire, α is the fire growth rate, and t is the time since the initiation of the fire (in seconds).
General observations of the remains of the structure and the surrounding area were made after the fire had died down. It was important to make these initial observations before stochastic factors, such as wind and rain, altered the physical state of the burnt remains.

It was noted that the depth of fire related deposits against the walls outside exB-48 varied. Around the exterior walls on the western side, from T1 to T10, the debris was between 0.10m and 0.20m deep up against the wall and tapered such that approximately 0.40m away from the wall it consisted of only a thin layer of ash (figure 7.14). The deposit consisted mostly of mud overlain by foliage, both elements originally part of the roof construction. The deposits along the eastern side, from T14 to T16, were only one or two centimetres deep and consisted mostly of broken and burnt fragments of reeds. The deposits were thicker on the west because the wind blew strongly from the east on the day of the fire, blowing the roof debris as it came free of the structure to the west side of the building. In other words, the varying thickness of deposits outside the structure does not correlate with a variation in architectural design but instead reflects the conditions under which the structure disintegrated and eventually collapsed.

Mud with impressions of reeds and foliage was frequently found both within and outside the structure after the roof had collapsed. The impressions demonstrated that this tumbled debris was clearly made from the roofing material. However, only the clumps of mud that had fallen with the impression face down on the ground could still be clearly identified one month after the fire. The impressions that had fallen face up had been rapidly eroded by both wind and rain. This indicates that similar impressions recovered face up from excavations must have been rapidly buried to have been preserved in the archaeological record.

The ashy layer covering objects placed inside the building, such as groundstone tools and remnants of baskets, that was noted immediately after the fire, had either been blown or washed away one month later. The thin layer of ash originally deposited was subsequently only visible in small sheltered corners of the building and in the lee of the stone walls.

With the roof gone and the walls left exposed the mud plaster on the interior wall face began to deteriorate quickly. After one month the mud plaster was partially washed off and was deposited over the burnt reeds and ash lying at the base of the walls within the structure.
The physical remains of exB-48 after the fire were further investigated through excavations on separate occasions during the twelve months after the conflagration. Initially a portion of the interior of exB-48 was excavated one month after the structure had burnt down. Only one quarter of the interior floor, a pie-shaped trench radiating out from the central post, was examined leaving the remainder for future investigation. The decision to excavate a portion of the debris so soon after the collapse of the structure was taken because of the potential disturbance from visitors, local children, and goats over the subsequent winter months when the site was less frequently monitored. The south-western quarter of the interior, measuring approximately 3.14m² (figure 7.15), was excavated first because it was most prone to disturbance from people entering the structure through the entrance.

The seven layers excavated in this section (figure 7.16) are described in Table 7.4:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Brief description of deposit</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Burnt timbers</td>
<td>Material from the final stage of roof collapse</td>
</tr>
<tr>
<td>2</td>
<td>Broken/burnt reeds, unburnt reed foliage, and clumps of mud</td>
<td>Collapsed roof material</td>
</tr>
<tr>
<td>3</td>
<td>Smaller leaves and charred organic material</td>
<td>Wind-blown deposits accumulating after the fire</td>
</tr>
<tr>
<td>4</td>
<td>Large clumps of mud, charcoal, stone slabs and modern plastic rubbish</td>
<td>Initial roof collapse, contaminated by subsequent wind-blown debris</td>
</tr>
<tr>
<td>5</td>
<td>Silty sand of various colours with charcoal flecks</td>
<td>Initial roof collapse, further oxidised on the ground</td>
</tr>
<tr>
<td>6</td>
<td>Very burnt reeds</td>
<td>Initial roof collapse</td>
</tr>
<tr>
<td>7</td>
<td>Orange-brown floor surface</td>
<td>Floor surface at time of burning</td>
</tr>
<tr>
<td>8</td>
<td>Compact orange-brown soil</td>
<td>Original surface at time of construction</td>
</tr>
</tbody>
</table>

Table 7.4 Description of deposits excavated inside exB-48 after the burning experiment

The upper layer (Layer 1) of debris resulting from the fire consisted of burnt roof timbers of which a selection had already been salvaged just as the fire died down on the day the structure was burnt. The remaining timbers were measured and compared to their original measurements to assess the damage undergone during the fire (figure 7.17). The measurements show that between 57% and 98% of the original length of the roof timbers had survived the fire. Approximately 10% of the original diameter was lost, with significant
charring up to a metre from the end that had been resting at the apex of the roof. This suggests that, in the interpretation of charred timbers from archaeological deposits resulting from fires such as this, a further 10% should be added when calculating the original diameter of the timbers used in the construction. Estimating the original length of a charred timber from an archaeological deposit is more problematic. This experiment indicated that the timber may be reduced in length by as little as 2% or as much as 43%.

<table>
<thead>
<tr>
<th>Roof Timber #</th>
<th>Original length (cm)</th>
<th>Length recovered (cm)</th>
<th>Original diameter (cm)</th>
<th>Diameter recovered (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT2</td>
<td>300</td>
<td>172</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>RT3</td>
<td>305</td>
<td>300</td>
<td>12</td>
<td>8 - 9</td>
</tr>
<tr>
<td>RT5</td>
<td>305</td>
<td>247</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>RT6</td>
<td>300</td>
<td>262</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>RT8</td>
<td>300</td>
<td>263</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>RT19</td>
<td>300</td>
<td>191</td>
<td>10</td>
<td>8 - 9</td>
</tr>
</tbody>
</table>

Table 7.5 A sample of measurements of timbers taken before and after the fire.

The majority of salvaged roof timbers were taken from the area around the origin, or seat, of the fire in the northwest of the building. Although these timbers were the first to catch light, the wind rapidly pushed the fire southwest across the structure. As a result the most heavily burnt timbers were RT2 and RT19 in the southern and western portion of the building. The timbers in this area smouldered for up to two hours. The majority of the other timbers in exB-48 smouldered briefly and then extinguished themselves.

Stratigraphically, below the charred roof timbers was Layer 2 which consisted of broken and burnt reeds, unburnt reed foliage, and clumps of mud. The mud clumps averaged 20mm to 70mm in thickness and often had imprints of reeds on one face. Only impressions that had fallen face down, approximately 75% of the mud clumps that had fallen from the roof, had survived the wind and rain that followed in the weeks after the fire sufficiently to be clearly identifiable at the time of excavation.

Layer 3 was 20mm thick and consisted of smaller leaves and charred organic material that had filtered down through the loose reeds and foliage in Layer 2. This layer is interpreted as representing wind-blown deposits accumulating after the fire (or post-abandonment). The material recovered from Layer 3 totalled 132.5 grams and was sieved through 1mm mesh. The results are described in Table 7.6:
Below this thin layer was a lumpy compact deposit approximately 30mm to 70mm thick containing large clumps of mud, small charcoal flecks, and modern plastic rubbish. This layer, Layer 4, contained the stone slabs that had been set into the mud on the roof. It represents the final stages of the roof collapse after the initial blaze, and therefore this material was not completely charred but only finally fell as the roof become too unstable. The modern rubbish was blown into the building in the intervening weeks between the conflagration and excavation.

Underlying Layer 4 was a thin layer, 30mm to 50mm thick, of silty sand of various colours ranging between red, orange and red-brown (Layer 5) containing flecks of charcoal but otherwise described as a ‘clean’ deposit because it did not contain any inclusions such as reeds or rubbish. This layer sloped down from the entrance. It was interpreted as a mud layer that had fallen from the roof in the early stages of the fire and had been further oxidized on the floor of the structure by overlying burning material collapsing from the roof.

Layer 6 consisted of very burnt reeds deposited to a thickness of 5mm to 20mm. These reeds were from the first stage of the fire during which the underside of the roof caught fire and roof material began falling onto the floor. This layer was removed to reveal Layer 7, the orange-brown floor surface of exB-48 exposed when the structure was set alight. Below Layer 7, approximately 25mm thick, was the original floor layer of exB-48. Therefore Layer 7 represents the accumulation of occupation deposits laid down between construction and destruction of exB-10, from July 2003 and November 2004.

<table>
<thead>
<tr>
<th>Description of material</th>
<th>Weight in grams</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal flecks, goat hair, fine grasses and sand</td>
<td>7.1</td>
<td>5.2 %</td>
</tr>
<tr>
<td>Charcoal (&gt; 4mm in length)</td>
<td>14.8</td>
<td>10.7 %</td>
</tr>
<tr>
<td>Small organic material (&lt; 3cm in length) such as goat dung, seeds, and grasses</td>
<td>20.8</td>
<td>15.1 %</td>
</tr>
<tr>
<td>Large fragments of reed foliage (&gt; 3cm in length)</td>
<td>95.4</td>
<td>69 %</td>
</tr>
</tbody>
</table>

Table 7.6 All sieved material excavated from Layer 3 in the southwest quarter of exB-48.

7.1.5 Discussion

Comparing the observations from exB-48 with the archaeological remains described by Byrd highlights some discrepancies in the current interpretation of the roof construction of early
Neolithic structures at Beidha. The archaeological record of exB-48, as described by Kirkbride and subsequently by Byrd, includes a series of deposits consisting of burnt timbers at the base of the stratigraphy, overlain by clay and stone slabs, then charcoal from the reeds and roof beams, then clay with reed impressions, and plaster fragments at the top of the sequence. From this sequence it has been concluded “that the roof was constructed of a series of beams which were covered in reeds. Then clay was laid on top, with stone slabs either below or on top of the clay. The ceiling and walls were then plastered” (Byrd 2005:34). The sequence from the experimental structure began with charcoal from the reeds at the base of the stratigraphy, overlain by mud and charcoal, then clay and stone slabs, then fine charcoal from reeds, then clay with reed impressions, then timber, and finally a layer of plaster from the walls (figure 7.16).

The main discrepancy in the two sequences is the position of the burnt timber horizon. It lies at the base of the archaeological record as examined initially by Kirkbride but was near the top of the sequence in the experimental case. Four explanations are possible:

i. the timbers will sink through the stratigraphy over an extended period of time, perhaps thousands of years. This taphonomic issue cannot be addressed during this current experimental study;

ii. a reconstruction based on the current interpretation of the archaeological record does not ultimately replicate the stratigraphic evidence upon which it was based. In other words, the archaeological interpretation is wrong such that either the design of the reconstruction building is incorrect and/or its destruction does not replicate the correct sequence of events;

iii. the timbers identified at the base of the archaeological record were not roof timbers but instead relate to non-structural features such as interior furnishings (e.g. platforms); or

iv. a set of variables that were not recognised in the sequence of events affected the outcome of the experiment. For example, the direction and force of the wind may have altered the sequence of events during the burning and dramatically affected the sequence of deposition. The experiment would have to be repeated to increase the sample size and the level of confidence.

Based on my observations during the experimental fire and the data collected during the excavation after the fire, I believe that ‘iv’ is the most satisfactory explanation for the discrepancy observed between the original archaeological record and the experimental excavations. In addition to repeating the experiment under different wind conditions, I also suggest that further experiments need to be carried out on the configuration of roof timbers converging at the central upright post, as well as the technique used to tie the roof timbers to...
the upright timbers set in the wall. Both of these variables would affect how the roof timbers fell, perhaps causing the timbers to fall earlier in the sequence of events and avoid the counter lever effect which delayed their fall.

With the exception of the burnt timber layer the relative sequence of the other layers from the archaeological record and experimental structure are comparable. However, despite some similarities in the description and order of the two sets of deposits, the interpretation of the stratigraphic layers in exB-48 differs from the archaeological record. For example, the plaster layer at the top of the sequence in exB-48 eroded off the walls weeks after the fire and gradually sealed the burnt debris on the floor of the structure. This deposit was especially prevalent near the base of the walls. The plaster layer is in a similar stratigraphic position in the archaeological evidence to that noted in the experimental work, however in the archaeological report it has been interpreted as part of the roof construction material that had fallen on to the floor of B-48 during the fire.

The absence of the fine layer of charcoal and burnt reeds (Layer 6) at the base of the archaeological record may be due to its delicate and potentially ephemeral nature in the preserved record. Similarly, Layer 5 was a relatively clean burnt sandy clay layer, and may be overlooked in excavation as it contains no obvious construction debris. This layer may mistakenly be identified as a burnt floor layer and interpreted as the bottom of the sequence, instead of being identified as collapsed roof mud that was further burnt on the ground as burning debris continued to fall on it, thereby maintaining a fuel supply.

Comparing the archaeological and experimental data indicates a significant discrepancy between the depths of debris within the structure. Notes from the original excavation of B-48 suggested that the debris from the superstructure accumulated to a thickness between 50cm to 80cm. The observations from the excavation following the experimental conflagration revealed debris to a maximum thickness of 35.5cm. This suggests that either a) the roof material on the experimental structure was not as thick as the original roof on B-48, or b) debris noted in the original excavation included material that did not originate from the superstructure, such as interior furnishing and wall plaster. Observations from the experiments lead me to believe that the latter is the most satisfactory explanation for the discrepancy. More organic material, such as nuts, baskets, wood, reeds, and straw, stored inside B-48 before the fire would have provided sufficient combustible material for the fire and would also have subsequently resulted in a thicker deposit in the excavation.
Intentional or accidental?

One important question not raised in the 1960s reports nor in subsequent publications is the question of intentional versus accidental burning of the Beidha buildings. Ethnographic studies and archaeological experiments have previously demonstrated that construction materials greatly influence the ease with, and the degree to, which a house will burn (Gordon 1953; Hansen 1966; Bankoff and Winter 1979; Wilshusen 1986).

A house with mud and rubble walls and a flat mud covered roof has to be prepared for burning or it will not burn at all: the two essentials being extra fuel and a good draught (Gordon 1953:149).

This contrasts with the rapid rate of conflagration of timber-built thatched houses in dry conditions (Friede and Steel 1980; Waddington 2004 pers. comm). The difficulty encountered in trying to burn down exB-48 suggests that structures of this type would not be readily destroyed accidentally. A blaze large enough to completely destroy the structure could only arise if ample combustible material was placed inside the structure. This may have been the case if the original primary function of the structures was the storage of perishable goods, such as baskets of nuts.

At various stages during the burning experiment construction material could be salvaged from the structure and neighbouring structures could be prevented from igniting by simple means. It is important to remember that the archaeological evidence for the neighbouring structure B-18 revealed minimal evidence of it having burnt. Thus, in the case of the original village either:

i. the neighbouring building lacked sufficient combustible material to catch fire, or

ii. precautions were taken to contain the fire and prevent it from spreading to the neighbouring structure.

During the experimental fire option ii was taken to safeguard other long-term monitoring programmes.

Ethnographic examples also suggest that even in the excavation of burnt thatched structures where conflagration had been swift, sometimes taking only two to three minutes to engulf the building, the structures had been stripped of valuable domestic artefacts. In the few minutes that it takes for the structure to burn to the ground, it may be argued, the inhabitants manage to rescue babies and invalids, valuables and domestic ware. In the case of Beidha the experimenters could still enter the burning structure to take photographs of the interior up
to 22 minutes after the fire was ignited. This would be enough time to rescue valuables including the baskets of nuts, which would presumably have constituted an important part of winter food supplies. However, the excavation of B-48 revealed numerous finds *in situ* on the floor of the structure. The evidence suggests that in the case of this building no attempt was made to rescue foodstuffs or tools either during or after the fire.

The experiment at Beidha suggests two scenarios for the destruction of B-48:

a) B-48 was intentionally burnt down. The structure would have been filled with combustible materials to assist the burning process, and neighbouring structures would have been protected to stop fire spreading.

b) The structure, filled with winter foodstuffs and fuel supplies, was in a poor state of repair and accidentally burnt down whilst unattended.

Ethnographic evidence suggests houses may have been intentionally destroyed when the owner of the house died. For example, Nguni huts were valuable commodities and the timber frames were carried on sledges from site to site. Traditionally, “if someone living in the hut died, the hut was either abandoned or burned down…old huts were also considered as the dwelling place of ancestral spirits” (Friede 1980:180). Applying this belief system to the Neolithic villagers in Beidha may explain why foodstuffs and timber were not salvaged from B-48 immediately after the fire. The material may have been left as components of the ritual associated with the closure and destruction of the building. It would also explain why the structure was then abandoned, and was not replastered or re-roofed for subsequent occupation.

### 7.1.6 Summary

The experiences at Beidha reflect McHardy’s observations during his experiments on producing the materials seen in the vitrified forts in Scotland, where he realised that explanations presented in books “do not seem such an easy manner in the field, when you tie yourself down to use only the materials found on the ground” (1906:143). In summary the results from the experiment indicated that the fire produced during the conflagration of exB-48 did not replicate the fire that destroyed B-48. The results differed on the following points:

- The depth of debris in exB-48 was almost half that recorded in B-48.
- The stones and mud plaster on the walls of exB-48 were not reddened or oxidized to the extent noted in B-48.
- The roof timbers did not fall in the same stratigraphic sequence.
- The upright timbers set in the wall did not burn below wall height or below surface level. Only the free-standing timbers burnt to the point of leaving a charred stump in the ground.

These points are further discussed below in Chapter 9. In the meantime, it may be remarked that the deliberate destruction of this experimental building at Beidha helped to formulate a range of hypotheses that went beyond those generated by the actual reconstruction of these buildings.
Chapter Eight

Archaeological Site Management of Beidha

The experimental reconstructions at Beidha formed part of a project that aimed to enhance our understanding of the early Neolithic both for archaeologists and for the general public. The experimental processes described in the previous chapters (Chapter 5, 6 and 7) addressed issues that principally involved only experimenters and archaeologists, not least for reasons of timing and issues of health and safety related to the management of visitors to a remote location at times of necessarily increased risk. This chapter focuses on broadening the field to incorporate the interests of the general public. For the public, the experimental reconstructions provided, and continue to provide, an important interpretative tool for explaining the prehistory of southern Levant.

In addition to dealing with issues of presentation and interpretation, the experiments at Beidha form part of a project that aimed to conserve the fragile prehistoric remains at the site. In this chapter the management and conservation issues raised during this project will also be addressed.

I have approached the site management issues of Beidha from an archaeological perspective (Appendix 1.1). As an archaeologist, I have been trained to record and interpret sites using artefacts, contexts and the remains of structures to develop intellectual theories and to formulate and test scientific hypotheses. As yet, the step from archaeological site recording to conservation and from interpretation to presentation has not formed part of the standard on-site archaeological process nor indeed does it figure largely in many archaeological training programmes. However, the realization of the need to incorporate heritage management into archaeological practice is growing (Cleere 2004; Stone and Planel 1999). The direct role of archaeologists in Archaeological Heritage Management, encompassing the preservation, protection and use of archaeological resources, clearly needs to be addressed.

8.1 Management and Conservation

The management of our cultural heritage is a complex and growing subject (Cleere 2004; Hunter and Ralston 2006) that tries to incorporate the multiple opinions expressed by the many parties involved, including archaeologists, conservators, scientists, landowners, locals,
tourist bodies, and developers (Aplin 2002; Avrami et al. 2000; Chitty and Baker 1999; Cleere 1989; De la Torre 1997; Layton et al. 2001; McManamon and Hatton 2000; Stone and Planel 1999; Tilley 1990; Willems 1998). Consideration of the conflicting values arising from such a cross-section of interested parties has to also be incorporated in the development of a site management plan, including evaluations of public versus professional interests, aesthetics and artistic views, economic and utilitarian principles, symbolism and historic relations (Stanley-Price 1990).

The value of cultural heritage is of growing concern in Jordan (Daher 1996; Greene 1999; Palumbo et al. 1993; Palumbo and Teutonico 2002), predominantly in relation to tourism. This concern manifests itself both in terms of presenting archaeology as a tourist attraction (Mahadin and Rifai 1995) and also in protecting archaeological sites against the potentially detrimental effects of development and tourism (Economic Development and Archaeology in the Middle East 1982). Tourism, as Jordan’s largest industry (figure 8.1), is focal to communities such as those living in the Petra region. Over the past ten years the area has been increasingly engulfed by the development of new hotels, roads, shops, tour companies, souvenir vendors, 4x4 vehicle trip operations and such like. It was within this commercially-driven environment that a small-scale archaeological site such as Beidha needed to establish itself.

The development of the management plan at Beidha began with considerations of a few questions such as –

- Why Beidha?
- Why do we value the early Neolithic village in Beidha?
- Why should we be concerned about conserving the archaeological remains for the future?
- For whom were we conserving the site?
- Which aspects of the Neolithic village were to be conserved?

Answering these questions and identifying the site’s values and cultural significance formed the first step of its management and conservation. Answers to these questions were fed into a simple four-step action plan. The practice of initiating and implementing a management and conservation programme on site involves informed decisions at each of the multiple stages in the process. This process can best be summarised as follows (adapted from Avrami et al. 2000):
Interest in Beidha began in the late 1950s when Diana Kirkbride commenced her investigations and excavations in the area. Academic interest grew with increasing references and comparisons with the renowned prehistoric site of Jericho. This had already led to the protection of the Neolithic site at Beidha by the Jordanian Department of Antiquities. However, the acquisition of the site by the government in the 1980s, is where the conservation of Beidha stopped. What follows here is a description of the practicalities of taking the conservation of Beidha along the next two steps of the process: Planning and Management followed by Intervention.

8.1.1 Forming the Beidha Project

The Beidha Project, initiated in 2001, aimed to conserve and present the early Neolithic site at Beidha. The project was a joint collaboration between the Council for British Research in the Levant (CBRL) and the Department of Antiquities (DoA) in Jordan with a strong emphasis on community involvement. My co-directors in the Project were Dr Mohammed Najjar (DoA) and Professor Bill Finlayson (CBRL).

Various proposals had been made in the late 1990s to try to prevent further deterioration of the archaeological site in Beidha, and to improve the presentation of the site. Numerous bodies had been involved in the proposals to varying degrees, offering both funding and practical aid, but these attempts at collaboration were complex and in some instances beset with problems. For example, disagreements arose as large NGOs vied for prime control of funds and endless delays were caused by attempts to communicate with multiple large international organisations. As a result, no action was taken.

The success of the current Beidha Project was in its manageable size, the dedication of the directors to the archaeology of Near Eastern prehistory (e.g. Finlayson et al. 2003; Finlayson and Mithen 2007; Najjar 1990; Simmons and Najjar 1998), and the directors’ local knowledge and awareness on both social and political levels. It is important to note that at the time the project was initiated all the directors were based in Jordan, were simultaneously carrying out research on other PPN sites in the southern Levant, and had spent at least three
years working on archaeological sites in the Petra region with the assistance of local Bedouin tribes. The stress here is placed on the importance of understanding, communicating, and getting involved with the locality and the people.

The successful establishment of the Beidha Project can also be attributed to the policy of using minimal intervention, and doing that at minimal cost. Ideally this shows how easy and effective conservation can be on any site using a limited budget. The action taken does not involve complex technology or specialised task forces, but instead uses simple, effective site management (Appendix 8.1).

The conservation work carried out by the Beidha Project acts in accordance with international policies such as the 1990 International Council on Monuments and Sites (ICOMOS) *Charter for the Protection and Management of the Archaeological Heritage* (Cleere 1993). Of particular relevance to conservation work carried out at Beidha is Article 7 of the *Charter for the Protection and Management of the Archaeological Heritage* (see Appendix 8.2).

The Beidha Project also adhered to subsequent influential documents such as the Malta Convention of 1992 (Council of Europe 1992). In summary, the code of practice outlined in these documents suggested that the main principles of conservation are: minimum intervention, reversibility, compatibility of materials, and authenticity.

### 8.1.2 Actions of the Beidha Project

The increasing rate of development and growing tourism in the Greater Petra region brought some urgency to the actions of the Beidha Project. According to the Jordanian Ministry of Tourism, 311318 foreign tourists visited Petra in 2005 (*Jordan Times* 12 Jan 2007). In its neglected state, the early Neolithic site of Beidha was safeguarded from development by its inclusion within the protective zone of the Petra National Park. This saved the site from the fate of other Neolithic sites in the southern Levant such as Ain Ghazal and Basta. Both these sites had been partially destroyed by development and construction work. One of the excavators from Ain Ghazal has convincingly claimed that “the social and economic demands of a developing nation have doomed Ain Ghazal to virtually complete destruction, and less than 10% of the site has been set aside as an ‘open-air museum’, protected from future development” (*Rollefson et al. 1992:468*). The inclusion of Beidha within the
confines of Jordan’s largest tourist attraction protected the site from such development but it did however potentially place the site in jeopardy from the negative effects of tourism including erosion from an influx of high visitor numbers, combined with the development of insensitive tourist facilities on the archaeological site. These real concerns were behind the rationale for establishing and implementing a conservation management plan for the site.

During the excavations in the 1960s the remoteness of Beidha meant archaeological equipment and supplies were brought to the site by donkeys trekking from the nearest village in Wadi Musa. In terms of planning excavation seasons the site’s remote setting meant its supply was arduous and presented logistical problems. Since the 1980s a road leading out of Wadi Musa has meant that a 4x4 vehicle will take just ten minutes to do the same journey. During the course of the project a road suitable for large tourist coaches was built to the adjacent Nabataean site in Little Petra, just a few minutes walk from Beidha (figure 8.2). The increased accessibility of the site today means that it is no longer protected by its remoteness and instead the essential framework – a vehicle route in - now exists for developing it as a tourist site. It is in close proximity to tourist facilities already in place for the major tourist attractions in Petra (e.g. hotels, shops, restaurants, and public transport). There are parking facilities, road signs, and a tarmac road for the majority of the journey from Petra to Beidha. And the local community, aware of the financial gain in the tourism business, has focused for a number of years now on revenue from tourists and already had taken the initiative to sell souvenirs along the road to Beidha and offer tea to visitors there. Tourists provide a source of income for the area, undoubtedly, but also contribute to the deterioration of the site. There existed the need to reconcile the fragility of the archaeological site, the economic development of the local community, and the desires of the tourists.

In addition to placing Beidha in harm’s way by attracting visitors to the area and encouraging them to stay in the area longer, Petra’s grandeur also protected the smaller site. In contrast to the spectacular monumental architecture of the Nabataean structures in Petra and the surrounding area, the early Neolithic remains at Beidha are small, elusive and receive very little attention from the locals and government bodies. But Beidha was not alone in this regard, for even at prehistoric sites where the remains are more substantial they are very difficult to interpret. They simply and understandably do not have the immediate impact of monumental sites from more familiar timeframes in history. There are a wealth of important prehistoric sites in Jordan that are overlooked by visitors including sites such as
Basta, Wadi Faynan 16, Ghuwayr 1, Ba’ja, and Shkarat Msaied. Some efforts have been made to conserve and present these sites, mostly to interested parties who know about them in advance, but none presently cater for the general public. Beidha was amongst the first prehistoric sites in Jordan where the initiative was taken to present the site with the general public in mind.

The momentum for presenting prehistoric sites to the public has increased in the region over recent years to the point where, in 2007, the development of the presentation of six Neolithic excavations in the area was proposed in the form of ‘The Neolithic Heritage Trail’ (Appendix 8.3). The objectives of the new trail, like those of the Beidha Project, are to increase national and international understanding and awareness of the importance of the Neolithic of southern Jordan and to enable the local community to be involved in and benefit from the presentation of cultural heritage.

Returning our focus to Beidha itself, the Neolithic settlement excavated in the 1950s, 1960s and 1980s was finally abandoned by archaeologists in the mid-1980s with little or no thought given to the future of the site. Therefore, one of the objectives of the newly established Beidha Project was to pick up where the archaeologists left off in the 1980s and to improve the state of the archaeological site from the neglect that had characterised it for some two decades. Starting in 2001 the Beidha Project put into action its policy of minimal intervention at minimal cost. This included work to:

- repair and, in places, relocate the line of the fence around the site (figure 8.3). The only measures taken by archaeologists in the mid-1980s to safeguard the exposed archaeological remains was the placement of a fence encircling the site. By 2001 the fence around the site was deteriorating seriously and was full of gaps which locals used as shortcuts back to their village, allowing livestock in to graze, and the fence was generally in an unattractive state. The holes in the fence were repaired and its entire west side was moved just 5 metres down the slopes of the tell so as to remove it from the skyline. Reducing the visible impact of this feature therefore enhanced the aesthetics of the site.

- construct a simple path around the margins of the site (figure 8.4), where necessary leading into it, to take in the major sights: the ‘Sanctuary’, the Neolithic steps, the two different types of architecture (circular and rectilinear), and various in situ artefacts, such as querns. There had previously been no pathway or signs to direct visitors, either the local community or tourists, around the extremely sensitive
archaeological remains. As a result, visitors and livestock were free to climb and walk over the remains of the Neolithic structures. Walls and other upstanding structures were therefore prone to collapse from the impacts of trampling as well as those of harsh weather. Exposed, and accessible to both man and beast, the archaeological remains had very little chance of survival in the longer term, and indeed substantial deterioration was noted between when the excavators first began exposing the site in the 1960s to the start of the Project in 2001 (figure 8.5). This level of deterioration had already led to both information loss for future archaeologists as well as a reduced potential to display some components of the site to visitors. The path constructed by the Beidha Project under my supervision is a simple earth-beaten track, demarcated along its sides by small stones. These edging stones are sufficient to indicate the recommended route, to minimise damage to the site and to allow the visitor to see a selection of the key archaeological features not simply on the margins of the site. This path, once established, was frequently used by visitors and within weeks of being delineated it became clearly visible in the soft soil around the site.

- backfill a selection of open trenches from the 1960s and 1980s using the soil from the excavator’s spoil heaps around the site (figure 8.6). Backfilling protected a significant percentage of the archaeological remains for future generations, while also producing areas for the footpath to cross to access visible archaeological features.

- continue monitoring the condition of the site, observe problems of stability, and evaluate the successes and failures of conservation procedures implemented.

The light-handed approach to the management and conservation of the archaeological features at Beidha kept the cost to a minimum. Alternative large-scale measures, such as building protective shelters across the site or installing walkways to enable features to be examined from above without impacting directly on the remains, were considered expensive and highly debatable in their efficacy and intrusive impact on the site. Constructing them and maintaining them in a safe condition thereafter required specialized skills. Many sites have crumbled whilst those involved in caring for the site debate about elaborate conservation plans. For example, plans to protect Ain Ghazal were published in 1995 (Mahadin and Rifai 1995) but still 12 years later no formal action has been taken to protect the site (figure 8.7). The design concept was for the development of an archaeological park
(Mahadin and Rifai 1995). However, the collaborative effort required for such a grand project has, as yet, not produced any tangible presentation or preservation of the site, and unfortunately, the converse is true. The site received minimal attention by way of maintenance each year and is very visibly degrading.

None of the light-handed approaches carried out at Beidha are absolute in the sense that no conservation technique will completely arrest the ageing process, and the techniques adopted, such as reburial, may only retard the losses on site. Backfilling, or reburial, of at least a portion of the site was carried out at Beidha in an attempt to return it to a state of equilibrium approximating that which existed before excavation. Reburial has been a conservation technique recommended since the Athens Conference (1931). An examination of the components in the environment threatening the archaeological remains at Beidha revealed that the main mechanisms causing accelerated rate of deterioration are trampling from livestock and severe rainfall. In such cases reburial created a constantly dry environment, prevented further erosion through the deflation of surfaces, and thus, whilst of course rendering them invisible, ensured the preservation of stone and mud architecture, bones and charcoal (Thorne 1991). The preservation of ceramics, wood and other organic materials did not have to be considered for preservation as they had either been removed through excavation or were completely eroded before site stabilisation got under way.

For many archaeologists, the focus of conservation is less directed towards the minimalist preventative measures mentioned above, but instead is aimed at more significantly conserving the archaeological remains – the buildings and the artefacts – through direct intervention.

… the greater part of all conservation research still focuses on the challenge of physical condition – namely, the deterioration of materials and possible interventions – concentrating on the objects as opposed to their contexts (Avrami et al. 2000:5).

At Beidha, the issues relating to conservation of the physical remains using direct intervention were addressed through the construction of the experimental buildings.

8.1.3 The Role of Experimental Reconstructions in Conservation

The experiments at Beidha produced data that could be directly translated for use in the conservation of the physical remains on the archaeological site. The experiments provided a
means of studying and monitoring the physical condition, mechanisms and behaviour of the materials incorporated in the composition of the structures. A prime example of this was the monitoring carried out on the mud plaster of all four experimental structures. The mud plaster monitoring programme led to an understanding of the causes and mechanisms of deterioration, as well as providing an opportunity to study the efficiency and consequences of any intervention, maintenance, and treatment to the plaster over a four-year period. This data was then used to guide a safe and efficient solution for the consolidation of the archaeological remains on site (figure 8.8).

Research into the conservation of mud plaster and early stone architecture was deemed important and was urgently needed in light of recent common practice in Jordan. Unfortunately, in recent years there were cases in Jordan of cement being used to cap and consolidate wall heads on archaeological sites (e.g. PPN site at Basta). This is now recognised as bad practice and attempts have been made to remove and reverse such harmful interventions. However, alternative materials to be used in consolidation and knowledge of conservation techniques were still poorly understood in the region. It seemed that a policy of no intervention was deemed better than carrying out conservation procedures without preliminary testing of their impacts and effectiveness (Barov and Faber 1996). The experiments on mud plaster at Beidha advanced our understanding of the stone architecture and the plaster facing. The results showed that:

- The majority of damage to the mud plaster was caused by standing or pooling water: as observed on the roofs of exB-18 and exB-10, and at the base of walls as seen in exB-49 during floods. Such effects were compounded subsequently by repeated wear and tear from channels of water.

- Mud applied to roofs would rapidly deteriorate and be washed off a surfaced angled at 40° or more, as seen on the roof of exB-49.

- The careful application of mud plaster, including associated pounding and burnishing, was instrumental in creating a durable and water-resistant surface. The matrix of the mud, whether silt or clay, was of less importance in achieving good results.

Therefore the mud plaster needed to consolidate the walls on the archaeological site at Beidha should:

- Be applied such that it disperses rain water off the wall heads to avoid pooling water and forming channels to the detriment of the structure.
- Flat or steeply angled surfaces should be avoided. In the climatic regime encountered in Jordan, the recommended ideal slope of the surface to be plastered is between 10° and 20°.

- The mud plaster needs to be pounded and burnished during the application process to prevent subsequent cracking, which will itself then allow more complex problems to develop.

A second example of the benefit gained from experimental tests at Beidha was the observation of the rapid rate of erosion on the baulk edges of experimental foundation trenches. During the early stages of experimental construction, the sides of the foundation trenches excavated to set the building in crumbled from the constant trampling of the experimenters around the trench. These observations of the short-term effects of trampling highlighted the immediate need for erosion control and site stabilization to dissipate the long-term effects of visitors walking on the archaeological site. This conservation issue was addressed through the construction of a pathway and by the use of reburial to protect fragile remains which did not require to be presented to the public.

The conservation, and in particular the consolidation, of the archaeological remains as described above could, in theory, be carried out by someone who was not an expert conservator. Trials and experiments such as these make conservation more accessible and consequently more successful particularly in settings such as rural Jordan, where access to high-cost specialist conservation services may not be viable.

8.2 Presentation and Interpretation

8.2.1 Policy of the Beidha Project

Until 2001, little attempt had been made at Beidha to interpret and present the site for its visitors (figure 8.9). The only sign on site was a battered, vandalised and faded metal sign with a few site details on it which eventually disappeared altogether; the enveloping fence was broken; rubbish littered the trenches; and unstable stone walls were disaggregating and crumbling into further piles of indistinguishable archaeological remains (figure 8.10). Fixing these issues on site formed part of the decisions made by the directors of the Beidha Project (Appendix 8.4). The steps taken in the presentation of the site were a direct reflection of
what we valued at the site and incorporated a consideration of the way in which our actions affected visitors’ experiences of Beidha. To develop a successful presentation of Beidha we applied the following two main principles at every level of planning:

- an understanding of the site, and
- an understanding of the public

a) Understanding the site

At the time when the Beidha Project was initiated there was little written about Neolithic Beidha beyond the realms of academic publication. Naturally the guide books to Jordan focussed on the neighbouring Nabataean remains in Petra, and only occasionally mentioned even the contemporary outlying Nabataean remains in Beidha. Rarely was there mention of the early Neolithic site. The occasional reference to PPNB Beidha did not rate the prehistoric remains very highly in terms of tourist attraction. For example, the Rough Guide referred to Beidha as a “rather less inspiring Neolithic village”. Additionally, the Footprints guide stated that “although to the untrained eye there is not a great deal to see here, in archaeological terms it is of major importance”. The guidebook continued to attribute incorrectly the excavations to one ‘D Kilbride’, instead of Diana Kirkbride. Potential visitors were therefore initially discouraged and then misinformed about the site, adding greatly to our challenge to present the site anew to visitors.

It was therefore important to have a thorough understanding of the archaeology, architecture and history of the site in order to present it accurately and positively to the public. In the case of Beidha this included studying the excavation reports from the 1960s and 1980s written by the excavator, Diana Kirkbride, and later by Brian Byrd, as well as studying the architecture and artefacts in situ. A broader knowledge of other prehistoric sites in the region helped to place it in context for visitors who often incorporate multiple sites in their tour itinerary. In the case of Beidha other accessible Neolithic sites in the area included Basta, Baja, Shkarat Msaied and Wadi Ghuwayr, now (2008) forming part of the proposed Neolithic Heritage Trail. Including references to Ain Ghazal, famous for its plastered statues, in discussions of the context of Beidha provided many visitors with a basic historical reference point to situate the latter in cultural and chronological terms.

At Beidha the key message is that it was the oldest village in Jordan and that it is extremely important in world history for our understanding of the transition from a hunter-gatherer
lifestyle to farming. This framework also included introducing the concepts of the birth of agriculture, domestication, and sedentism.

b) Understanding the public

In the spring of 2001 I conducted a survey of tourists entering and leaving through the gates of Petra. The prime objective of the questionnaire was to establish the depth of knowledge visitors had about the early Neolithic in general on a global scale, and about Beidha specifically. This questionnaire provided a starting point for formulating site presentation. The questionnaire indicated that 60% knew nothing about the Neolithic and 70% had never heard of Beidha.

The results from this survey went towards establishing a clear understanding of who the visiting public was. At Beidha itself, the visiting public consisted largely of international tourists as well as Jordanian tourists. However, it remains important not to overlook the interests and needs of the local community who were not canvassed during my questionnaire survey because of language barriers. It is of course appreciated that to reveal the impact of tourism we need to focus on the locals (Stronza 2001). At Beidha we acknowledged the importance, but also the difficulty, of involving the local community in the presentation of the site. My understanding of the local community was gained through making repeated social visits, hiring local people to assist with aspects of the on-site work, and observing their attitudes towards the site and towards tourists. The majority of the local community, both young and old, had very little understanding of the Neolithic period, compared to the wealth of knowledge that they had acquired of later periods in history such as the Nabataean times. Many locals were able to replicate Nabataean artefacts to sell as souvenirs and recount ancient traditions. In contrast, I heard local tour guides famously describe Neolithic villagers in Beidha as dwarfs, based on the fact that the walls only stood to a maximum of 1.20 m high! A case for effective site interpretation and presentation could not have been more clearly expressed.

The presentation of many archaeological sites focuses on providing visitors with a connection to the past and to their heritage. But is the PPNB of Beidha beyond our cultural identity? Indeed, the religious beliefs of some visitors, both Christian and Muslim, attracted to the Levant, and specifically the Holy Lands, prevent them from acknowledging the chronology of the Neolithic settlement in Beidha. Therefore, in order to appeal to the
cultural heritage of all visitors the site had to be set within global history, identifying the cultural and social roots common to all human society, set beyond the reach of conflicting modern religious beliefs and rival nationalisms.

As such the site had distinct advantages as it did not appeal to a single group of people or nationality. It promoted reflection of past realities and enabled visitors to make sense of the ruins. The ruins are the remains of past societies; they are the ‘reflections of political struggles, cultural fashions, technological skills, artistic expressions, religious beliefs, and other aspects of human behaviour’ (Sivan 1997:52). Beidha’s narrative is the story of the human past, and gave a sense of belonging and understanding of our place in the world. This is especially important with early prehistory as we begin to recognise crucial events in the developments that led to modern lifestyles, and see the genesis of a new relationship with the natural world. It is these aspects, encompassed in the phrase, ‘the way that people of the past lived’, that really interest visitors, and unify all visitors. It was the global issues raised by the archaeological remains and not the few stones and fragmentary architectural features that remain on archaeological sites that are presented to visitors.

8.2.2 Actions of the Beidha Project

The interpretation and presentation of Beidha draws on existing action plans and manuals produced for British sites (e.g. Binks et al. 1988). The Beidha Project proposed a five-step approach to site presentation, including: signs, leaflets, website, guides, and a visitor centre. It was proposed that the combination of all five of these levels of presentation constituted a successful presentation of a small site. Beidha, like most early prehistoric sites, could not rely on its grand architecture to tell the story. Neither could the site rely on extensive descriptions in travel guide books to draw in and inform visitors; nor indeed could it rely on picturesque photos in brochures, souvenirs and postcards.

At the time of writing this account, the programme of presentation and interpretation at Beidha had entered its fifth year, at which point the strengths and weakness of the five-strand approach had become apparent. These are listed below in direct reference to each of the five steps, and remarks on these are followed by an overall evaluation of the approach adopted. The lessons learnt during this trial period will be taken forward into the next phase as Beidha is incorporated into a larger programme of presentation as part of the Neolithic Heritage Trail.
a) Signs
The planning and design of the signs placed on site by the Beidha Project are described in detail elsewhere (Appendix 1.2). In summary, the initial design took into account
- the nationality/language of the visitor: English and Arabic were employed,
- the length of their visit: observations indicated that this often lasted less than 30 minutes,
- their interests and average attention span: signage should never include more than three main facts which should be put across in fewer than 225 words (Ambrose and Paine 1993:91-92),
- the location of the sign should be selected sympathetically with respect to the feature discussed,
- promoting a heritage friendly attitude by positive encouragement and by citing examples of damage caused by walking off the paths and climbing on walls, and
- entertaining as well as guiding visitors.

Temporary signs were placed on site during the period of experimental programme (2001 to 2006) (figure 8.11). The temporary nature of the signs ensured that they could be updated each season. However, as work on site becomes less frequent the temporary signs weather, fade, and eventually become illegible. Unfortunately the final step, of erecting permanent signs with contents which capitalize on the presentational lessons learnt, has not yet proved possible. This delay is largely in the difficulty in producing signs that will withstand harsh summer sun, torrential winter rain, and the occasional vandalism (figure 8.12).

b) Leaflets
For those visitors who seek further detailed information about the site the Project proposed a second level of presentation: the leaflet (figure 8.13). These could be carried around the site by the visitor and referred to as necessary. The leaflets highlighted individual features at the site, for example the Neolithic steps leading into the settlement, and provided a more comprehensive chronology of the site and its place in history. Trial samples were produced in English, Arabic, French and German. The intention was that an unlimited number of leaflets would be available to visitors as the infrastructure of the site grew. At the time of the trial there were however inadequate facilities available to produce and distribute the leaflets in the periods when I was not on site.
Leaflets can also be used off-site to draw visitors to a location. This was not a tactic used at Beidha because of the small size of the site. A steady, if small stream, of visitors already visit Beidha, and increasing the number of visitors would increase the levels of damage to the site; numbers would reach an unsustainable level. Unlike Petra, Beidha is too small and remote from appropriate infrastructure to provide visitors with extensive printed material such as guide books and booklets, or even postcards.

As with the signs, the leaflets have not become a permanent feature on site because of cost and lack of infrastructure to produce and distribute the leaflets.

c) Website

Websites provide a powerful off-site level of information, enabling the archaeological site to be available globally, beyond the physical boundaries of the site itself, to visitors who are unable to visit directly. Additionally, websites extend the length of the ‘experience’, allowing visitors who have been to the location the opportunity to learn more after leaving the site and returning home. The Beidha website as well as providing information presented on the site signs and leaflets, and in the visitor’s centre, also provides additional information about the site. For example, it provides information about members of the team working on the site and the aims of the project. The website could be updated more regularly than printed material.

As with the signs and leaflets, the website remained effective only during the active period of experimental research on site. The website continues to be hosted by the Council for British Research in the Levant (www.britac.ac.uk/institutes/cbrl/projects), and renewed efforts are being made to update the website at this stage in the research programme.

d) Guides

Trained professional tour guides, and to some extent local guides, provide another level of presentation on site. The advantages of guides are that they can provide pertinent information as the group moves around the site, which alternatively would require several, and perhaps fairly intrusive, signs on site. Guides can also adapt the presentation of the site depending on the nationality, age and specialised interest of a group. In the case of Beidha the majority of the local guides are youngsters from nearby Little Petra and Baida Hausing. Many of these had been periodically employed by the Beidha Project to help backfill trenches or participate in the experimental reconstruction programme. In so doing we have
encouraged a greater and more intimate knowledge of the site, and hopefully stirred some enthusiasm, affection and pride for Beidha.

Unlike the previous three steps in the interpretation process, the guides continued to be effective on site after the main body of experimental research was completed. The success was attributed to the fact that the guides were both self-motivated and the main beneficiaries. They were local and did not rely on foreign aid or contributions, and were not limited by access to an external resource, such as printing leaflets or editing webpages. This highlights the need for the presentation of a site in a location such as Beidha to be placed in the hands of the locals in order for it to be a success in the future.

e) Visitor Centre
The fifth level of presentation comprises a visitor centre, allowing a site to be rapidly absorbed and visually understood. The experimental reconstructions at Beidha aimed to address Objective XVIII (as outlined in Chapter 5) which was to share with the public the intricacies of Neolithic life. The method adopted was to adapt one experimental reconstruction to serve as a visitor centre, provide interpretative signs, and to organise open days and tours (figure 8.14). The role of the experimental reconstruction is discussed more fully below.

8.2.3 The Role of Experimental Reconstruction in Site Presentation

Some of the beneficial roles of experimental reconstructions have already been presented in Chapter 2 in discussions related to Experimental archaeology as an educational tool. In addition, using experimental reconstructions in site presentation can appeal to the imagination of the public and can stimulate interaction with the presenter, whether archaeologist or local guide. Visitor centres, like museums, are no longer simply places for displaying material culture, they are now required to entertain the public (Stone and Planel 1999). The presentation of the archaeological site aimed to stimulate the imagination of the tourists. People expect to be able to interact and participate. These experimental reconstructions of Neolithic houses provided a space for visitors to interact with the reconstructed buildings and a visual stimulation for imagining Neolithic life. These reconstructions therefore brought alive the archaeological site. However, reconstructions as a form of tourist attraction should always enhance, and not detract, from the main focus of a
site which should be the archaeological remains themselves. On a practical level, these experimental reconstructions provided a sheltered environment for displaying signs and further information about the site (figure 8.15).

The criticisms of using experimental archaeology were broached in Chapter 2 (2.1.2 h). All reconstructions of the past are in some sense constructs of the present. This is inevitable. The methods and theoretical approach of archaeologists imposes a subjective bias even during excavation, recording and reporting of archaeological sites. By the time analysis and publication are complete an accepted version of the results has been agreed. The result is one story, one model, and only in effect one moment that is captured in a whole history of human stories that took place at a site. However, at Beidha four experimental reconstructions present four different interpretations of the structures from the site in an attempt to suggest a multifaceted story. The variations in construction suggest that:

…these structures can help provide insights regarding the continuing debates concerning structure size and organisation, function of individual buildings, site location, organisation of interior space, and intersite variability over time. They will consequently help our understanding of significant patterns of social organisation of settlement types, domestic activities and storage space, and settlement population (Dennis et al. 2002, see this volume Appendix 1.7).

The placement of experimental reconstructions, conducted under scientific conditions, in an environment open to tourism has led to conflicts of interest. Compromises had to be made notably when using experimental reconstructions as visitor centres. For example, a standard modern door was fitted to a reconstruction of a Neolithic house at Çatal Höyük (Turkey) despite evidence suggesting that the entrance was through an opening in the roof. The compromise was made to accommodate the tourists, and ensure their safety. Similarly compromises were made in the construction of replica Chalcolithic structures at Lemba (Cyprus) where modern sealant was used in the plaster on the walls to augment the weatherproofing of the largest roundhouse, currently serving as a visitor centre. The addition of modern materials “of course diminished the experimental value of the exercise but was carried forward nonetheless in the interest of site presentation” (Thomas 1995:124).

Further examples include the use of petrol in the experimental conflagration of a prehistoric house in order to provide a spectacle for the media (Hansen 1966) and the use of steel bolts in the construction of an Iron Age roundhouse at Archaeolink to secure a poorly designed roof.
At Beidha the experimental reconstruction of exB-18, built with the intention of forming a visitor centre, was not structurally compromised. However, a stage of the experimental reconstruction of a neighbouring structure, exB-10, had to be abandoned in the interest of visitor requirements. It was decided that partially blocking the entrance, as observed in the archaeological evidence, would restrict visitors’ access into the structure. All the experimental reconstructions were however affected by visitors in the monitoring stage of the experiments.

Despite problems of sustaining long-term action (involvement of transitory foreigners, and initial lack of interest from Jordanians in prehistory of the country) – Beidha has successfully gained increasing support in the conservation of the site, as well as providing opportunities for young Jordanians to take active roles in protecting local sites.
Chapter Nine
Discussion

9.1 Reanalysis of Pre-Pottery Neolithic Architecture

A thorough examination of the archaeological evidence from Beidha followed by a series of experiments has placed me in an informed position to re-interpret Pre-Pottery Neolithic architecture in the southern Levant. Below I re-examine the experimental objectives, as outlined in Chapter 5, to further shed light on the results and observations from the experiments. This process of re-examination provides the opportunity to augment our current understanding of issues such as maintenance costs, construction techniques, and the organisation of interior spaces of Neolithic architecture.

Below, each experimental objective is discussed based on experimental results presented in Chapters 6 and 7.

9.1.1 Objective 1: To estimate the amount of time taken for the construction process

In previous chapters I have mentioned the shortcomings of using time and energy expenditure data as a means of quantifying the construction process involved in building prehistoric houses. Despite these shortcomings, and taking them into account, I have compiled the energy expenditure data in terms of person hours for the experimental work at Beidha on a house-by-house basis as a means of comparing and contrasting the construction of individual structures. The amount of time spent on each individual structure provides a simple scale of comparison, since there were no marked differences in the expertise of the labour force involved or other such significant variables. Building knowledge was gained and increased rapidly in the initial stages of the experimental construction process - so much so that a developed system of work incorporated individual’s strengths and weaknesses - was evident from early on in the first experiment. Therefore it is felt that the inexperience of the builders was only a factor of consequence in the very initial stages of the first reconstruction, such that thereafter this factor did not significantly alter the amount of time spent on each structure. Exceptions, such as those that occurred during the construction of the first roof, have been highlighted in the experimental process and were noted in the results.
The data are not intended to represent accurately the exact number of hours it would have taken a prehistoric community to build these structures; instead it is used here as a comparative tool to rank orders-of-magnitude. A similar quantitative method was used in experiments carried out at Overton Down in the 1960s to indicate the amount of time taken to dig a ditch and create upcast mounds using prehistoric tools (Ashbee and Cornwall 1961). Results from these experiments were then extrapolated to calculate the effort involved in the construction of ditches associated with large monuments such as Avebury and the Dorset Cursus, as well as smaller barrow monuments measuring less than 12m in diameter. The person hours involved in constructing the banks and ditches associated with these monuments were estimated at 680000, 740000, and less than 700 hours, respectively; figures achieved by scaling up the experimental results. This set of data is an example of how person hours can be used to provide relative scale when comparing structures that were originally built using similar construction techniques.

As such, the data (Table 9.1) summarising the working hours involved in the experiments at Beidha should be used with caution relative to assessments of time taken to build structures in early Neolithic villages.

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<thead>
<tr>
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<th>Circular structures</th>
<th>Pier structure</th>
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<tr>
<td></td>
<td>ExB-49</td>
<td>ExB-48  ExB-18</td>
</tr>
<tr>
<td><strong>Time in person hours</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digging foundation</td>
<td>14</td>
<td>60</td>
</tr>
<tr>
<td>Building wall</td>
<td>132</td>
<td>80</td>
</tr>
<tr>
<td>Building roof</td>
<td><strong>142</strong></td>
<td>96</td>
</tr>
<tr>
<td>Second storey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total hours</td>
<td><strong>288 / 242†</strong></td>
<td>220</td>
</tr>
<tr>
<td>Size (floor space in m²)</td>
<td>11.4</td>
<td>15.9</td>
</tr>
<tr>
<td>Volume of foundations</td>
<td>5.7</td>
<td>7.95</td>
</tr>
<tr>
<td>Trench (in m³)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9.1: The approximate amounts of time in person/hours involved in the construction of exB-49, 48, 18 and 10. Within each task field the greatest expenditure of hours is highlighted in **bold**.

† The figures show the total expenditure in digging the foundation and building the wall plus two separate sums representing the first and second roof construction.

¹ The figures show the total expenditure in digging the foundation and building the wall plus two separate sums representing a) only the first floor and then b) first floor plus second floor construction.

* Floor space of the upper and lower storey combined
Time expenditure data has often been used by archaeologists to build up a profile of a settlement in terms of its labour division, labour investment, and - by further extrapolation - population size. The data from Beidha are similar to other experiments that have quantified construction processes in terms of person hours, and thus provide another example of what can be inferred roughly as the average time taken to complete a task; such calculations can be pooled into a larger dataset for describing prehistoric construction processes. For example, experiments at Overton Down illustrated that on average 0.15m³ (5 ft³) of soil could be loosened and removed by one person in one hour (Ashbee and Cornwall 1961); a similar experiment by Coles (1973) indicated a rate of roughly 0.175m³ per hour; and Erasmus (1965) estimated 0.325m³ per hour. At Beidha the average hourly rate for digging was 0.253m³, which fits within this range. However, a closer look at the digging rates for each individual structure at Beidha indicates a range that extends either side of previous experimental results, from 0.112m³/hour to 0.407m³/hour.

<table>
<thead>
<tr>
<th>Circular structures</th>
<th>Pier structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ExB-49</td>
</tr>
<tr>
<td>Digging foundation (hours)</td>
<td>14</td>
</tr>
<tr>
<td>Volume of foundation trench (in m³)</td>
<td>5.7</td>
</tr>
<tr>
<td>Digging rate (m³/hour)</td>
<td>0.407</td>
</tr>
</tbody>
</table>

Average rates (m³/hour)
| Ashbee and Cornwall (1961) | 0.150 |
| Coles (1973) | 0.175 |
| Beidha | 0.253 |
| Erasmus (1965) | 0.325 |

Table 9.2: Rates for the extraction of soil at Beidha in comparison to published results from similar digging experiments

The results from Beidha (Table 9.2) indicate that real productivity levels can vary considerably as the results conceal the underlying factors that contributed to the number of hours recorded. For example, a dramatic increase in the hours taken to dig the foundation for exB-48 is apparent. It took five times longer to dig in comparison to exB-18 despite being less than twice its volume. The reasons behind the slow digging included

- unfavourable weather conditions (strong summer sun and dry sand storms)
- a relaxed working schedule with no pressing deadlines

Digging foundations in cooler weather, as with exB-49, clearly shows that more favourable weather can speed up the process. With regard to time constraints, we were not relying on the constructions to be erected for immediate shelter, warmth, storage and protection unlike the original builders who would presumably have needed to complete the houses in time for either the extreme cold of the winter or heat of the summer.

Similarly, the comparatively quick rate of digging the foundations for structures such as exB-49 should also relate to the loose sandy soil of the Petra Region in contrast to the compact soil of most similar European-based experiments reported above. It is also important to note that a further approximation is involved as for the majority of the experiments at Beidha modern tools were used, and estimates are based on the extrapolation of work rates achieved during a brief experiment using digging sticks. This extrapolation does not take into account a gradual decrease in activity rate, such as is often noted as energy levels decrease.

Another way to place the experiments in a wider context of time expenditure is to consider data collected during the construction of the house walls. Modern standards of dry stone wall building suggest that approximately 4.5m to 5m of wall of approximately 1.4m high can be built per day. This equates to approximately 3.3 cubic metres of stonework being displaced per day. ExB-48 has approximately 63m of wall (this total includes the construction of both the inner and outer wall-faces) which would, in modern terms, equate to 96 person hours. In reality it took less time to build the walls of exB-48, totalling approximately 80 hours.

Roof construction provides another example of the additional variables concealed within the data. The 142 hours involved in roofing exB-49 were largely taken up by a trial and error process, as the best method of covering the building was devised in real time. The roofing process became more streamlined by the time exB-18 was put up. The erection of a viable roof involved coming to grips with the best way to use available materials, coupled with devising simple but effective techniques, such as binding together mats of reeds to form the roof canopy. The requirement to go through these learning stages illustrates that the inexperience of the builders can heavily influence the rate of construction for particular stages of the building.
Table 9.1 also highlights differences in the construction of a pier house (exB-10) from Phase C and a circular structure of Phase A. The former, even taking into account the variables mentioned above, took twice as long to build as the round building. A proportion, but not all, of the increase in person hours can be accounted for by the different sizes and surface areas of the structures in question. However, close examination indicates that much of the time attributed to the construction of the pier house was consumed in the acquisition and transport of the stones that were needed. Compared to Phase A-type buildings, structures in Phase C incorporated twice as many stones, most of which were built into the piers. This increased deployment of stones was more significant in terms of the time and energy required to gather them rather than in the additional time needed for the construction itself, compared to the simpler Phase A-type building. This is illustrated in the anecdotal descriptions in Chapter 6 of the construction process for structures in which the experimenters worked more slowly when they had to gather more stones from the fields and manually lug them back to the site. The experiments none the less indicate that a pier structure took longer to build than a circular structure and the investment of this extra time focused predominately on the solid stone construction of the piers themselves. This point is further discussed later in relation to a consideration of the transition from circular to rectangular structures (Objective 13).

In conclusion, calculating the energy expenditure involved in separate tasks can provide useful information, without necessitating an accurate scientific account of calories burnt per minute. Here, experiencing the time and effort needed to carry out each task leads to an appreciation and understanding of each stage in the construction process in comparison with the commitment invested in each other stage.

*  

9.1.2 Objective 2: To estimate the labour expenditure needed

It has been proposed that the increase in building size, and the implied increase in labour costs, seen in Phase C in comparison to Phase A, led to “the expanding role of community regulatory mechanisms” (Byrd 1994:658). The data gathered during the experiments challenges this statement.

Assessing the cost of buildings can be calculated in terms of energy and raw material requirements, a procedure sometimes termed ‘architectural energetics’ (Abrams and Bolland
The method, as described by Abrams and Bolland, offers a means of translating the construction cost of a structure into levels of power and status in a society and aims to infer patterns of human behaviour from architectural remains. This method is used in Mesoamerican studies to quantify the investment cost in the construction of temples (Abrams 1994) and irrigated field systems (Arco and Abrams 2006). The strengths of this analytical technique are described by the authors thus:

Based on the cost of tasks derived from architectural energetics and the sequence of tasks derived from the architectural record, we generate one probable model of labor organization. The utility of this analysis is fourfold: (1) it forces the researcher to consider explicitly the parameters which influenced construction through time, which should contribute to future excavation designs of architecture; (2) it yields a model or hypothesis which can be tested against the empirical archaeological record; (3) it provides a model of labor allocation and organization which relates to the structure of bureaucratic decision-making; and (4) in a broader sense, it encourages the use of econometric models in the analysis of patterned economic behaviors (Abrams and Bolland 1999:272).

The data from the Beidha experiments clearly suggests an increase in labour expenditure over time, illustrated in Table 9.3. This may imply the development of a more complex social system, which is further discussed in Objective 17. Here, I would stress that the increase in labour expenditure is directly invested in the time and materials consumed in the construction of the piers themselves. As an architectural feature, it was the pier within these buildings that consumed a considerable increase in investment.

<table>
<thead>
<tr>
<th>Circular structures</th>
<th>Pier structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ExB-49</td>
</tr>
<tr>
<td>Size (floor space in m²)</td>
<td>11.4</td>
</tr>
<tr>
<td>Total hours</td>
<td>288 / 242†</td>
</tr>
</tbody>
</table>

Table 9.3: The approximate total amount of time (person/hours) involved in the construction of exB-49, 48, 18 and 10, based on observations made during the reconstructions.

* Floor space of the upper and lower storey combined
† The figures show the total expenditure in digging the foundation and building the wall plus two separate sums representing the first and second roof construction.
¹ The figures show the total expenditure in digging the foundation and building the wall plus two separate sums representing a) only the first floor and then b) first floor plus second floor construction.
Lipe and Breternitz (1980) provide comparable information in their study of a similar architectural transition in the southwestern United States, where the tradition of building circular semi-subterranean pithouses was replaced by rectangular pueblo buildings. Their data suggests that the energy expenditure for buildings of similar surface area in these two styles of architecture was comparable. This point is further discussed below in *Objective 13.*

The results from the experiments at Beidha show that the building size (floor space in m²) does not increase – certainly not significant - from Phase A to Phase C. Taking the average size of the structure types, and disregarding the possibility of second storeys based on the problematic evidence available, the available figures illustrate an increase in labour expenditure but a decrease in floor space. In other words, the experiments contradict the assumption that greater building size equates to greater labour expenditure. Therefore, in returning to Byrd’s proposed model - the increase in building size, and the implied increase in labour costs, seen in Phase C in comparison to Phase A, led to “the expanding role of community regulatory mechanisms” (Byrd 1994:658) – the experiments support the model in suggesting that labour costs may reflect an increase in social complexity in the form of community regulatory mechanisms but the assumption that building size correlates directly with labour expenditure has to be reconsidered.

*  

9.1.3 **Objective 3: To assess the maintenance costs of a structure**

In the experimental programme at Beidha the structures were maintained to varying degrees over time in an attempt to assess both the upkeep costs as well as to provide an opportunity to observe the taphonomic processes underway in decaying buildings. The experimental objectives were therefore designed to address both monitoring and maintenance issues. For example, the mud plaster and stone walls of exB-49 were carefully monitored for decay whilst the walls and floor of exB-18 were repaired and replastered as and when required. All these calculations are based on buildings which were not permanently lived in for any period of time.

In summary, the circular structures did not require any major structural repairs during the five years of the experimental programme. The monitoring programme of the mud plaster on exB-49 indicated that, when applied correctly, it remained intact for approximately three years. The exception to this observation was the damage caused by flooding (figure 9.1).
Equally the stone walls remained stable and intact during the experimentation period, with the exception of occasional stones (usually at wall ends either side of an entrance) that were dislodged by general wear and tear. These dislodged stones could be repaired and stabilised following such mechanical damage in a matter of a few minutes of labour.

The roofs, unsurprisingly, required the most maintenance. The roof of exB-49 was monitored, but not repaired, during the initial three years of experimentation. In contrast, the roof of exB-18 was maintained regularly. The experiments indicate that the mud plaster on the roof was the first element to show signs of erosion and, if not repaired, its disintegration provided a catalyst for further collapse of the main roof framework. A roof would disintegrate to its bare rafters within three years and required replacing in parts, if the mud coat was allowed substantially to erode (figure 9.2). Constant maintenance of the mud coat on the roof ensured water-tight coverage was kept for over three years.

Some upright timbers were replaced in exB-49 after four years, when signs of rot were noted at the interface between timber and soil. However, it must also be noted that the timbers used in exB-49 were from salvage, rather than being freshly cut. There was no apparent difference between the timbers concealed behind layers of mud plaster and those open to ventilation. It was also noted in the monitoring of exB-49 that rotting upright timbers did not significantly alter the stability of the roof. The timbers continued to support the rafters despite significant signs of erosion at the base of the timbers. Instead, erosion of the mud and stone collapses played a more significant role in impacting on structural stability. Further monitoring of these roofs over the next five to ten years may indicate the finite lifespan of a roof, and specifically the timbers that form its framework. In a comparative example at Lemba, Croft has claimed that the replica mud structures are low maintenance (Croft pers comm.), in that the timbers (of local pine) only needed replacing after eleven years.

Similarly, the roof of the pier structure was monitored and required occasional new coats of mud to replace layers deflated by wind and rain. The repairs were predominantly carried out after winter rain and/or after strong summer sand storms. It is possible that the timbers in the pier structure would have a longer use-life compared to the upright timbers of the circular structures because they are not in direct contact with the fluctuating level of moisture in the ground and therefore are less prone to rotting at that interface.
One of the walls of pier structure (exB-10) required a major repair within a year of its construction (figure 6.112). However, the wall in question was a segment of the upper storey which did not conform to the original design of the structure but instead incorporated an additional entrance, designed to improve visitors’ visibility inside the structure. This additional entrance essentially created more points of weakness either side of the entrance gap.

In conclusion, in the absence of very heavy rainfall and severe floods, the experimental structures required little maintenance. Over the short-term that observations could be made, there was no apparent increase in maintenance needs for the pier structure in comparison to the circular structures. Each architectural form required occasional repairs to walls and mud plaster, and all the experimental designs were similar in regard to the vigilance needed to maintain a water-tight roof; this was especially the case with steeply pitched roofs. Monitoring over a longer period, perhaps a further ten years, may show a discrepancy in maintenance costs between the circular and pier structures. It is possible that the reduced number and placement of timbers in the construction of the pier structure may decrease relative maintenance costs of this style of building, compared to the earlier circular design, in the long-term.

* 

9.1.4 Objective 4: To analyse construction techniques

Analysing construction techniques at Beidha through experiments proved to be unavoidably affected by issues of subjectivity. Essentially, the term technique refers to the mechanical skills applied; however a slight alteration in approach can change a technique. For example, in infilling the wall core some experimenters chose to pat the mud down diligently with the palm of the hand whilst others let the mud sink naturally around the rubble layer. Unlike such tasks as chopping wood, the technique of applying mud is not mentioned in detail in consideration of prehistoric building techniques, nor will these two different techniques of applying mud be distinguishable archaeologically within the completed wall. Many of the intricate facets of construction techniques are not visible in a readily distinguishable way in the archaeological record and therefore do not lend themselves to the experimental process.

Amongst the experiments that produced no clear-cut differences in results is the following:
• Three larger posts were amongst those used in the construction of exB-48 in an attempt to develop hypotheses to explain the real variability on post sizes recorded during the excavation. However, no explanation can be given after the experiments for the placement of these larger posts. It is possible that more advanced analytical methods, such as mechanical stress grading used to gauge the load bearing of these timbers, may have provided a technical explanation.

Some experiments on technique produced noteworthy results, including:

• The technique of building a roof, as described in Byrd’s interpretation of collapsed material (2005:34), was investigated in all four experimental structures. The design of their roofs differed, however the technique of building up layers of timbers, reeds and mud proved to be successful in each case. The use of stone slabs around the edge of the roof of exB-18 seemed to extend the use-life of the mud on the roof by decreasing the rate of erosion caused by the run-off of water.

• Varying construction techniques were adopted to investigate the possible reasons for having slightly battered stone walls. Monitoring of these walls did not provide any utilitarian function nor hint at a symbolic explanation. Instead the experiments indicated that people naturally tended to build walls that tapered in as they built up. The position of each stone stepped in slightly in what was thought to be a more secure manner. This created a wall that slightly sloped outward, as described in the archaeological record (see Section 5.4.2). Continued long-term monitoring may provide an alternative utilitarian function.

• Experiments were carried out to investigate the small walls added to the interior and exterior of pier structures in an attempt to examine their construction technique as well as design. For example a small partition wall was added between two piers of exB-10 to create a small chamber. The results indicated that a narrow wall, only one course deep and three or four courses high, was enough to shelter that chamber from aeolian and alluvial disturbance. Building a thin wall meant that it did not stand up to a year of wear and tear, suggesting that walls of this type were temporary additions, repeatedly replaced, perhaps to protect a season’s crops, or bulk storage before processing, in the short-term.
The natural irregularities of the stones and timbers of the circular experimental structures would for some (e.g. Charles 1982:10) indicate a higher level of skill and construction technique in comparison to geometric structures. The stone wall of exB-49 was built around the timbers to accommodate the different shapes and sizes of the upright timbers, as can also be seen in the crooked slots visible in the archaeological record, perhaps straight timbers were unavailable or too costly in terms of energy expended to transport them. In contrast the timbers obtained from the timber yard for exB-18 were straight and of roughly uniform size making the construction much easier to put up. However, the result does not reflect the archaeological record and an examination of the construction technique reveals that relatively slender timbers were used in the original PPNB structures. Similarly, the use of irregularly-shaped stones in the early structures at Beidha suggests that the stone slabs available in the area were not actively sought for construction. However, these slabs were used in the pier structures indicating increased investment in the selection of building material but reducing the level of skill needed in construction.

In conclusion, the intricacies of construction technique are difficult to identify in the archaeological record and therefore do not lend themselves to the experimental process. However, experimenting with variations has led to a better understanding of possible techniques used and further hint at the evidence concealed within the archaeological record.

9.1.5 Objective 5: To analyse construction designs

The experiments at Beidha primarily attempted to identify the functional and utilitarian factors in the design of the structures. However, it is widely accepted that symbolic functions also enter into the equation when designing a building (McGuire and Schiffer 1983), for example in the cruciform plan of Christian churches and the elaborate decorations on Classical architecture. Each architectural feature analysed in the experiments at Beidha looks at utilitarian requirements first without seeking a symbolic explanation.

Timber slots
One of the most striking elements of the architectural design of structures in the early phase of occupation at Beidha is the vertical slots in the stone walls in the interior of the structures. Similarly, the communal building in the early Neolithic site at Jerf el Ahmar (Syria) was
built using a wooden framework set into the wall (Stordeur 2000). The purpose of this architectural design feature is unclear. There is evidence from historical periods in the Near East and from the fifth millennium BC in Mesopotamia for the use of timber in walls as a form of reinforcement (Wilcox 1981). The lower part of the wall would be built of stones with the upper part made of mud brick strengthened by a timber framework. Also, at the excavations in Beycesultan, gaps in the brickwork were revealed where the vertical timber framework had been inserted (Lloyd and Mellaart 1956). In these historical examples the timber reinforcements are thought to offer stability in the event of an earthquake (Hendry and Khalaf 2001; Wilcox 1981). It does not seem likely that PPNB communities in Beidha used such advanced technology to safeguard their structures against earthquakes. Earthquakes are recorded in the region in historic times, as is evident in the timber implants in buildings designed by the Nabataeans to absorb earthquake tremors in monumental structures such as Qasr el-Bint (Petra). No earthquakes struck Beidha during the experimental period and therefore this theory could not be directly tested. Instead other structural explanations were considered for the timber slots.

Many architectural features are designed to address primary utilitarian needs such as shelter from rain and staying warm using thermal insulation. It is likely that these slots were structurally fundamental in creating a stable base for the roof framework. The timber posts in circular structures bear the load of the roof whilst the stone wall creates a curtain (Wright 1985:27), as at Dhra’ where archaeological evidence suggests wattle and daub walls with post rings (Finlayson et al. 2003). The combination of timber posts and thick stone walls at Beidha provides resistance to rain penetration and thermal insulation respectively. The experiments showed that this design was practical and effective.

Whilst analysing the fieldnotes and results after the experiments, it was noted that the upright timber posts, as well as the stone wall and mud plaster, were constructed in a sunwise direction. We began the construction either side of the entrance way and worked clockwise. Townend would suggest that this is a meaningful and deliberate action in the construction of roundhouses representing the cyclical character of time (2007). However, during the experiments at Beidha I believe that we built sunwise, or clockwise, because it was a logical sequence. This modern view of orientation (note how the timbers are numbered like a clock face in figure 6.20) may have originated in cosmology but now simply forms part of ingrained human behaviour. The direction in which the timber posts were erected was not structurally significant in the experiments at Beidha.
Second Storeys – a Neolithic reality?

Strong and wide exterior walls, thin upper walls, and small rooms suitable for staircases, are architectural features that suggest the presence of a second storey. These features have been cited elsewhere as possible evidence for more than a single storey (discussed by Neal (1982) in relation to Romano-British villas) and those recently discovered at Ba’ja and Ghuwayr. The experimental reconstruction of exB-10 demonstrated that second storeys are feasible on the pier houses at Beidha based on the raw materials available. However, the absence of stairways and the presence of thin exterior walls on the lower storey, casts further doubts on the existence of upper storeys on pier houses during Phase C of the Beidha occupation. It may also be the case that the thin upper walls, cited as evidence for second storeys, recorded in the original excavations at Beidha are later structures built on earlier walls. Successive superimposing of walls was recently recorded in the excavations at the PPN site in Ba’ja where it was thought that structures were built up as the lower storeys silted up (Gebel 2006).

By contrast, the thick walls of the earlier circular structures would have been more suitable as the foundations for upper storeys. However at Beidha buildings from all periods of occupation lack the clear evidence for stairways that have recently been discovered at other PPN sites including Shkarat Msaied, Ba’ja and Ghuwayr.

Placing my own doubts as to the viability of upper storeys in pier houses aside, the design of the second storeys as suggested by Byrd and Banning (1988), from a utilitarian point of view, is argued to have created storage chambers below and either additional storage, or activity areas, in the upper storey. It is possible that storage of harvests such as hay took place on the roof of the structure, away from the damp floors. The lack of wide exterior walls and the presence of possible thin upper curtain walls above suggest that the upper storeys could only carry light loads.

Once again I would stress that the experimental reconstruction is not conclusive proof of the form of the superstructure of these pier buildings. The archaeological evidence for a second storey is poor and the successful construction of a second storey on exB-10 does not ultimately validate the design but simply demonstrates that the hypothesis of an upper storey is feasible. Further experiments including multiple reconstructions of pier structures, incorporating evidence of staircases present at Ghuwayr, Ba’ja, and Shkarat Msaied, would
need to be carried out in the future to focus specifically on these very important design questions.

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9.1.6 Objective 6: To analyse construction materials

Table 9.4 summaries the quantity of building materials used in the construction of each of the experimental structures.

<table>
<thead>
<tr>
<th></th>
<th>Circular structures</th>
<th>Pier structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ExB-49</td>
<td>ExB-48</td>
</tr>
<tr>
<td>Raw materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>timbers</td>
<td>30</td>
<td>47</td>
</tr>
<tr>
<td>Stones</td>
<td>± 900</td>
<td>&gt;± 1200</td>
</tr>
<tr>
<td>Small stones</td>
<td>1800</td>
<td>2400</td>
</tr>
<tr>
<td>Mud</td>
<td>5 m³</td>
<td>6.5 m³</td>
</tr>
<tr>
<td>Water</td>
<td>1800 l.</td>
<td>2000 l.</td>
</tr>
<tr>
<td>Reeds</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Size (floor space in m²)</td>
<td>11.4 m²</td>
<td>15.9 m²</td>
</tr>
<tr>
<td>Volume of foundation trench</td>
<td>5.7 m³</td>
<td>7.95 m³</td>
</tr>
</tbody>
</table>

Table 9.4: Approximate amounts of raw material used in the construction of exB-49, 48, 18 and 10. The quantities of stones, mud and water were calculated through extrapolation. * indicates the total floor space including the upper storey.

There is no standard system employed by experimenters for recording the amount of materials used in any one experiment. Units of measurement used could include kilograms or pounds, cubic metres or cubic feet, and indicative volumetric measurements such as buckets and wheelbarrows of various sizes, and so on. I chose to record the approximate quantity of each material used in the construction as opposed to calculating the weight of each material precisely. This reflects a personal preference in which I find a wall built of approximately 900 cobble-sized stones easier to visualise than a wall of 19,890 kg. This contrasts with total weights recorded for each material used during the experiments conducted at Lemba (Thomas 1995), making direct comparison difficult. Unfortunately, I noticed this discrepancy in recording units only after my initial experiments had begun, and
thus too late to provide directly comparable data to accommodate different recording methods. Until standardised units are adopted by all experimenters, it seems that the responsibility lies with the individual experimenters to provide enough information for others to convert the data to different units. None the less, it is possible to see that the materials used during the experimental process at Beidha were predominately recorded in terms of total items, with net weight and volume used only for total liquids (Table 9.4).

The most logical building material is the “one with the least transformation cost and, possibly, the one closest to hand” (McHenry 1980:97). At Beidha all the material used in the construction of the experimental structures were, in McHenry’s terms, the most logical building material. All the building materials could have been collected from within a 5km radius, though as discussed in Chapter 6 some material for the experimental reconstructions had to be collected from further afield not for reasons of availability but because of legal and environmental restrictions, as in the case of the reeds and timbers. The transformation cost of the locally-accessible materials was low; for example the stones were not worked and no chaff was added to the mud plaster mixture.

The experiments revealed that:

The quantity of mud required to infill the stone walls and coat the roof of the circular structures corresponds roughly to the volume of soil removed during the excavation of the foundation trench. For example, the foundation trench for exB-49 was approximately 5.7m³ and the mud required for roofing and walling totalled approximately 5m³. The soil removed could be placed conveniently alongside the trench and mixed with water to form mud, as was done during the experimental reconstruction. However, the experiments suggest that the mud needed in the construction of a pier structure was greater than the soil excavated from the foundations. During the experimental programme this extra soil could be obtained unproblematically: it was readily available from the 1960s excavations spoil heaps. However, during the Neolithic, the implication is that more soil would need to be dug and transported to the site for the construction of the walls and roof of each pier building than its immediate site furnished. This once again points to the greater investment needed in the buildings of the later phase of occupation of Beidha, and is discussed further in Objective 13.

The use of stone as the primary building material for domestic architecture is said to be uncommon amongst hunters and primitive farmers (Orme 1981:87). Often stones were used in the construction of the foundation or to form a plinth, as seen in early Cypriot architecture
at Khirokitia and Lemba, upon which a structure of mud or terre pisé was built. Stones are more frequently used by nomadic pastoralists in this general region, suggesting a “correlation between the use of stone as a building material and environment and means of subsistence” (Orme 1981:89). At Beidha, the superabundance and quality of the stones in the area suggest they formed a logical choice based on simple availability rather than providing a direct reflection of the socio-economic characteristics of the community.

Notably, the increase in materials needed from Phase A to Phase C did not necessarily equate to an increase in available space within the individual structures that were built. More space was available in exB-49, a structure representing the average size of a Phase A building (Byrd 2005:105, table 12), in comparison to the lower storey of the average pier house. The materials and energy invested in the lower storey of the pier structure were devoted to establishing new forms of enclosed spaces and perhaps for providing a solid base for a putative second storey; the latter could be built subsequently with marginal additional costs both in terms of materials and energy. This suggests that the initial investment in materials for the construction of a pier structure was motivated by the opportunity to compartmentalise and increase space for activity areas and storage space. The experiments thus supported the view that the increased size of structures is “dependent on solid internal subdivisions of stone, to support the roof, creating separate rooms” (Orme 1981:89).

However, the exception to the above observation in terms of resource consumption in constructing these types of buildings is apparent in the dramatic decrease in the quantity of long timbers used in the pier structure as reconstructed, compared to the earlier circular structures. Not only could fewer timbers be used for the construction of a pier structure but they could also be shorter because the stone piers reduced the linear distance to be spanned. The roof timbers of a circular structure (exB-48) measured 3m in length, almost double that (only 1.50m to 2.30m) needed in the pier structure. It is conceivable that environmental constraints, or a depletion of mature trees in the region, during Phase C limited the availability of long timbers suitable for constructions of this type, so that load-bearing timbers had to be deployed in shorter lengths.

*
9.1.7 **Objective 7: To evaluate the effectiveness of individual structures**

The effectiveness of the experimental structures was measured during the monitoring phase. Ideally the structures were to be efficient and effective in providing shelter for people and goods. The structures were therefore monitored for fluctuations in temperature, problems of water ingress, and ventilation.

Temperatures

<table>
<thead>
<tr>
<th>Structure</th>
<th>Month</th>
<th>Temp inside</th>
<th>Range/average inside</th>
<th>Temp outside</th>
<th>Range/average outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExB-10</td>
<td>April</td>
<td>23</td>
<td>Range 10 – 26</td>
<td>21-25</td>
<td>Range 18 – 31</td>
</tr>
<tr>
<td>ExB-10</td>
<td>May</td>
<td>24</td>
<td>Average 24.3</td>
<td>28</td>
<td>31</td>
</tr>
<tr>
<td>ExB-10</td>
<td>May</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ExB-10</td>
<td>May</td>
<td>20-22</td>
<td></td>
<td>18-24</td>
<td>Average 28.6</td>
</tr>
<tr>
<td>ExB-10</td>
<td>May</td>
<td>10-15</td>
<td></td>
<td>21-31</td>
<td></td>
</tr>
<tr>
<td>ExB-10</td>
<td>Nov</td>
<td>15</td>
<td>Range 15 – 22</td>
<td>24-26</td>
<td>Range 9 – 26</td>
</tr>
<tr>
<td>ExB-10</td>
<td>Dec</td>
<td>15-22</td>
<td>Average 18.5</td>
<td>9-25</td>
<td>Average 17.5</td>
</tr>
<tr>
<td>ExB-49</td>
<td>May</td>
<td>26-30</td>
<td>Average 24.6</td>
<td>28-35</td>
<td>Average 27</td>
</tr>
<tr>
<td>ExB-18</td>
<td>May</td>
<td>16-21</td>
<td>Range 16 – 22</td>
<td>16-25</td>
<td>Range 16 – 29</td>
</tr>
<tr>
<td>ExB-18</td>
<td>May</td>
<td>21-22</td>
<td>Average 20</td>
<td>25-29</td>
<td>Average 22.5</td>
</tr>
<tr>
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<td>22-24</td>
<td>Range 22 – 24</td>
<td>29-34</td>
<td>Range 29 – 34</td>
</tr>
<tr>
<td>ExB-48</td>
<td>Nov</td>
<td>24</td>
<td>Average 23.3</td>
<td>31</td>
<td>Average 31.5</td>
</tr>
</tbody>
</table>

Table 9.5: Sample of temperatures taken inside and outside the experimental structures

Temperatures were taken both inside and outside the experimental structures (figure 9.3), and a representative sample of these are listed in Table 9.5. The results obtained were used to address two main questions: a) were the pier buildings more effective for sheltering people and goods? And b) were the pier buildings effective for storing goods all year round?

One implication behind the transition from circular to pier structures is that the new design was an improvement on the old. However, from the point of view of maintaining an agreeable ambient temperature all the experimental structures were between 2°C and 7°C
cooler inside than without, and no significant improvement in terms of producing a cooler interior was noted between circular and pier structures.

It has been suggested that the pier structures facilitated a growing need to store foodstuffs and fuel through the winter as part of the process of becoming sedentary farmers reliant on seasonal crops (Banning 1996). Typically, “the structures of a winter station are semi-subterranean; the roof is substantial – more so than a summer station which is used in the dry season – and waterproofed with dung plaster” (Horne 1993:45). The semi-subterranean nature of exB-10, plus the thick pier walls, provided good insulation in both hot and cold conditions. The ideal temperature for storing foodstuffs is between 10°C and 15.5°C (Food Standards Agency, UK). The results from the experiments indicated that in the spring exB-10 maintained a daily range between 17.4°C to 24.3°C compared to an outside average of 20°C to 31°C. In winter the temperature inside ranged overnight from 22°C down to 15°C, compared with 25°C down to 9°C outside this structure. This illustrates that the structure minimised fluctuations in temperature, and thus extended the life-span of stored commodities.

Water Ingress
The effectiveness of the structures was also gauged on the amount of water ingress. With respect to storing foodstuffs it is recommended to find a cool and dry place. Unfortunately, all the structures suffered from water ingress during torrential rain. Surface water from the immediate environs ran into the structures through the entrances which were located on the upslope end of the buildings. Modifications to the structures, such as blocking upslope entranceways and building partition walls and retaining walls, reduced the water influx during flash floods, and increased the effectiveness of the structures as feasible places for sheltering people and storing goods. These additions however did not entirely stop water getting into the buildings, and so suggest that further precautions, such as the use of raised platforms, may have been taken to safeguard valuables and perishables from water ingress.

Experiments relating to the ventilation of each of the reconstructions at Beidha were not fully explored during this programme of research because of the absence of archaeological evidence relating to doors and windows. Temporary blinds were constructed from reeds for exB-18 (figure 9.4). These helped shield the interior from the harsh sun and wind, but were not permanent features during the experimental programme.
The monitoring of the hearth inside exB-18 indicates that some form of door would be needed to shelter a domestic fire from draughts. As with issues relating to water ingress, the construction of a door would form an impermanent barrier to the adverse weather conditions in place of blocking the entranceway with a stone wall, as noted in the archaeological evidence of B-49 and B-18.

Apertures, or gaps between the wall head and the roof rafters, were built into exB-48 and exB-18 but not in exB-49 and exB-10. These did not have a noticeable effect on the air temperature within the structures.

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9.1.8 Objective 8: To explain site location

Everyone then who hears these words of mine and acts on them will be like a wise man who built his house on rock. The rain fell, the floods came, and the winds blew and beat on the house, but it did not fall, because it had been founded on rock. And everyone who hears these words of mine and does not act on them will be like a foolish man who built his house on sand. The rain fell, and the floods came, and the winds blew and beat against that house, and it fell – and great was its fall! (Matthew Ch VII: 24-29).

The ideal location for a village is not in sand for the simple reason that it does not provide a solid foundation for houses. The layout of the Neolithic village in Beidha was designed to overcome this inherent weakness in its setting. A terrace wall was built downslope from the village to contain and stabilise the tell mound (figure 9.5). And secondly, each structure was semi-subterranean to increase the stability of house walls, by having a proportion of the walls bedded against the foundation pit rather than being free-standing. The instability of the ground was illustrated twice during the experimental process:

- the edge of the foundation pits crumbled under the pressure of general traffic in and out of the foundation pit whilst we built the walls; and

- in the construction of the northern walls of exB-10 two different construction techniques were adopted (see Chapter 6 for a full description of the experimental process). The experiment indicated that a structural weakness swiftly occurred at the base of the wall if the wall was built resting on the edge of the foundation pit rather than standing on the compact base of the foundation pit.
Typically the selection for the location of a settlement is influenced by the slope of the terrain, soil type, water run-off, vegetative cover, and the microclimate (Rapoport 1969). However, Rapoport goes on to say that ultimately site location is cultural, not physical, because human goals, ideals, and values underpin the choice of a site (Rapoport 1969). I would suggest that houses are designed and built to accommodate the strengths and weaknesses of a chosen location, presumably chosen as the best available site. As such the physical features of a location influence the cultural decisions made. To balance out the sandy environs of southern Jordan, the design of structures at Beidha were built to accommodate the loose foundations. These decisions, amongst others, are further discussed in relation to the overall form of the structures, Objective 9 (Section 9.1.9).

The site location description for Beidha is as follows:

The local palaeoenvironment during the Neolithic would have included grassland vegetation in the alluvial valleys adjacent to the village and Mediterranean forest on the highland slopes immediately to the east (Byrd 1994:664).

Alternative locations for a settlement in the immediate surroundings area would be on the sandstone outcrops. The steep slopes of these outcrops would need to be levelled by carving or chiselling in preparation for a foundation of a structure, a method employed by subsequent civilisations in the area (e.g. a Nabataean caravanserai and village at Little Petra, known locally as Siq al-Barid). This level of preparation and investment far surpasses the construction of a retaining wall in the sandy wadi bed.

There are four main PPNB sites excavated in the Petra Region of southern Jordan including Beidha (e.g. Kirbride 1966, 1967), Ba’ja (Gebel and Starck 1985), Basta (Gebel and Starck 1985; Gebel et al. 2006), and Shkarat Msaied (Jensen et al. 2004). With the exception of Basta, the location of each of these sites has been noted by the excavators as being a point of interest either due to their inaccessibility and/or lack of ready access to running water. The positions selected for PPNB sites in this region contradict the commonly held belief that PPNB sites occur in relatively predictable locations (Banning 1989:216), with a range of recurrent characteristics. These include on lower slopes, near a reliable spring source, and with access to diverse hunting grounds. The situation in the Petra Region seems to deviate markedly from this simple model.

**Ba’ja**

This site is a large, Late PPNB village with terraced houses in a rather odd physiographic setting today. It can only be reached through a Siq, which is
sometimes as narrow as two metres. The Siq is blocked by fallen rocks at several spots, so that the site can only be reached today by mountaineering across the almost vertical blockings, which may reach heights of 6m. No water resources are in the immediate vicinity of the site today. Apart from numerous large water pools in the depressions of the Siq...in the dry season water must have been obtained from spring horizons of the eastern limestone ridge (Gebel and Starck 1985:97).

Is it possible that the major spring near Ba’ja is still to be discovered, as at Beidha, 40 years after investigations began?

As at Beidha, the semi-subterranean construction method employed compensated for the loose sandy geomorphology of the location. This provided adequate stability for tall architecture, with second storeys. When the sand moved, at times engulfing the lower storey of a structure, the PPNB villagers seemed to have simply built more storeys on top of it (Gebel pers comm.).

**Basta**

The PPNB village in Basta is also built on sand. However, in contrast to Beidha, stability for the houses was created initially by preparing a complex series of platforms and terraces.

In contrast to Ba’ja, Basta is located near a major spring but was situated on a “plateau, characterised by vast, tree-less fields” (Gebel and Starck 1985:98).

**Shkarat Msaied**

This site is situated on a small plateau set on a saddle between rugged hills. There is no permanent spring near the village. Like the structures at Beidha, the foundations were cut into sloping ground.

The experimental results from Beidha, in conjunction with a review of architectural adaptations seen at other PPN sites in the region, suggest that structural stability was evaluated at foundation level. PPNB builders were able to adapt to the various sandy slopes in the region. The structural adaptations and the implied increased energy expenditure in these adaptations (e.g. building terrace walls) indicate that more important issues were at play than avoiding sandy locales when choosing a location for a settlement; perhaps these included proximity to food and water sources.
9.1.9 **Objective 9: To evaluate the overall form of the structures**

...house form is the result of choice among existing possibilities - the greater the number of possibilities, the greater the choice – but there is never any inevitability, because man can live in many kinds of structures (Rapoport 1969:59).

This quotation from Rapoport suggests that no amount of experimentation, analysis or research into prehistoric architecture will reveal the reasons that a particular structural form was adopted at a site, because we can not quantify the unknown variable which is the unpredictable nature of human choice involved in the design and construction of a building. And here, I would reiterate that even though experimental reconstructions bring us closer to experiencing the making of prehistoric houses, such rebuildings cannot recreate the exact circumstances or decisions influencing the construction process.

However, evaluating the possible choices available and testing the constraints that were in place, leads to a closer understanding of the form, or forms, present at a site. As such, the physical constraints, as opposed to the cultural constraints, on house form are typically the climate, availability of building materials, and technology. The form of structures at Beidha followed a pattern recognised in vernacular architecture in comparable semi-arid environments (Khammash 1986; Kinzel 2006). For example the houses in such environments are typically:

a) made of adobe, *pisé*, or mud and stone to create a heat sink which slowly absorbs the heat during the day and radiates it during the cold nights.

b) constructed in a compact geometric format with maximum volume relative to minimum surface area.

c) built in groups of structures, with mutual crowding, so that more shade is created

d) cooking will take place outside

e) window gaps will be located high up on walls to reduce the impact of ground radiation

f) the exterior of the dwelling will be painted white to reflect the heat of the sun
With the exception of the last two points, there is evidence for all of these features in the early Neolithic architecture at Beidha and each was addressed in the experiments to confirm ultimately the efficiency of the architectural form of these structures. One such example was seen in the temperature readings taken in and around the experimental structures which illustrate the thermal efficiency of each of the semi-subterranean buildings (see Objective 7, Section 9.1.7).

An evaluation of building materials, including their availability, was addressed in the experiments and was detailed in Section 9.1.6 (Objective 6). Based on the experimental data, the form of structures at Beidha was not constrained by the availability of building materials. There was ample supply of stones and soil in the environs for the construction of the main framework of both the circular and pier structures. Accessible timbers are notably scarce in the region today, and if a depletion of suitable timber had already begun in the Neolithic period, then the form of the structures would have been constrained by the limitations of roofing a house with inferior quality wood or short timbers. This may have been the case in the change from circular to rectangular structural form during the occupation of the site (see Section 9.1.13 for further discussion, Objective 13).

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9.1.10 Objective 10: To determine the function of individual buildings

Identifying the function of individual structures based on archaeological evidence is not as straightforward as interpreting spatial organization or distribution patterns as is done in many ethnoarchaeological investigations (Kramer 1982; Watson 1979). Functional interpretations have to take into account the partial preservation that characterizes the archaeological record. For example, perishable organic material rarely survives, with the notable exception of the burning of B-48 revealing the presence of basketry and the products of nut harvests. Equally misleading in the interpretation of a building’s function is the risk of evidence relating to its final, and perhaps atypical, use masking the original function and subsequent changes or reuse.

Byrd classifies buildings at Beidha into three functional groups - domestic dwellings, storage facilities, and non-domestic buildings – based on building size, construction style, activities associated with in situ artefacts, and the nature of their abandonment (Byrd 1994:646). His classification system is flawed in some cases, such as his interpretation of B-48. In this
instance, his categorisation of the structure is based on the rich carbonised material excavated from the building, in contrast to neighbouring unburnt buildings that lacked good evidence for \textit{in situ} artefacts. Clearly, the distribution and type of artefacts upon which to interpret activities varies depending on the level of preservation in each structure. Therefore, ultimately his classification can only be employed in terms of building size because of the variable and fragmentary nature of the archaeological evidence at Beidha.

As mentioned earlier, experimentation aimed at determining the function of a structure will not provide conclusive evidence because space can be used in multiple ways. Instead experiments suggest an array of possibilities whilst eliminating others. During the experiments conducted at Beidha the main questions concerning function centred on the rather enigmatic form of the pier structures. Possible interpretations included workshops for craft specialisation (Kirkbride 1962) and storage facility for perishable items (Banning and Byrd 1983). A simple experiment involving sitting in one of alcove spaces in exB-10 strongly suggested that the space was too small and dark to be used as a workshop. However, the spaces did prove to be ideal for storing goods in a sheltered and concealed area, and also one with optimal temperature control for storing perishable goods above ground. Therefore the experiments strongly suggest that pier structures could have been storage facilities, though this is not necessarily their exclusive use. The three functional groups – domestic dwellings, storage facilities, and non-domestic buildings - suggested by Byrd need to allow for the overlap of multi-functional spaces that may cross over between domestic and non-domestic activities.

Kirkbride (1966a:203) suggested that pier structures formed workshops to deal with specialised production. My experiments suggest that this was not a reasonable interpretation of the function of these spaces, for reasons of practicality (too cramped and poorly lit), but what of the second part of her interpretation in which she suggested that these buildings presumably belonged to individual families? Commenting on social groupings through experimentation is difficult, if not impossible. However, observing people as they moved around the different experimental reconstructions can shed some light on the issue. I noted that people, including members of the team, approached the pier structure with slight apprehension. They stayed a few paces back from the entrance to the pier structure and would wait for an invitation to enter. This contrasts with the ease and insouciance with which people wandered in and out of the more open-plan of a circular structure. Is this contrast that people felt as they approached the building an indication of private space?
From this can we infer private or family ownership? Such proposals may of course simply be an example of experimenters embedding the past with modern concepts, such as the culturally variable notion of privacy.

Even if the small alcoves of B-10 were not used as workshops the issue of specialisation in craft production remains pertinent to discussion relating to the function and form of the pier houses. In addition to the concentration of tools and artefacts in the so-called activity areas within the structures (Byrd 2005b:117), increased specialisation can also be seen in the architectural form, design, building material, and construction technique of the pier structure in contrast to the earlier circular structures; the stones are more regular in shape and must have been deliberately selected; walls are more perpendicular and incorporate right-angles; the pier structures are rectilinear suggesting specialised storage in a similar way as one might use rectangular boxes with multiple compartments for storing more specialised tools, in contrast to round vessels used for storing grain or water; and the buildings fit into a village grid or plan with the main axis running north-south, perhaps to provide access routes and clarify community organisation. These all indicate an increased concern for specialised function in the construction of houses, as seen at other PPN sites such as Ghuwayr and Ain Ghazal.

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9.1.11 Objective 11: To analyse organisation of interior space

An understanding of the spatial organisation of interiors in archaeological contexts has been proposed through the use of space syntax (Banning 1996; Hillier and Hanson 1984) and graphs of spatial differentiation (Hanson 1998). However, these basic principles of space configuration are only effective with simple structures such as those at Beidha if one is able to incorporate into the equation associated features such as furnishings, people and invisible boundaries. At Beidha the experimental structures focused less on the interaction with these associated features and more on the architecture of the individual buildings. A deeper understanding of the organisation of interior space, including associated features, may have been achieved if experimenters had lived in the structures. However, re-enacting early Neolithic life, itself laden with cultural problems, was not feasible in this project, and did not form part of the current programme of experiments. Another downfall of trying to use spatial syntax at Beidha, especially in the earlier phases, is that the effectiveness of analysis is limited when the structure consists of only one or even two demarcated interior spaces (Cutting 2003).
Some valuable understanding of the practical use of space was gained through day-to-day activities carried out during the reconstruction process. For example, a marked difference was noted in observing the movements of experimenters inside exB-49, as noted in Chapter 6, compared to tourists who came into the structure. The latter commented on the low roof and lack of headroom available inside. As a result, the main tourist traffic in and out of the structure followed a circuit set closely around the central post, whilst seating and storage for the experimenters was based at the foot of the interior wall face. A year after its construction, the central area of this building, approximately 2m in diameter, was characterised by a compact soil produced by trampling, in contrast to the build up of loose soil at the foot of the walls (figure 9.6). Soil and debris also gathered immediately around the base of the central post. In contrast, the flat roof of exB-18 allowed for a more even distribution of activity across the floor of the structure. The experiments suggest that the distribution of compact soils versus loose debris in archaeological deposits may be used to further extrapolate upon the design of the roof, and its affect on headroom to facilitate the movement of people within a building.

Observations of people’s reactions to, and interactions with, the two distinct forms of Neolithic structures were also made during the experimental process (as discussed above in Objective 10). The hesitation noted in visitors approaching the pier house when compared to the circular houses supports Banning (1996) and Byrd (1994) theories that open access in houses and communities developed into a more distinct organisation of public and private space in early Neolithic villages. The sub-divisions in the organisation of space (connectivity, access, and spatial integration) can indicate a “society’s level of socio-political complexity” (Hanson 1998:47). The latter is usually measured by considering social hierarchy and material wealth. Observations during the experimental process at Beidha may indicate an increase in social complexity reflected in the increase in segmentation and partitioning.

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9.1.12 Objective 12: To explain patterns of structural adaptations and re-use

In accordance with the original archaeological evidence, each of the experimental buildings at Beidha underwent some structural modifications during the experimental period. An entranceway in exB-18 was completely blocked (figure 9.7), timber uprights were adjusted in exB-49, and a new retaining wall was built upslope from exB-10. Adaptations such as
these may indicate the reappropriation of a structure, changes in rights of access, or symbolise a social event in the community, similar to the way modifications are carried out on doorways into houses in Navajo communities after the death of the inhabitant (Kent 1991).

Once again these socially driven factors are difficult to elucidate through experimentation, however many practical reasons for structural adaptations were noted during the experimental process. For example:

- Adding new external walls in the immediate vicinity of a building changed the flow of surface water and wind through and around the structures. In the case of exB-10, the addition of a small wall helped reduce flooding inside the structure, and in exB-18 blocking the entranceway reduced draughts. Each of these tasks took no longer than half an hour to execute, did not require any specialised material or skill, and was reversible. This illustrates the versatility of the architectural designs as well as the fluid – and temporary - nature of the adaptations.

- New upright posts could easily be added to provide extra support for the roof rafters with little disturbance to the infrastructure of the original roof framework. A new posthole was dug adjacent to the hole and a new post could be inserted. Whether this new upright timber was coated in mud plaster would be an aesthetic consideration because from a practical point of view the internal structure of the walls would still be protected with the previous layers of mud plaster.

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9.1.13 Objective 13: To explain changes in architectural styles, from circular to rectilinear

With its excellent preservation of both circular and rectilinear architecture, Beidha is in a prime position to furnish explanations for the transition in architectural form from circular to rectilinear houses seen on a global scale throughout human history. Other early Near Eastern sites with the presence or co-occurrence of circular and rectangular architectural form include: Mureybet (Cauvin 1977), Ain Abu Nekheileh (Kirbride 1978), Jilat 26 (Garrard et al. 1994), Çayönü (Özdoğan and Özdoğan 1989), Jerf al Ahmar (Stordeur 2000), and Nemrik 9 (Kozlowski and Kempisty 1990). The experiments at Beidha on the two forms of
architecture have shed further light on theories previously proposed by archaeologists working in the Near East. It should be noted here that the experiments conducted at Beidha were unable to address all aspects of the transition from circular to rectilinear structures. Firstly, the experiments were site specific, therefore the rectilinear architecture analysed in the experiments at Beidha does not typify rectilinear structures elsewhere in the Near East. At Beidha the piers continue to brace the lateral forces of the structure perpetuating the inherently stable design of circular structures in a way that typical square or rectangular houses do not. Secondly, the time frame and resource limitations of the experimental project at Beidha did not allow for the experimental reconstruction of an example of a building from Phase B. Experiments were not conducted to address the construction of a sub-circular building without the use of upright timber posts set into the stone wall cavity, as seen in Phase B.

Therefore the contribution that the experimental results from Beidha makes towards the problem of the transition from circular to rectilinear, on a regional scale, should be adopted with caution. Despite the similarities with architectural forms and features seen at other sites, for example the niches at Jericho (Kenyon 1985) and hearths at Ain Ghazal (Byrd and Banning 1988), there are differences in the organisation of space within the pier structures. The differences led Byrd and Banning to label the Beidha structures as ‘corridor’ buildings to differentiate them from the pier structures at Ain Ghazal and Jericho (1988).

Observations made during the experiments at Beidha suggested that the change in architectural form was accompanied by the following changes:

- an increase in time taken to build the pier structure
- an increase in labour expenditure
- short-term maintenance requirements were comparable, but may be reduced in the long-term
- demand on construction technique decreased marginally
- reduction in timber size and quantity needed
- increase in volume of mud required
- increased effectiveness in partitioning and storing goods
- increased temperature control
- increasing focus on storage and specialised activity areas, in the construction of piers and a possible second storey
So what do all these changes in architectural features indicate? Here I would like to draw on comparative material provided by archaeologists working in the Americas where a substantial body of research has been carried out on the transition from pit structures to pueblos in the Southwest (Gilman 1987; Whalen 1981). The excavators at Ba’ja have also recently noted the similarities between early Neolithic architecture in southern Levant and the pueblos of the American Southwest (Gebel and Kinzel pers comm.). In the American Southwest Gilman defines pit structures as buildings with a floor excavated below the ground surface, and thus semi-subterranean. This form contrasts to a pueblo which is characterised by multiple-roomed structures built above ground using adobe, stone, or masonry walls. The architectural transition in the American Southwest is, like all analogies, not perfect in relation to the changes seen in architectural form at Beidha. In this analogy the architectural styles are comparable but not identical. Early Neolithic structures at Beidha are contiguous, unlike the pit structures of the Southwest. And the Beidha pier structures, despite possibly having a second storey, remain semi-subterranean in nature, unlike pueblos. However, the analogy allows some pertinent social aspects that accompanied the transition to be enumerated.

Cultural-ecological aspects have been central to explaining the Pithouse-to-Pueblo transition. Essentially this transition is seen as an adaptation from small-scale and extensive, to large-scale and intensive, in terms of subsistence patterns, demographics and social organisation (Whalen 1981). Specifically, Gilman has identified the transition as an adaptation to the intensification of storage needs in a growing community. Ethnographic studies of details of the economic and social organisation of over eighty pit structure settlements have led Gilman to conclude that the use of pit structures “in a cultural system is a direct indicator or measure of the state of seasonality and mobility patterns in that system” (Gilman 1987:547). Her study indicates that pit structures, accompanied by storage facilities, would be occupied at least during cold months when stored food will be the dietary mainstay. Her results suggest that early pit structure settlements, similar to those excavated at Beidha, represent a community reliant on both a mobile hunter-gatherer subsistence lifestyle as well as on agriculture. In the past, Beidha has been described, although tentatively, as a village occupied year round by fully sedentary groups (Wright 2000). This may apply to the final phase of occupation at Beidha (Phase C), however, even tentatively, this cannot as yet accurately describe the village at Beidha throughout its long occupation history (see Section 3.1.2, for evidence of subsistence practices at Beidha). Returning to Gilman’s model may address long standing queries such as: “Although it is risky to try and correlate round
structures with less permanent settlements, could the initial building phase at Beidha reflect the architectural tradition of local hunter-gatherers shifting to a more sedentary lifestyle?” (Byrd 1992:53). According to Gilman’s model the pit structures are used seasonally, usually in the winter, when the focus turned to stored food. An indication of this seasonality comes from one of Beidha’s neighbouring early Neolithic sites, Shkarat Msaied, where buildings were sealed up on a seasonal basis to preserve the structures and the stores within them (Jensen et al. 2004). Also the presence of domesticated goat within the faunal assemblage (Perkins 1966), along with cultivation of wild barley and domesticated emmer (Helbaek 1966; Legge 1996) at Beidha suggest a transition from hunter-gatherer subsistence lifestyles to adaptations of seasonally available foodstuffs for storage.

The introduction of pueblos in Southwest America marks the increasing need for more storage space, and with it came separate areas for processing, preparing and cooking food. It reflects growing pressures in the community, perhaps from growth in population size, pressures on wild food resources, and/or an increasing need to protect stored food against wild animals and thievery; and planning for provisions set aside in case of food shortages in the event of failed crops.

Kent, citing case studies in Kalahari Desert and Navajo communities, showed that the increase in segmentation paralleled an increase in socio-political complexity and sedentism (1991). An inverse relationship also exists between mobility and segmentation such that decreased mobility caused increased sociopolitical, spatial, and architectural segmentation (Kent 1991:442). As with Gilman, one of the focuses of Kent’s perspective on cultural change is on increased sedentism, but Gilman goes on to comment on the complexity of the community and touches on issues of gender-segregation, activity-restricted areas, and age separation. “…this change correlates with changes in other factors such as population size, subsistence strategies, settlement systems and mobility, and food storage” (Gilman 1987:538). It is easy to see how the transition in architectural style at Beidha could fit into a similar pattern identified by Gilman in Southwest America and spark so many questions for archaeologists working in the early Neolithic in southern Levant.

Supporting evidence for this theory of increased complexity in relation to sedentism can be found in the artefact assemblages at Beidha. Firstly, an increase in the diversity of groundstone tools discovered in the pier structures in Phase C at Beidha has led to the argument that an element of agricultural specialisation had developed by this stage and is
evidenced in the range and function of vessels and tools (Wright 2000). Secondly, the Late PPNB layers at Beidha showed an increase in number and size of features associated with the preparation of food (for example milling tools and vessels) (Byrd 2005). The focus here is placed on the possible parallel development of food-related activities and spatial organisation from unspecialised and unstructured in the Natufian and PPNA to structured areas in the Early and Middle PPNB through to privatisation of milling, cooking, storage, and dining in the Late PPNB (Wright 2000:117). This leads to one of the characteristics of the emergence of the early Neolithic farming village in the southern Levant, according to Byrd (1994), which is the increasing pressure on local resources resulting in restrictions on certain types of raw material (especially those directly related to subsistence), intrasite competition between domestic groups and households, and also differential access to raw material and produce.

During the experiments at Beidha the spaces, or chambers, between the piers of exB-10 were used for storing our equipment, tools and materials. Unlike the interiors of the circular experimental structures, exB-10 offered discrete sheltered spaces ideal for concealing tools and wood overnight out of the view of passers-by. The crime rate in the area is very low and the misfortune of having belongings stolen was unlikely. However, fuel in the form of wood is very hard to come by, as was demonstrated in the arduousness of acquiring timbers for the experiments, and concealing such a precious resource was highly advisable during the experimental programme on site especially between construction seasons when the reconstruction site was left unattended. During the first couple of years of the experimental programme at Beidha, before the reconstruction of the pier house, our equipment was concealed in a natural crevice in the rock outcrops within easy reach of the site. Later the spaces between the piers provided an ideal private location to cache such items. Possessing similar desirable goods in the early Neolithic would have led to the need to build these hiding places in private secluded spaces.

Therefore the catalyst for the transition from circular to rectilinear architecture may have been linked with a change in subsistence strategies (Gilman 1987:538) and settlement systems and mobility (Byrd 1992:53). But how did the change occur? Was the change introduced into the population, along with agricultural innovations and domestication, through a colonising population from elsewhere or did an indigenous population initiate the architectural change? The experiments indicate that the construction techniques, use of raw materials, and patterns of structural adaptations were comparable between the two distinct
forms of architecture suggesting indigenous development. However, there was no distinctive occupation phase at Beidha exhibiting signs of experimentation in architectural forms and the co-occurrence of round and rectangular buildings. There is a marked shift from circular structures to pier structures, interrupted only by an architectural style occasionally seen in Phase B that is characterised as subcircular structures with no upright timbers. There is no predecessor to the pier features on site, thus suggesting that the design was brought to the site rather than developing on site. In these circumstances it could be postulated that the local population, using local construction materials and techniques, imported and adapted the architectural design of the pier structures.

Deffontaines would have us believe that the transition from circular to rectangular structures is driven by religious beliefs (1948). A rectangular house, with four corners, is seen to be an indication for a desire for orientation. However, in the early Neolithic of the Levant, the opposite seems to be true in that the circular structures continued to be used as communal or ritual structures after the introduction of rectilinear houses (Byrd 2005b; Stordeur 2000).

Technological developments have been cited at early Neolithic sites such as Nemrik 9 (Kozlowski and Kempisty 1990) as the catalyst for the transition from curvilinear to rectilinear structures. Similarly, Byrd (2005b:99) suggests that the appearance of sandstone slabs in the wall construction of buildings in Phases B and C may indicate that the use of these slabs was better suited to rectangular buildings rather than circular post-socket structures. However, the experiments conducted show that this is not the case, since construction techniques did not markedly develop from Phase A to Phase C. The use of sandstone slabs in the later building phases reflects greater care in the procurement of stones from the slopes in the immediate surroundings, rather than technological developments.

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9.1.14 Objective 14: To explain intrasite variability over time

This objective was introduced into the experimental programme in order to address the frequent references made by Byrd (2005b) to variability, both structural and design, in the architecture at Beidha. His discussions centre on the continuity and change in architectural form, style, and construction technique; and patterning in construction timing, building longevity, and building abandonment (Byrd 2005b:73-102). His evidence is based on stratigraphic relationships, absolute floor elevations, and relative depths of wall bases. In
summary his conclusions suggested that building design and construction varied little in Phase A, but varied considerably in Phases B and C. The experiments conducted in this programme of research have helped reassess the reliability of Byrd’s criteria when trying to determine variability over time by re-examining the evidence relating to when a building was constructed, how long it was occupied, and when it was abandoned.

Byrd’s interpretation of the relative sequence of abandonment was based on evidence for the character of abandonment. In other words he looked at whether the building was burnt or not. The burning experiment indicates that the fires that terminated the use of a building were in some instances at least intentional, and clearly marked the end of a building tradition. Also, Byrd cites the infrequency of the post-abandonment fills within the buildings of Phase A as an indication of the very occasional gradual abandonment of buildings before their catastrophic burning. However, the experiments indicate that fills of the nature described in accounts of the excavation could accumulate in one season and were thus not a token of gradualism. Therefore gradual abandonment of a structure, and the occupation phase which it represents, may have taken place over months, rather than years as previously implied.

The variability noted by Byrd in the shapes and sizes of stones in the circular semi-subterranean structures was confirmed through experimentation. Byrd thought that this variability “no doubt reflected the inclinations of particular builders” (Byrd 2005b:74). Indeed this was the case during the experimental reconstructions, however the experiments indicated that the variability not only reflected builders’ personal preferences for particular sizes and shapes of stones but more significantly expressed the choices made by the procurers of this material rather than the builders themselves.

According to Byrd, habitation longevity, although not quantified but perhaps expressed as generations, was substantial in Phase A as seen in the amount of refurbishing of individual structures that took place (Byrd 2005b:79). However, refurbishments such as blocked entranceways were made during the experimental process to counteract the damage to structures after observing the effects of one winter on the building, and therefore a series of modifications may not necessarily imply longevity, but instead rapid and dynamic responses to weather conditions.
Byrd notes a greater degree of refurbishment and an increase in gradual abandonment of the whole settlement in Phase C. Over time the length of habitation was longer, the rectangular buildings were more readily adapted and modified, but were also more inherently unstable as, for Byrd, they were undoubtedly two-storey buildings (Byrd 2005b:94). The experiments supported his interpretations of changes noted in pier structures by reinforcing the concept that modifications, such as partition walls, were more easily carried out. However, as with Phase A, the experiments indicate that a reassessment of the longevity and rate of abandonment needs to be made based on new experimental data demonstrating the rapid rate of deposition within the structures.

In summary, the intrasite variability over time seen at Beidha correlates directly with the transition from circular to rectangular structures. Changes in spatial organisation over time included an increase in specialised activities areas and storage facilities associated with domestic architecture, and more compartmentalised spaces within the buildings specialised for production and storage (Byrd 1994). However, the experiments carried out challenge the time frame associated with the variations noted.

An examination of the intrasite variability in any one phase naturally leads to discussions on intersite variability over time. Byrd makes comparisons on a broad geographical and chronological scale incorporating sites from Ujrat el Mehed in southern Sinai to Azraq Basin in northern Jordan, and a range of aceramic Neolithic sites from PPNA to PPNC (Byrd 2005b). Here I would like to limit the comparison to the aceramic Neolithic sites within the Petra Region: Beidha, Basta, Ba’ja, and Shkarat Msaied, as well as Ain Ghazal in Amman.

Kuijt and Goring-Morris believe that in the PPNB, and in the MPPNB in particular, “settlements that were close to each other tend to have similar architectural practices” (2002:392), citing examples from Ain Ghazal and Jericho which rarely exhibited more than 0.50m variation in the lengths of walls. However, this is not the case in the Greater Petra region where a greater degree of variation exists in overall size, shape, and the subdivision of buildings as exemplified by internal partitions, despite their similarities in climate, availability of construction material, and technology. Kuijt and Goring-Morris believe this may be due to “unrecognised differences in economic practices, differential rates of diffusion of cultural practices from communities living in Mediterranean areas…and/or differences in social organisation” (2002:393). This view places Beidha once again in a peripheral zone whilst placing mega-sites such as Ain Ghazal at the core (Hole 2003).
The experiments at Beidha offer some clues to the unrecognised differences cited above. I would suggest that the function of the buildings were the driving forces in the development of their form. The increased compartmentalisation characterised by the pier structures in Phase C at Beidha directly reflected a change in the villagers’ food gathering strategies. This further implies differences in the economics and storage needs of other PPN villages in the Greater Petra region.

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**9.1.15 Objective 15: To analyse post-abandonment processes, and**  
**Objective 16: To assess intentionality in prehistoric destructions**

The focus of the study of post-abandonment processes at Beidha, both in the current experimental work and in the interpretation of excavated material from the 1960s, has been on the burnt remains of the early circular structures of Phase A. Evidence relating to the intentionality of the fire that destroyed Building 48 has been presented in detail in Chapter 7. The general pattern observed at Beidha is comparable to those noted in other experimental burnings (Gordon 1953; Hansen 1966; Harrison pers comm.; Wilshusen 1986) in which the burning of a structure built at least partially of mud will typically undergo an initial, rapid combustion, displaying substantial flames, as the roof material catches light and will then begin to collapse within 20 minutes of igniting. This is then followed by up to 8 hours of smouldering, usually of the timber supports of the roof and walls.

However, at Beidha the structure would only burn readily to the degree noted in the archaeological record if large amounts of inflammables were present to fuel the combustion. The possible scenarios are a) the buildings were packed with fuel and combustibles with the intention of destroying the building; or b) the structure was completely filled with inflammmable stored goods (for example, wood and crops) and caught fire accidentally whilst unguarded, perhaps in the dry summer months? Understanding the character of discard within buildings is pivotal to interpretations (Schiffer 1987). Determining whether a building was intentionally or accidentally burnt is crucial to our overall understanding of attitudes towards ‘homes’ (Watkins 1999).

Further in-depth analyses of the burnt remains of exB-48 could unfortunately not be conducted within the period of experimentation at Beidha reported here due to restrictions of time. Future investigations at the site could include magnetic susceptibility of the sediment.
to reveal patterns of the distribution, intensity and temperature of the fire that could be compared with observations made on the day of the conflagration. Further experiments involving X-ray diffraction would confirm the patterns exhibited in the mineral magnetics. The remains of the fire could also be analysed through the examination of thin sections to reveal the microscopic content of the burnt remains. The results could then be compared to archaeological samples and thereby bring us closer to understanding the posited intentional destruction of houses in the early Neolithic.

In addition to the burning experiment the following observations were made during the experimental reconstructions:

- It is surprising, considering the large amount of stones needed in the construction of pier structures in Phase C, that more stones were not robbed from accessible building remains of Phases A and B. During the experimental process, considerable time and energy was spent gathering stones from the adjacent fields. It would have been so much easier to use the stones already lying around the archaeological site. In the absence of a utilitarian explanation for leaving the structures intact, I turn to social and symbolic motivations. Is it possible that, like us, the builders of Phase C at Beidha were forbidden to take stones from earlier buildings? Did they respect the buildings, and the burials within them, as representing the homes of ancestors?

- The current interpretations of the Neolithic phases at Beidha depend partially on the nature of abandonment. For example, a structure that has a significant depth of post-occupational debris within it is thought to have been abandoned at the end of a phase, as opposed to a burnt structure which had a shorter occupation history. This is not necessarily the case and in light of the experiments the ratio of depth of internal deposit to years since abandonment need to be reassessed. The experiments indicated that within two and half years internal deposits of 20cm depth accumulated. This is comparable to the depth of deposits recorded in the 1960s excavations and subsequently interpreted as either a re-flooring event or post-abandonment accumulations (Byrd 2005:36). The experiment supports the latter suggestion but further suggests a time frame as short as two years for the formation of such a fill. This period could be even shorter if taking into
account that deposits may accumulate quicker if the structure was completely abandoned, or if the roof material was robbed to leave the interior exposed.

- The distribution of deposits that accumulated within the experimental structures could be largely explained by a) the effects of wind and rain on the buildings, and b) architectural features. The former was clearly demonstrated in the great depth of deposits noted to the west of exB-48 compared to the east side. This resulted from a strong easterly wind blowing material to the west during the burning experiment. Similarly, debris was deposited at the southern (downslope) end of the interior of exB-49. This resulted from water running in through the doorway at the north end of the structure. Architectural features such as the pitch of the roof also influence the distribution of deposits as seen in the interior of exB-49. The reduced headroom near the walls restricted traffic and hence left deposits to accumulate more steadily as this area was predominantly protected from trampling.

Distinguishing deposits resulting from aeolian and alluvial activity, in contrast to the attractant and repellent effects of different architectural features could, in future, be achieved at Beidha through microstratigraphic sampling.

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9.1.16 Objective 17: To evaluate the social organisation required for the construction process

The degree of social complexity during the PPNB is still a matter of great debate. Edwards sees no evidence to support any changes in social hierarchy (1989); Watkins (2002, 2003) envisions cognitive changes taking place during this period; Cauvin sees the development of religion (1994); and Rollefson believes that the “development of social complexity during the Middle and Late PPNB refers to the increasingly intricate interrelationships among the inhabitants of growing populations. The precise form that social complexity obtained at this time may never be recoverable…” (Rollefson 1989:171).
Observations made during the construction of exB-10, exB-18, exB-48 and exB-49 suggest that a complex social organisation is not needed to build either early circular semi-subterranean structures or pier houses. Each of the experimental buildings was predominantly constructed by four to five unskilled individuals. However, certain tasks within the construction process could have benefited from a larger construction team. For example, more hands would have facilitated the raising of the roof on the early circular structures. More people would also have increased the rate of gathering stones from the surrounding areas and thus preventing a bottleneck related to the stone supply occurring in the construction process. Viewed as an efficient industrial construction, the task force would normally be organised to avoid bottlenecks which equate to costly obstructions in the productive flow of the construction process usually caused by limiting factor in either time or material (Abrams and Bolland 1999). The principle of this theoretical approach to the organization of operations states “that all systems of production of goods or services are necessarily constrained by virtue of limited amounts of some resources, and these limitations play a profound role in decisions concerning the organization of production” (Abrams and Bolland 1999:272-3). In the case of experimental reconstructions at Beidha the bottlenecks were created by a fixed number of workers in the task force for the majority of the construction process. In other words, a total of four workers was deemed an efficient size of task force for building the walls of the structures and the same four also gathered the raw materials. However, a task force of ten to twenty would have been ideal for gathering stones. Presumably, in a Neolithic village the size of Beidha it is conceivable that there was more flexibility in the size of the work force in that more people would be readily available to help as and when needed. The tendency is to imagine the construction process as a linear event involving locating raw materials, transporting them to the site, preparing the materials, and then ultimately start building. However, in reality the various tasks in the construction process can happen simultaneously as was done during the experimental reconstructions. Similarly, raw materials, such as piles of stones, could be accumulated gradually before the construction phase begins.

The increase in labour expenditure recorded in the construction of a pier structure compared to a circular structure, as described in Objective 2 (Section 9.1.2) and in Table 9.6, may be interpreted as implying an increase in social complexity. A pier structure involved the organisation of more labourers and/or investment of hours, especially if one was to consider the construction of a second storey.
Observations from the experiments carried out at Beidha indicate that a limiting factor in the rate and efficiency of construction is the space available for circulation around the small structures. Personal working space was important and a team of about four people was able to organise itself into an amenable and cooperative task force. Increasing the size of the force caused conflicting opinions and inefficiency. Abrams and Bolland (1999) suggest that pre-existing kin-based relationships or teams such as those involved in cooperative tasks such as agriculture may facilitate the organisation of the construction and introduce a level of efficiency. This was observed to a limited extent during the experiments at Beidha in terms of the short time taken to construct the third circular structure, exB-18, using a small team that had already worked cooperatively in the construction of exB-48 and exB-49.

The degree of skill and craftsmanship required of individuals constituting the small team is, based on the experimental reconstructions, negligible. Experience and knowledge of basic construction techniques, such as building stone walls, is obviously a prerequisite however it would not be described here as a specialisation. Therefore, despite dividing the task force into two main groups, builders and collectors, there is no complex organisation of labour or skill needed.

In summary, the implications are that the construction of an early Neolithic structure involves organising a large team to gather the raw materials whilst a small team executes the construction. In other words, all able-bodied members of different ages within a small village community may collect raw materials for an entire day whilst a small percentage of the population spend one to two weeks building a structure. In this model the buildings could have been constructed using community labour which functioned to further integrate the community (Byrd 1994:660).

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9.1.17 Objective 18: To share with the public the intricacy of Neolithic life

The inherent weakness of many museums is the difficulty in making the encoded meaning of past cultures accessible through displays of artefacts. The artefacts in museum displays are
usually incomplete due to erosion and unidentifiable to most visitors lacking specialised archaeological training. Here lies the strength of reconstructions.

Adapting one of the experimental reconstructions at Beidha to serve as a visitor centre allowed visitors to interact with and experience the early Neolithic architecture. This is especially important on prehistoric sites where structural evidence is harder to understand when compared to classical architecture, such as that seen at Petra. Although difficult to quantify the degree to which visitors’ understanding of the Neolithic was ameliorated by the reconstructions at Beidha, conversations with tourists on site during the experimental programme were positive and full of praise. Part of its success was that the construction process was on-going and formed part of the display, rather than being a static finished object. The reconstructions were able to communicate in three-dimensions and without words to the low level of illiterate in the local community as well overcome language barriers amongst the many foreign visitors.

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9.2 Summary of Reanalysis

Table 9.7 briefly summarises the results of each of the experimental objectives:

<table>
<thead>
<tr>
<th>Objective</th>
<th>To estimate the amount of time taken for the construction process</th>
<th>Experiments are comparable to other prehistoric reconstructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective 2</td>
<td>To estimate the labour expenditure needed</td>
<td>Experiments contradict the assumption that greater building size equates to greater labour expenditure</td>
</tr>
<tr>
<td>Objective 3</td>
<td>To assess the maintenance costs of a structure</td>
<td>Minimum short-term maintenance costs, except for roofs</td>
</tr>
<tr>
<td>Objective 4</td>
<td>To analyse construction techniques</td>
<td>The results of the experiments were subjective</td>
</tr>
<tr>
<td>Objective 5</td>
<td>To analyse construction designs</td>
<td>Structures demonstrated simple and effective design solutions</td>
</tr>
<tr>
<td>Objective 6</td>
<td>To analyse construction materials</td>
<td>Demands on local raw materials increased per m² in Phase C</td>
</tr>
<tr>
<td>Objective 7</td>
<td>To evaluate the effectiveness of individual structures</td>
<td>Experimental structures flooded, but effectively maintained optimum storage temperature</td>
</tr>
</tbody>
</table>
Table 9.7. Summary of experimental objectives and results

<table>
<thead>
<tr>
<th>Objective</th>
<th>Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective 8</td>
<td>To explain site location</td>
<td>Foundations of semi-subterranean buildings counteract instability of sandy subsoil</td>
</tr>
<tr>
<td>Objective 9</td>
<td>To evaluate overall form of the structures</td>
<td>Form may have been constricted by availability of timbers</td>
</tr>
<tr>
<td>Objective 10</td>
<td>To determine function of individual buildings</td>
<td>Reconstructions were ideal for storage, though also multi-functional buildings</td>
</tr>
<tr>
<td>Objective 11</td>
<td>To analyse organisation of interior space</td>
<td>Design of roof affects use of floor space</td>
</tr>
<tr>
<td>Objective 12</td>
<td>To explain patterns of structural adaptations and re-use</td>
<td>Problems relating to wind and surface water led to the most adaptations/modifications</td>
</tr>
<tr>
<td>Objective 13</td>
<td>To explain changes in architectural styles, from circular to rectilinear</td>
<td>Demands on storage, perhaps caused by increased agricultural practice, was a catalyst for change</td>
</tr>
<tr>
<td>Objective 14</td>
<td>To explain intrasite variability over time</td>
<td>Little variability was noted, except transition for circular to rectilinear buildings</td>
</tr>
<tr>
<td>Objective 15</td>
<td>To analyse post-abandonment processes, and assess intentionality in prehistoric destructions</td>
<td>Circular structures were burnt intentionally; deposits accumulate more rapidly than previously thought</td>
</tr>
<tr>
<td>Objective 16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective 17</td>
<td>To evaluate the social organisation required for the construction process</td>
<td>Minimal social organisation was required</td>
</tr>
<tr>
<td>Objective 18</td>
<td>To share with the public the intricacy of Neolithic life</td>
<td>Visitors gain positive interactive experience</td>
</tr>
</tbody>
</table>

As outlined at the start of this dissertation, the experimental objectives were designed to elucidate data to address key questions in the study of early Neolithic architecture. These questions were continually addressed throughout the experiments on site, and again during the transcription of the experimental process and results. To summarise, these questions are answered briefly here.

**How does the experimental construction, maintenance and destruction of structures at Beidha alter the current interpretation of early Neolithic architecture at the site?**

Observing the experimental process of the structures at Beidha has shed light on each of the three phases of the buildings’ history: construction, maintenance and destruction. For example, data collected pertaining to labour costs and construction materials means that we now have a more accurate model for estimating investment, in terms of time, materials and...
skill, to be further used in assessing issues relating to social organisation, environmental impact, and technological developments of an early Neolithic village in this environment. Secondly, observations of the form and function of the structures suggests that these early Neolithic structures may have been used for habitation in winter and storage in summer. A third example is the results of the burning experiment indicating intentional conflagration thus altering our current interpretation of the events at the end of Phase A.

What can researchers learn from these experiments?

In addition to the site-specific data produced by the experiments, Beidha, together with experimental sites such as Butser Ancient Farm, has successfully demonstrated the beneficial use of experiments as an alternative archaeological research tool to address specific research issues.

What is their value to non-specialist visitors, either those on an extended tour from the nearby ruins of Petra or those specifically touring the many Neolithic sites in the region?

The sentiments and reactions of the hundreds of tourists who visited Beidha during the experimental programme related to the great visual impact the experimental reconstructions had on their understanding of the early Neolithic architecture. This is especially important for prehistoric sites in Jordan which are predominantly aimed at presenting to an international and multi-lingual audience. Amongst the hundreds of visitors were prehistorians who were able to use the reconstructions to further develop their own interpretation of early Neolithic architecture at the site and in the region as a whole.

In conclusion, the reanalysis of the architecture at Beidha through the examination of the experimental objectives has shed further light on matters such as:

- the impact on social organisation of settlement types,
- significant patterns of domestic activities and storage space,
- the concomitants of sedentism, and
- the impacts of seasonality

By extension, our understanding of these issues brings us closer to understanding the transition from mobile hunter-gatherers to sedentary farming villages. These are addressed in the next, concluding chapter.
Chapter Ten

Conclusion

The series of experimental reconstructions conducted at Beidha between 2001 and 2006 were designed to address standard perceptions of early Neolithic architecture. The use of experimentation as a means of examining the evidence proved to be, for the most part, successful. The results from the experiments provided the opportunity to re-examine our current understanding of the early Neolithic in southern Jordan.

10.1 Success of Beidha as a site for experimental archaeology

Based on the criteria introduced in Chapter 4 for assessing the success of an experimental archaeology site, the programme of work at Beidha has had mixed success. Its main point of weakness was the inadequate management of visitors, their needs and their impact on the experiments. This led to some damage to the experiments, interference with the recording systems, and continued damage on the archaeological site itself. A preliminary consideration of visitors had been made, for example through a survey questionnaire, however insufficient time was available to spend on realising the plans to present the programme to the public. Temporary signs remained so and the programmes of demonstrations and guided walks were necessarily sporadic and spontaneous rather than planned and proactive. Indeed, visitors should not be an afterthought when dealing with archaeology, whether in excavation or experimentation, and in the case of the experimental programme at Beidha equal time should have been spent on presentation as was spent on experimentation. In addition to the small team of experimenters the project should have called for an individual working specifically to manage visitors in order to successfully share the Neolithic experience with the public; however this was neither practical nor viable.

On the positive side the experiments at Beidha were successfully completed without the use of modern technology to an extent where it interfered with the experiments (Coles 1973); the project successfully disseminated experimental objectives and results off-site within the field of archaeology (e.g. Dennis et al. 2002, Dennis 2003, and Dennis 2004); and it completed a full programme of active research for five years and encouraged further experimentation on site (e.g. Brown 2006).
On a broader scale the experiments at Beidha proved that experimental archaeology could be successfully carried out on a rural Jordanian prehistoric site. The experiments opened people’s eyes and minds to the possibilities, potentials and scale of experimental archaeology in Jordan beyond single event experiments such as firing pottery or knapping flint. These reconstructions now form an experimental arena that will hopefully be used by others to expand upon current experiments, to test and re-examine theories as they develop and evolve. The experiments at Beidha have begun to expand the field of experimentation with early Neolithic architecture, its correlation with domestication and sedentism. There are many questions that could still be addressed through experimentation (e.g. variations in the roof design of Phase A circular buildings, the construction of a Phase B building, and the design of second storeys on Phase C pier structures).

10.2 Examining Beidha through experimentation

The experiments carried out on two separate forms of early Neolithic architecture at Beidha have provided data on construction elements such as time and labour expenditure for individual construction tasks and quantities of raw materials needed; as well as providing an evaluation of maintenance costs, site location, form, function, structural adaptations, variability, and post-abandonment processes. This data was presented in Chapter 6 and further discussed in Chapter 9. Essentially the data furnished information to underpin our view of the construction process of an early Neolithic building from the point of gathering materials, to erecting and maintaining the structure. The experiments carried out at Beidha have contributed to our understanding of the early Neolithic on various scales from micro to macro, intra- to intersite, local to regional, for excavators in the field and fellow researchers. The scale of the knowledge gained can be illustrated through the examination of one of the simplest of raw materials used in the experiments: mud (Table 10.1).

<table>
<thead>
<tr>
<th>Micro-scale</th>
<th>The mud mix was made without adding a binding agent such as vegetation, but still proved to be effective and required minimal maintenance in the first three years of experimentation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro-scale</td>
<td>It would take 5 m³ of mud to construct Building 48. This may approximately equate to 66 hours of labour.</td>
</tr>
<tr>
<td>Intrasite</td>
<td>The soil excavated for the structure’s foundations was enough to make the mud for the walls and roof of the circular building. However, the soil excavated from the foundations of a rectilinear structure was insufficient for the construction of the superstructure.</td>
</tr>
<tr>
<td><strong>Intersite</strong></td>
<td>The proximity to a water source is essential even for stone built architecture. Investigations and excavations at other early Neolithic sites in the region, such as Ba’ja and Shkarat Msaied, may need to look for evidence of a prehistoric water source in the form of palaeochannels and palaeo-springs, as was recently discovered at Beidha (Black 2008).</td>
</tr>
<tr>
<td><strong>For the Excavator</strong></td>
<td>During the building’s use life mud from the wall construction gradually washed out to form layered lips at the base of the wall. In excavation these have in the past been interpreted as layers of mud plaster intentionally curved at the interface between the wall and the floor.</td>
</tr>
</tbody>
</table>

Table 10.1 Example of the scale of knowledge gained through experimentation

Equally important in the experimental process is the insight gained into the human dimensions of building a house. As Townend states “qualitative experiential elements of an experimental reconstruction are as much a part of the building as the quantitative materials and techniques” (2002:73). These experiential observations may alter the dehumanised view of the construction process as seen through the data. For example, the hardest task during the construction process was, by far, gathering stones. This is not conveyed in the data that simply states that it took 96 hours to procure more than 900 stones for the construction of exB-49. Each experimenter made their thoughts of this back-breaking task very clear, and would use any short cut available whenever possible. During the experiments this short cut was the use of a 4x4 vehicle to transport the stones, and conscious efforts were made to drive the vehicle within centimetres of the pick-up and drop-off points to avoid any unnecessary carrying. So why, during the construction of Phase C at Beidha, did the villagers not completely rob out the abandoned and ruined structures from earlier phases to avoid hauling so many stones greater distances? Many of the stone walls of the structures from Phase A remained intact to the point of retaining the large boulders used in capping the walls. Our experiential observations suggest that, like us, villagers in Beidha during Phases B and C revered the old structures from previous times and went out of their way to collect stones from further afield.

From a personal point of view, the act of experimenting with past technology has placed me in a better position to appreciate the skill and achievements of early Neolithic communities. By carrying raw materials, handling and sizing up stones, and often standing back to consider the next step, I have come very close both literally and metaphorically to the early Neolithic buildings. It has provided me with an experiential set of knowledge from which to draw conclusions and provide a new standpoint from which to ask more questions.
So how could this new standpoint change studies on early Neolithic architecture and communities? The experimental studies have contributed to issues relating to socio-economics, social organisation, and the technology of early Neolithic communities in southern Levant. Analysing the socio-economics of the early Neolithic is paramount to understanding the major transitions that occurred in this period. The experiments on the architecture at Beidha suggest that the community took part in a much larger socio-economic network. A change in architectural form but continuation of building technique from Phase A through to Phase C strongly suggests that local builders used traditional building techniques but imported the new pier construction design from another PPN village. As with mapping exchange spheres through the distribution of objects such as obsidian or dentalium (Bar-Yosef Mayer 1997), the pier construction suggests intra- and inter-regional communication taking place in the early Neolithic. The similarities in architectural styles suggest some level of communication between communities at Beidha and those in Ain Ghazal (Banning and Byrd 1987) and Jericho (Kenyon 1981). Further experiments with the construction of pier buildings at Beidha, including the construction of more pier houses to replicate the spatial organisation of buildings within Phase C, may prove or disprove Banning’s suggestion that the pattern of spatial organisation of circular structures in Phase A is the same as pier structures in Phase C (Banning 1998). This would further support the theory that some local building traditions were retained during the transition to rectilinear architecture. Examining the building traditions at Beidha and the southern Levant in such a way could further contribute to disentangling the various models that attempt to explain sedentism, colonisation, spread of agriculture, and the dissemination of cultural traditions in the early Neolithic. The adoption of a new architectural design using traditional building techniques could be cited to support the theory that saw the spread of agriculture throughout the regions in the PPNB via a network centred on the colonisation and adoption of food production among local hunter-gatherers (Byrd 1992). Equally the re-examination of the architectural designs in the region could support the notion of a network, or sphere, of sedentary communities that operated as self-regulating communities in an extensive region (Watkins 2003).

Although the experiments did not and could not conclusively prove the function of the buildings at Beidha they did provide strong data to suggest that the pier structures were built to store goods. This new evidence goes some way to replace dated theories such as that of Flannery (1972) in which he views the transition in architectural form from circular to rectilinear as an indication of a transition from compounds of polygamous families to...
households of nuclear families. The experiments illustrated that relative to total surface area there was an increased investment in materials and time in the construction of the piers of the rectilinear structures. This indicates increased investment in the need for storage facilities.

Social organisation is difficult to infer from the archaeological record. It is usually only successful, with limitations, through studies of burial practices. However, the experimental studies at Beidha may have shed some further light on the social organisation of the village during the early Neolithic. The experiments suggested that frequent renovations, modifications, dismantling and rebuilding recorded in PPNB architecture may be explained as responses to changing and adverse weather conditions, and not necessarily reflect a changing pattern in family residences (Banning 1998). The piecemeal approach to the spatial organisation of circular structures in Beidha could reflect a need to protect stored goods from surface water and flash floods. New settlers to the area would lack generations of intimate local knowledge necessary to predict the adverse effects of rain and wind on their newly built village. Each newly built wall would have altered the flow of surface water, and created new sheltered areas out of the wind and sun. The experimental studies proved how easily doorways could be blocked up and small terrace walls could be built in response to fluctuating weather conditions through the seasons. This being the case, the modifications to both the circular and rectilinear structures suggest some level of occupation during the wet winter season. Accompanied by faunal and botanical data (Helbaek 1966; Perkins 1966), the experimental studies indicate that Beidha was occupied year round during the early Neolithic. Evidence from recent excavations at the neighbouring site of Shkarat Msaied suggest that the structures may be completely sealed out of season to preserve the foodstuffs stored inside and therefore questions the level of occupation at Beidha at any single point of the year.

The conflagration of the houses during Phase A at Beidha, if intentional as the experiments suggest, may indicate that property was family-owned or heritable, and was destroyed at the end of an important life or a family line. The notion of an increased focus on the memory of certain family members in the early Neolithic is not new, and has been suggested through studies of burial rites in the PPNB (Banning 1998), perhaps a trait with its origins in the PPNA (Finlayson and Mithen 2007; Kuijt and Goring-Morris 2002). Indeed mortuary rites in the PPNB become increasingly standardised through time and from site to site (Verhoeven 2002) including examples of infants interred in sub-floor ritual contexts or within the walls of buildings, and adults usually interred in association with architecture. This suggests a
close ritual relationship between the dead and residential structures. Perhaps future experiments could include the reconstruction of non-residential architecture from Beidha to question differences in the structural design, spatial organisation and use of ritual and communal structures at Beidha in comparison to exB-48, 49, 18 and 10.

From an architectural point of view the experiments at Beidha have provided new hypotheses and considerations on the technological issues relating to the construction of both the circular and rectilinear buildings. In both cases the most informative of these have been the insights gained into the construction and design of the roofs. Despite being inconclusive, the series of experiments strongly indicated that an almost flat roof, rather than a sloped or completely flat roof, was both more effective in use and more accurately mimicked the evidence in the archaeological record.

In conclusion, the experimental studies conducted at Beidha have successfully demonstrated the range of hypotheses and considerations that can be considered through experimental reconstructions. As Bartovics stated “a demonstration of fact promotes additional experimentation but an argument of fact promotes debate” (1974:204). Thus it is hoped that this volume of research prompts future experimentation as well as further debate on the interpretation of early Neolithic architecture and the people who lived in the buildings it produced.
Appendix 1.1

Paper given at: The First Workshop on “Cultural Resources Management in Jordan: Facts and Ambition”, Yarmouk University, Jordan

Presenting Prehistoric Sites in Jordan
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Abstract

The aim of this paper is to raise the public profile of prehistoric sites in Jordan, which have to a great extent been ignored in the development of sites for the public, and introduce some ideas on presenting these sites with reference to sites in Cyprus.

The paper is written from an archaeological perspective. As an archaeologist, I have been trained to record and interpret sites using artefacts, contexts and the remains of structures to ultimately develop intellectual theories and to form scientific hypotheses. As yet the step from site recording and interpretation to presentation and conservation has not formed part of the standard archaeological process, although the realization of the need to incorporate heritage management into archaeological policy is growing. The direct role of archaeologists in Cultural Resource Management planning clearly needs to increase.

CRM and Prehistory in Jordan

As the workshop where this paper was first presented clearly demonstrated, there is a growing concern for the cultural resources of Jordan. However, not enough of this concern is directed at the archaeological remains of prehistoric periods.

There is tremendous cultural significance in the prehistory of the Levant. Jordan represents a core area for one of the most important moments in human history, the development of agriculture and sedentism. Within this phase both the Natufian and Pre-Pottery Neolithic periods are regarded as pivotal in our understanding of the development of communities and social organization. It is a period of human history that “provides our earliest case studies for how food production, social differentiation, and population aggregation and growth are interrelated” (Kuijt 2000:vii). The archaeological evidence from these periods provides extensive evidence of the transition from hunting and gathering to farming, as well as the earliest sedentary villages and the first substantial architecture.

Unlike monumental historic sites such as Petra and Jerash, prehistoric sites in Jordan receive very little attention. Yet there is a wealth of important prehistoric sites in Jordan including sites such as Beidha, Basta, Wadi Faynan 16, Ghuwayr 1, as well as Ain Ghazal, Ba’ja ‘Dhra, and Fidan 1. Some small efforts have been made to conserve and present these sites, but none presently cater for the public. This may be because prehistoric sites are for the most part ephemeral in nature. Even where they are more substantial the remains are very difficult to interpret and they do not have the immediate impact of monumental sites. Standard CRM approaches therefore need to be tailored to accommodate the nature of the prehistoric archaeology.

The use of reconstructions

There are a variety of methods and media that can be used to present interpretive material to visitors. These include models, replicas, 3-D images, illustrated panels, sculptures, brochures and guidebooks. In this paper, I focus on the use of reconstructions. The Venice Charter (1964) states that "all reconstruction work should…be ruled out a priori" (ICOMOS...
1964:art 15) and rejects reconstructions on excavation sites. The Charter only considers reconstructions carried out on remains that are in situ. The policy is designed to prevent both a false re-creation of the past and permanent damage of archaeological evidence. Reconstructions are criticized for-
- falsifying the archaeological reality and forming a modern creation,
- compromising the historical and aesthetic values of a site, and
- simply being expressions of contemporary fashions and trends and therefore not accurate interpretations of the evidence (Sivan 1997).

All reconstructions of the past are in some sense constructs of the present. This is inevitable. The methods and theoretical approach of archaeologists imposes a subjective bias even during excavation, recording and reporting of archaeological sites. By the time analysis and publication are complete an accepted version of the results has been agreed. The result is one story, one model, and only one moment that is captured in a whole history of human stories that took place at a site.

Beyond the conventional site restoration, there are many successful archaeological parks, open-air museums and experimental villages around the world that present aspects of prehistoric life. Some of the most successful projects include Butser Ancient Farm in England and an Iron Age farm in Lejre, Denmark. They are both viewed as ‘experimental’ archaeology and present an impression of prehistoric life that would be difficult to convey in a static museum setting.

Closer to Jordan, in Cyprus, prehistoric settlements have been presented to the public using reconstructions. The two main sites that I will refer to in this paper are Khirokitia and Lemba.

In comparison to the Natufian and Pre-Pottery Neolithic periods of Jordan, these sites in Cyprus vary in date though share many characteristics culturally and technologically, and therefore serve as comparable examples. Of course the methods used in Cyprus would have to be changed slightly because of the differences in climate, environment, economy, and politics but many of the CRM techniques used on these Cypriot sites are worth noting.

Khirokitia
Khirokitia is an aceramic Neolithic site and has been made a World Heritage Site. The site spreads across approximately 1.5 ha of a hill slope at the foothills of the Troodos massif, in southern Cyprus. A series of Neolithic villages, dating from the eighth to seventh millennium BC, have been discovered and excavated since 1934 (Le Brun 1997).

With the rising number of visitors to the site and increasing concern for the site’s protection, the Ancient Monuments section of the Department of Antiquities of Cyprus initiated a project to “preserve the authenticity of the neolithic in its entirety, to protect the human and natural surroundings, and to provide richer information by the creation of a Visitor’s Centre” (Le Brun 1997:61).

Therefore five neolithic units were reconstructed to form the visitor’s centre. The reconstruction of neolithic structures was seen as preferable to modern buildings when trying to form an intermediary between the archaeological remains and the visitor. Unfortunately, it does not fulfil the requirements of a visitor’s centre in that there are no displays of information concerning the site.
Visitors pay a small entrance fee of only 75 cents at the ticket booth, where they can also purchase comprehensive guidebooks. A clean and organized impression is conveyed by the new World Heritage ticket booth, toilets and pathways.

Before climbing the hill to the excavated site, visitors can pass through the archaeological park to see the reconstructed village. This provides the visitors with a complete image of the neolithic structures before they approach the archaeological remains. Along the pathway leading up the hill to the excavated site are various information points. These include relevant, although long, excerpts from the guidebook and are written in Greek, English and French. They also include plans and reconstruction drawings to further help the visitor understand the archaeological remains. A wooden fence around the site protects all the archaeological remains. Selections of structures are further protected by consolidation. The excavated site as a whole is easily viewed from two panoramic terraces.

The main drawback with the reconstructions at Khirokitia is that there is a low level of interaction. There are bars on the windows and doors that prevent the visitors from entering. As well as looking modern and out of place, these bars restrict the experience of what it was like to be in a neolithic structure.

Lemba

Lemba is a Chalcolithic site in the south of Cyprus dating from 3500 BC to 2500 BC. The Lemba Experimental Village is the result of a project that was established to examine our understanding of Chalcolithic buildings, and to help to develop models regarding the formation processes on archaeological sites (Croft 1999).

Lemba Experimental Village project clearly contrasts with the World Heritage support that Khirokitia receives. There is no entrance fee, no public toilets, and the pathway is merely a beaten track. The signs, although informative, have begun to weather and are becoming illegible. In contrast to Khirokitia, Lemba attracts fewer, but a more manageable, number of tourists.

The Experimental Village is placed adjacent to the excavated area. The largest of the ‘roundhouses’ functions as a visitor’s center, and contrasts with the visitor’s centre in Khirokitia in that it contains information on the site and related finds. The aim of these ‘roundhouses’ was to also function as experimental units. There are several units built using different materials, different designs and left at different stages of construction and collapse. These structures were specifically made to enhance our understanding of archaeological site formation processes by observing the effects of building construction, use, decay and collapse. They provide a test ground for archaeological theories. Working within an experimental framework allows various alternative interpretations and hypotheses to be presented. The work was not originally designed for tourists, but it has subsequently been overtaken by tourism. The experimental structures dominate the site and distract the visitor’s attention away from the importance of the archaeological remains. The excavated area has been partially backfilled, but the remaining exposed archaeology seems to be neglected and in a poor state of conservation.

Site presentation

For tourists the presentation of sites should stimulate the imagination. It should promote reflection of past realities and enable visitors to make sense of the ruins. The ruins are the remains of past societies; they are the “reflections of political struggles, cultural fashions, technological skills, artistic expressions, religious beliefs, and other aspects of human
behavior” (Sivan 1997:52). It is the story of human past, and gives a sense of belonging and understanding of our place in the world. This is especially important with early prehistory as we begin to recognise crucial events in the developments that led to modern lifestyles, and see the development of a new relationship with the natural world. It is these aspects, the ways that people of the past lived, that really interest the visitors, and not the few stones and fragmentary architectural features that remain on archaeological sites.

On the other hand there are the needs of the researchers and academics. Their needs include the protection of the site's integrity, its scientific value, and the need to conserve the site for future research. This contrasts with the needs of the CRM managers who would argue that archaeological researchers are amongst the biggest vandals. Excavation implies destruction. Excavators have destroyed many sites in Jordan and recent initiatives to control excavation through permits have begun the slow process of controlling the level of destruction.

Jordan
Reconstructions are possible in Jordan, for example at the Neolithic site at Beidha. Two distinct cultural phases are present here. There is the Natufian dating from about 13,000 BC to 10,000 BC, and the Neolithic dating from about 8330 BC to 7000 BC (Kirkbride 1966). The site has undergone years of excavation and research, and contains a wealth of information, including substantial standing architecture. Beidha is located in a picturesque position approximately 5 km north of Petra, just a few hundred meters away from ‘Little Petra’ and is within the protected area of Petra. The historic importance and location combine to make this an ideal candidate for presenting to the public.

Excavation at the site began in 1958 and continued until 1983 when excavation work stopped, but no conservation work has taken place to protect the archaeological remains. Exposed they have very little chance of survival, and substantial deterioration can already be seen, leading to both information loss and a reduced potential for display. Various proposals have been made over the last few years to try to both prevent further deterioration, and to improve the presentation of the site. Numerous bodies have been involved to varying degrees, for both funding and practical aid, but collaboration is complex and beset with problems. This means that as yet no action has been taken. At present the fence around the site is full of holes and generally in an unattractive state. Also, there is no pathway or signs to direct either the local community or tourists around the extremely sensitive remains. As a result, visitors and livestock are free to climb and walk over structures. No attempt has been made to interpret the site for the visitors.

The various proposals that have been put forward have made a foundation for a management plan at Beidha. This makes it clear that it is an ideal location for further development both for tourists and research. The benefits of the site include:
- It is in close proximity to the major tourist attraction of Petra
- There are parking facilities and road signs
- The local community have taken the initiative to start selling souvenirs and offering tea to visitors

However, in the first instance emergency measures have to be taken to protect the site and consolidate the remains to prevent, or at least slow, the ongoing deterioration. After such measures have been taken to protect the site, small steps can be taken to improve the presentation of the site. This should include practical measures, such as the laying out of paths to reduce if not eliminate visitors walking over the fragile remains. In addition information should be provided to help visitors to both appreciate the overall significance of the remains in terms of human social and economic development and to understand the specific features that they can see. Taking into consideration that the archaeological
remains are difficult to interpret and that ideally interpretations should be as physically unintrusive as possible, I suggest that a visitor centre should be built off site. This would combine both the needs of the tourist and the research. If it was built as an experimental reconstruction it would also be visually acceptable within the wider landscape. This could possibly be one of a number of experiments that could be conducted and used as part of the visitor’s attractions on the way into the site. In this way, visitors could best appreciate the remains.

The reconstructions would be based on the evidence that has been gathered from the years of excavation and analysis at Beidha. The archaeological evidence indicates that the sandstone walls were built around timber supports, and that the roofs were made of large branches with twigs of wood on top. Both the inside and outside of the structures were plastered. Experience from Lemba shows that attempting to build such structures as part of a scientific experiment adds enormously to our understanding of how such buildings worked, how long they could last, and what maintenance was needed. At the same time they provide immediate material through which visitors can grasp the actual prehistoric remains.

Conclusion
In conclusion, prehistoric sites in Jordan warrant further attention. They represent a valuable and non-renewable resource that has to be protected. They include key sites for the history of humanity. The nature of these sites means that special attention needs to be paid to the cultural resource management plans to be implemented, not only in terms of protecting relatively fragile remains, but also in how to interpret them for the public. Scientific experimental reconstructions not only provide visitors with a direct visual portrayal of prehistory but also provide researchers with a means of testing interpretations.

References


Appendix 1.2

Paper given at The Second International Conference on “Science and Technology in Archaeology and Conservation”, Queen Rania Institute of Tourism and Cultural Heritage, The Hashemite University, Jordan (December 7-11, 2003)

Presenting small scale archaeological sites: the five levels of presentation at Beidha
By Samantha Dennis (University of Edinburgh, UK)

Since 2001 the members of the Beidha Project have endeavoured to conserve and present the early Neolithic settlement at Beidha. The site is of international importance, important in our understanding of the transition from hunter-gatherer to farmer. It is a small site in comparison to Jordan’s Nabataean, Roman and Islamic sites such as Petra, Jerash and Qasr Amra, and therefore Beidha requires a different approach in its cultural resource management plan. The size, location, and archaeological nature of the early Neolithic site of Beidha dictates how it is interpreted and presented. The five levels of presentation are: signs, leaflets, website, guides, and a visitor’s centre.

Introduction
We have just heard Dr Bill Finlayson provide examples of successful presentations of prehistoric sites outside of Jordan and also discuss the potential for presenting such sites in Jordan. What I would like to do is present to you an example of a site with such potential and the 5 levels of presentation employed at the site. The site I am talking about is the early Neolithic settlement at Beidha, in southern Jordan, near Petra.

The Pre-Pottery Neolithic site at Beidha contrasts greatly with the neighbouring site of Petra. It is small, with simple entrance, it doesn’t have ticket office, it is off the main tourist route, and is very difficult for most visitors to interpret.

The Rough Guide refers to Beidha as a “rather less inspiring Neolithic village”. The Footprints guide states that “Although to the untrained eye there is not a great deal to see here, in archaeological terms it is of major importance”. The guidebook continues by saying D Kilbride discovered the site, but in fact it was Diana Kirkbride. The visitors are therefore initially discouraged and then misinformed about the site, adding greatly to our challenge in presenting the site to visitors.

Every archaeological site holds a wealth of information, it is part of our job as archaeologists to share this information with the wider public. But presenting the Neolithic site at Beidha is a challenge for many reasons including its small size, the fairly ephemeral nature of early Neolithic architectural remains, and because it is the first early prehistoric site to be presented in Jordan. It is for these reasons that we have adopted five levels of presentation at the site. These include: signs, leaflets, guides, visitors centre and website.

These multiple levels of presentation are needed at a site because visitors are said to recall:

Only 10 % of what they hear
30 % of what they read
50 % of what they see
and 90 % of what they do

Before embarking on the presentation of a site the presenting body must have a clear understanding of the message that needs to be conveyed and the goals for using interpretation.
At Beidha: the message is that it is the oldest village in Jordan and is extremely important in world history for our understanding of the transition from a hunter-gatherer lifestyle to farming, this also includes the birth of agriculture, domestication, and sedentism.

The goal of interpretation is to share the importance of the archaeological site with the public. And by the public I mean international tourists as well as Jordanian tourists, and also presenting the site to the local community. The majority of the community, both young and old, have very little understanding of the Neolithic period, compared to the wealth of knowledge that they have acquired of later periods in history such as the Nabataean period. And therefore they have not been able to incorporate Neolithic Beidha into their view of their own heritage. At Beidha we have acknowledged the importance, but also the difficulty, of involving the local community in the presentation of the site.

To develop a successful presentation of Beidha we have applied the following two main principles at every level of presentation:
Firstly it is important to develop an Understanding of the site
And secondly an Understanding of the public

I can illustrate these two principles in the production of signs displayed on site. Firstly, we need to have a thorough understanding of the archaeology, architecture and history of the site. In the case of Beidha this includes studying the excavation reports from the 1960s and 1980s written by the excavator Diana Kirkbride and later by Brian Byrd, as well as studying the architecture and artefacts. We also need a knowledge of other relevant sites in the region. In the case of Beidha this includes the Neolithic sites at Basta, Baja, Shkarat Msiad and Wadi Ghuwayr.

Secondly, we need an understanding of the public. When it comes to reading signs at sites there are three kinds of people:
There are the Streakers – who only spend 3 seconds looking at a sign
Then there are the Browsers – who take a little longer, perhaps taking 30 seconds per sign,
And then there are the Studiers – who will happily spend up to 3 minutes with each sign.

Very few people will spend more than three minutes reading a sign and therefore it is important to limit the text to no more than 225 words. A careful balance needs to be achieved between detail and brevity.

Another important factor to consider is that people don’t always read things in order.

Here is an example of a temporary sign currently in place at Beidha on site they are in English and Arabic. In developing these signs we have tried to cater to a variety of tourists and nationalities, as well as the local community. The information ranges from a basic introduction to the Neolithic period, to more detailed information on Neolithic architecture.

This is one of the signs. Within about 3 seconds you can appreciate that there are two sorts of architecture present at Beidha.

A further 30 seconds and you could appreciate that the circular houses preceded the rectangular houses.

A full 3 minutes of reading and studying the sign, you would learn specific terms such as ‘pier house’, and be able to identify architectural features on the plan and on the site itself.

The placement of signs is as important as their content. Usually they should be placed where the object they discuss can be seen so that the visitor can relate the information given to the heritage being discussed. Too often signs are placed so that visitors have to turn their backs to the point of interest.
As well as educating visitors on the archaeology of a site, signs can be used on site to keep visitors on designated paths and avoid damaging sensitive areas. This promotes a heritage friendly attitude and helps to conserve the site. Often providing a reason behind the message helps to enforce the sign for conservation management purposes and also provides an educational dimension for visitors. For example at Beidha, we have asked visitors to help conserve the site by remaining on the pathways, to not walk on the walls, and to close the gate, and we have reinforced this request by illustrating the damage done to the fragile walls from livestock and visitors trampling over the site. This photograph was taken in the 1960s and this one just a year ago, and as you can see the damage to the site is extensive.

After having just mentioned the variety of information that can be placed on signs, it is also important to realise that visitors do not want to be overwhelmed by information on signs, but instead want to be guided and entertained. And therefore signs should be enjoyable, relevant, organised, and thematic. And once again a balance between detail and brevity needs to be struck.

For those visitors who seek further detailed information about the site there is a second level of presentation, the leaflet. These can be carried around the site by the visitor and referred to as necessary.

At Beidha we have designed leaflets that highlight individual features at the site, for example the Neolithic steps leading into the settlement. And also provide a more comprehensive chronology of the site and its place in history. In addition to English and Arabic versions, these leaflets have been translated into French and German. Because of limits in the budget at Beidha these leaflets are currently simply covered in plastic for weather proofing and are only available for visitors to use on site and they are asked to return them before leaving the site. The intention is that an unlimited number of leaflets will one day be available to visitors as souvenirs.

Leaflets can also be used to draw visitors to a site. This is not a tactic currently used at Beidha because of the small size of the site. A steady but small stream, of visitors already visit Beidha, and increasing the number of visitors would increase the levels of damage to the site and would reach an unsustainable level.

Unlike Petra, Beidha is too small to provide visitors with extensive printed material such as guide books and booklets, or even postcards.

Guides
Trained professional tour guides and to some extent local guides provide a third level of presentation on site. The advantages of guides is that they can provide information as the group moves around the site, which alternatively would require several, and perhaps fairly intrusive, signs on site. Guides can also adapt the presentation of the site depending on the nationality, age and specialised interest of a group.

In the case of Beidha the majority of the local guides are youngsters from nearby Little Petra and Baida HAusing. We have employed a large percentage of them over the past two years to work on the site, in so doing we have encouraged a greater and more intimate knowledge of the site, and hopefully stirred some enthusiasm and affection for Beidha. A good guide is one that is able to relay their interest in the site and entertain the visitor.

Visitor Centre
The fourth level of presentation is a visitors centre. It allows a site to be rapidly understand by sight what would normally require extensive guidebooks and signs.
The experimental reconstructions at Beidha serve as visitors centres and appeal, both, to the imagination of the public and stimulate interaction. Visitors centres, like museums, are no longer simply places for displaying material culture, they are now required to entertain the public. People expect to be able to interact and participate. These experimental reconstructions of Neolithic houses provide a space for visitors to interact and provide a visual stimulation for imagining Neolithic life. It therefore brings alive the archaeological site. Additionally these experimental reconstructions provide a sheltered environment for displaying signs and further information about the site.

On a community level we have employed men from the nearby village of Baida Housing in the construction of the visitors centre. In so doing we have tried to use the visitor’s centre to bridge the gap between the Neolithic site and the modern community.

Website
The fifth and last level of presentation is websites. They provide a powerful off-site level of information. It makes the archaeological site available globally, beyond the physical boundaries of the site itself. And therefore making the site available to people who are unable, physically or financially, to see the site. Additionally it extends the length of the ‘experience’ - visitors will be able to learn more after leaving the site and returning home.

The Beidha website as well as providing information presented on the site signs and leaflets, and in the visitor’s centre, also provides additional information about the site. For example, it provides information on members of the team working on the site and the aims of the project. Additionally the website is updated regularly to include updates on the experimental reconstructions and progress made in conserving the site.

In conclusion, it is the combination of all five of these levels of presentation that makes a successful presentation of a small site. Unlike Petra, Beidha, like most early prehistoric sites, can not rely on its grand architecture to tell the story. Neither can it rely on extensive descriptions in travel guide books. Nor indeed can it rely on picturesque photos in brochures, nor on souvenirs and postcards.
The Experimental Reconstruction of a Pre-Pottery Neolithic B Structure at Beidha – a Visual Introduction

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The architecture, and hence social and economic structure, of Neolithic Beidha is still poorly understood. Experimental archaeology will help develop our understanding of the evidence from the 1950s, 1960s and 1980s excavations and provide a means for the non-archaeologist to interpret the site. This paper presents the plans of the first reconstruction at the new experimental site at Beidha, the problems and obstacles encountered, and discusses the contrasting objectives.

Introduction

Diana Halbäck-Kirkbride excavated at Beidha in the 1950s, 1960s and 1980s (Kirkbride 1960, 1966a, 1966b, 1967, 1968; Byrd 1994). The site was immediately recognised as important for our understanding of the transition from nomadic hunter gatherers to sedentary farmers. It is a complex, multiple-phased site with remains dating from the Natufian and the early Neolithic, with remarkably little disturbance from later Nabataean occupation. A total of 95 buildings from three main phases were uncovered between 1958 and 1983. These structures vary in size, shape and construction leading to various interpretations of spatial organisation and functional classification. One of the most important aspects of the site is that it shows the evolution of early Neolithic architectural forms, including the transition from the early circular structures to later, rectilinear ones.

Despite its archaeological significance, the physical remains of the site have been neglected for the past 20 years and the excavations remain unpublished. Sadly the exposed archaeology has begun to collapse under the strain of livestock, tourists and weather. Our current project is a collaboration between CBRL and the Department of Antiquities (directed by the author, Dr Mohammed Najjar of the Department of Antiquities and Dr Bill Finlayson of CBRL) which aims to stabilise the site by backfilling selected trenches, moving obstructing spoil heaps, laying out pathways, building terrace walls to retain the subsiding site, conducting limited conservation of walls, establishing long-term maintenance of the site, including regular weeding, and interpreting the site for the public through experimental reconstruction and signs. The work at Beidha concentrates on conserving and presenting the Neolithic remains.

This paper will focus primarily on experimental reconstruction that began at Beidha in 2002 (Fig. 1), and is a report on a work in progress. This research was designed to test interpretations based on primary data obtained from the excavations of Pre-Pottery Neolithic B (PPNB) structures. Over the past year the aim of the experimental work has been the reconstruction of early Neolithic architecture and the development of an open air laboratory to try various building possibilities within the constraints of the archaeological evidence. The initial work being conducted has multiple purposes. Firstly it is an experiment to investigate the design of the circular structures, in particular to assess how some of the distinctive features of these, such as the rings of poles embedded in the walls, functioned. Secondly, there is an aspect of learning involved, learning about building techniques, materials required, procuring materials, and in developing working relations with the local population. Thirdly, the reconstruction also forms part of the effort to present the complex nature of the prehistoric archaeology to the public. Not only does it provide a visual representation of the archaeological interpretations, it also forms a focal point for the public, and it will become a visitors' centre, containing further information about the site. This will operate both for tourists (local and foreign) and for the local community, helping, in conjunction with their
involvement in the project, to improve their awareness of past and place.

The experimental reconstruction goes beyond the study of building techniques. The experiment will continue once the basic structure is complete. For example, there are important questions about the purpose of a number of early Neolithic structural details, such as the purpose of raised floors and air vents, the dimensions of surviving walls, and the absence of doorways. In addition there are ongoing structural issues, such as the replacement of timbers, and the addition of further circular cells, that need to be examined. The reconstruction process, the subsequent monitoring of the structure, and the use of the structure in further experiments, will at least provide some parameters for the answers.

Building 49 from the southern part of the archaeological site (Byrd 1994, 648) was chosen as the model for the first experimental reconstruction. This circular semi-subterranean structure is thought to be contemporaneous with the adjacent circular structures (buildings 18 and 48) which collectively represent the earliest PPNB occupation at Beidha (see Fig. 2 for an artist's impression of buildings 18, 48 and 49). The foundation of the structure is approximately 5.00 m. in diameter, although it is not at all a perfect circle. The walls stand to a height of approximately 1.20 m. (Fig. 3). The walls are 0.50 m. thick but are over double that width (1.10 m.) where they are shared with adjoining building 18. They are mostly constructed from large limestone cobbles which appear to have come from the wadi bed. This is the evidence as seen and discussed today, it may differ slightly from the final site report currently being produced by Brian Byrd, and therefore the experimental reconstruction is based on a compromise of evidence seen on-site and the availability of archive data. The final report schedule means that a complete description of the evi-
Figure 2. This is an artist’s reconstruction drawing representing the various levels of evidence and understanding of the earliest PPNI circular structures at Beidha. The representation of building 49 shows an interpretation of the structural details, the drawing of building 18 shows the evidence as seen today, and building 48 is an artist’s impression of the reconstruction.

dence on which the experiments are based will be available before the final results of experimentation are complete.

The experimental site is located to the east and away from the fragile archaeological remains but within the fenced area of the site, close to the entranceway. It is located in an area that was largely sterile of archaeological material (only a few Nabataean pot sherds were found on the surface). The placement of the experimental site accords with advice given by ICOMOS in the Charter for the Protection and Management of the Archaeological Heritage established in 1990. This states that “reconstruction should not be built immediately on the archaeological remains”.

I will be using the term ‘experimental reconstruction’ here to make it clear that the work described is not a reconstruction using the actual remains. Alternate terms such as experimental construction and construction site can be used to emphasise the fact that these experiments are based on contemporaneous interpretations of the past and are not accurate replicas (see Stone and Planel 1999; Coles 1979; Reynolds 1999 for further discussions on this issue).

Construction stages of the first experimental reconstruction at Beidha

At the time of writing, the walls of the first reconstruction were completed and the initial preparations were being made for the roof. This description of the roof is therefore in its preliminary stage.

The following seven steps outline the stages of the first experimental reconstruction at Beidha (Fig. 4):

1. A foundation trench was excavated with a diameter of 5 m. and depth of 0.40 m. The soil was loose and the foundation trench was easily completed by five people using shovels in a day. It was almost entirely sterile with only a few small fragments of Nabataean pottery and undiagnostic lithics.

2. Timbers. A circle of 14 upright timbers were each placed in shallow (0.10 m. deep) postholes within the foundation trench at a distance of
0.50 m. from the outer circumference of the trench. The postholes were dug with a hand trowel, to the size of the individual timbers. No stone or mud packing was used. The timbers vary in species (including pine and juniper) and in size, but average 1.80 m. in length and 0.10 m. in diameter.

The next three steps were part of a sequence of building, repeated every three to four courses until the wall was 1.10 m. high. The building stones were collected from the wadi bed to the south-west of the site. This was an extremely labour-intensive activity as the inner and outer faces alone consist of over 900 stones.

3. The inner face consists of large cobbles (0.20 x 0.10 m.) placed between and supporting the upright timbers (Fig. 5). The wall face is based on a dry stone construction technique but it is not completely freestanding. In order to bond the inner face with the inner mud and stone fill, the wall was constructed three to four courses at a time to allow for homogenous drying. "Stretchers", running horizontally from the inner face, and sometimes reaching to the outer face, were placed approximately every three courses to provide additional opportunities for bonding.

4. A mud and stone fill was placed behind, and bonded to, the inner face. The mud is a simple mix of sand and water with no added organic material. The sand was derived from the foundation trench spoil and water was fetched from the modern Baida Housing village. Approximately 18 litres of soil was mixed with 10 litres of water for about 10 minutes. The consistency of the mud was dependent on vari
ables such as time of day (which had a dramatic effect on drying rates), water availability, intended function of the mud, and on the individual making the mud. A layer of 0.05 m. of mud mix alternated with a layer of small to medium stones (0.05 to 0.20 m.).

5. The outer face was begun once the mud and stone fill had reached the exterior surface level. This wall consists of large stones (~ 0.20 m. x 0.10 m.) placed in crude layers and not necessarily forming clear courses. Unprovenanced fragments of grinding stones, also collected from the wadi bed, were incorporated into the outer wall.

6. The capping stones, also collected from the wadi bed, consist of very large boulders (~ 0.40 m.) placed on top of the wall and covering, wherever possible, the inner and outer wall, but more importantly covering the mud and stone fill.

7. A roof (under construction) consists of a timber frame supported by a central post and tied to 14 upright timbers using rope. The roof slopes at an angle of approximately 20 degrees. The timber frame supports a lightweight matrix of reeds which will eventually support a thin layer of mud plaster. The archaeological evidence for the roof material is limited to a fragment of mud plaster with impressions of cross-hatching thought to be from reeds (Kirkbride 1967, 8). The overall form of the roof is based on the evidence for a substantial central post and a ring of smaller posts embedded in the wall. It is clearly more open to varied interpretation than the evidence for the walls, but in a sense this makes it one of the more important parts of the experiment.

One significant choice was to make the roof pitched. It is commonplace for reconstructions in Jordan, artistic and architectural, to employ flat roofs, much in the style of recent vernacular architecture, yet traditionally roofs were more varied in form. The picture of the PPNB village as an early counterpart to early twentieth century villages needs to be considered carefully. While the arrangement of posts appears to make most sense supporting a pitched roof, the relative slenderness of the ring posts has to be considered in terms of their capacity to take the lateral load from a heavy pitched roof. I have assumed that the roof should extend over the wall, to protect the wall core from rain. This has implications for the height of the posts, which have to be high enough to support the roof which will continue sloping down to at least the outer face of the wall. It is possible that the capping stones were considered adequate to protect the wall core. This will need to be examined after winter rains. It is of course possible that the structures were used seasonally, for summer occupation. In this case the roof may have
been quite light. Roof structure may therefore have some bearing on evidence for the degree of sedentism in the earlier PPNB.

Problems and obstacles

It is too early in the course of this experimental reconstruction project to draw conclusions on the successes and failures of the chosen architectural design of the first of the Neolithic structures. At this stage I am able to make a number of observations on the resources used in the process of construction. Water and timber are both essential in the construction process but are largely invisible in the archaeological record. In particular, the use of water as a construction material has received little attention in discussions on Neolithic architecture in the Levant.

Water

During the experimental reconstruction of building 49 approximately 1800 litres of water was used for the wall fill alone. Fetching this vast quantity of water for making mud proved to be a time consuming and complex procedure. At present the nearest natural spring, Dibadiba, is an hour’s walk up Jabal Shara’ (Fig. 6). This water is diverted into pipes for distribution across the valley, but the spring is now in a neglected state. For ease of construction we fetched water from the piped water in Baida Housing village, only a few minutes drive away. Even this was not without its own difficulties. Water is a precious commodity, and even now that it is piped, access and consumption is controlled. Piped water places the settled villagers apart from the still mobile Bedouin community who continue to fetch water by donkey from communal watering holes. Similarly access to a water source would have played a decisive role to the first sedentary or semi-sedentary communities during the early Neolithic.

It is generally accepted that Natufian and early Neolithic villages were located next to perennial water sources. A permanent water source ensured year round subsistence and formed the essential environmental ingredient for an agricultural economy. In contrast, Beidha, even during the Neolithic period, was an extremely marginal environment for agriculture and the probable rainfall alone would not have been sufficient for cereal cultivation (Helbaek 1966). The additional water source that needs to be considered in such arid areas is water catchment and runoff (Aravik 1976). Relatively shallow pits and wells could provide the occupants of Beidha with a perennial water source (Miller 1980). Evidence in Jordan of PPNB hydraulic systems and technological knowledge is still unknown. However, evidence from a Cypro-PPNB site at Kissonerga-Mylouthkia in Cyprus, revealed wells from the tenth and ninth millennium BP consisting of large cylindrical shafts at least 7 to 8 m deep (Peltenberg et al. 2001, 46–48), showing that the knowledge and skills necessary existed elsewhere within the PPNB world.

Timbers

There are only remnants of thin oak, pistachio, coniferous and juniper forests left in Jordan after years of cutting by nomads and villagers for firewood and grazing by goats (Aravik 1976, 176). In addition, clearance for construction has destroyed natural woodland. By law no unautho-
rized tree felling is permitted, but grazing is unrestricted. Therefore obtaining timbers for the experimental reconstruction was, like fetching water, difficult and time consuming. As a result the lapsed time between digging the foundation trench and the placing of the timbers resulted in the gradual collapse of the structure’s foundation pit. The edges began to crumble (largely due to the local children clambering in and out to have a closer look) and the original circular foundation pit resulted in an irregular sub-rounded foundation pit that more accurately reflects the archaeological evidence.

Ideally we would have liked to fell the trees ourselves and have the opportunity to select the timbers first hand. Instead we settled for a collection of second hand timbers obtained from various local sources including firewood piles. These timbers vary in size, quality and species. Many are not ideal building material and already show signs of rotting and woodworm. They may need to be replaced soon, but as this appears to have been a regular activity in the PPNB, we look forward to having to do this.

The archaeological evidence, in the form of charred remains, indicates that oak, pistachio or juniper may have been used for the roof timbers (Kirkbride 1985, 120). The irregular form of some of the slots in the walls shows that bent branches were frequently used. Although the modern surviving forest is not a direct analogue for the early Holocene, it is likely that such forests were equally sparse and scrubby.

**Seeing contrasting objectives**

Working with contrasting and conflicting research objectives on archaeological projects is not a new problem. Generally, on experimental archaeology projects the primary objectives include research, education and presentation (Stone and Planet 1999). This requires a balance between science, education and tourism. This is reflected at Beidha, where we are responding to the different objectives of the groups involved. The main groups involved are the local community, tourists, the government agency, and the archaeologists.
The different perspectives form a valuable resource, as they provide a welcome provocation to the established homogeneity of archaeological interpretations, especially in asking questions often ignored by the professionals.

The local community plays a vital role in the project, but this is not without its own set of conflicts. The community is divided on many levels, the most prominent division being between the B'dul and Ammarine tribes. These two tightly-knit kin groups compete economically. They have already lost their traditional nomadic lifestyle, which formed the essence of the management strategy for a sustainable lifestyle (Chatty 2002). Both tribes are now looking for a sustainable income and therefore have turned to tourism. The B'dul have a complicated relationship with tourism at Petra, it has both brought them income and has led to their removal from their traditional homes in the site. At Beidha, unlike in Petra, the Bedouin have attempted to encourage tourism and it has not been imposed on them. For example the Beidha Tourism Cooperation has been established by the Ammarine tribe, as a deliberate attempt to break into the B'dul domination of tourism in the Petra region, from which many of the Ammarine see themselves as being excluded. This view is based on a perception of the wealth that the B'dul gain from the tourists that visit Petra.

Despite their differences we have hired Ammarine as workmen and encouraged the local B'dul family to participate with the continuous process of conservation and presentation (Fig. 7). We want the local community as stakeholders with an investment in the site as a source of income and work, and therefore to develop an understanding of the site as part of their own heritage. Either the community is part
of the further degradation of the site or they actively protect it. Through community involvement we hope to create a sense of place and reintroduce the site as a part of their cultural background instead of simply a grazing patch for their goats. Through the involvement of the "local community, particularly its children, they may well have felt a sense of ownership rather than resentment at an initiative imposed upon them" (Blockley 1999, 27). We have also encouraged active individual participation from the local community. We appreciate that specialists and experts have to value local perceptions and recognize the expertise of so-called non-experts, making use of their talents and advice. Unfortunately in Beidha we have to be wary of the local traditional building techniques, not only are these separated by time from the PPNB, they have been very recently influenced by conservation training work on Nabatean structures in Petra, which provides the local community with their only model of ancient sites. Since 1946 change, although voluntary in most cases in Jordan, is hastening and we may worry that the Bedouin are losing their traditional values and acculturising as they integrate with tourism, consumerism and commodification. A recognised by-product of tourism is that it destroys the authentic qualities of the social and cultural landscape and further introduces social problems. It is not simply an economic solution, in introducing employment it also introduces to the community an economic dependency on (largely) western money. This is a high risk policy whilst Jordan's tourism industry remains unstable in light of Middle Eastern political events – most recently the events of September 11th and the latest terrorist attack, which if it holds for 12–15% slump in tourism for 2001–2002 was reported in the Jordan Times in March 2002.

Tourists today are in search of the authentic experience (Stromza 2001). In contrast the Bedouin want an immediate and sustainable income and hence have overlooked the experimental value of the project and instead want a visitor's centre made of concrete and full of consumables. There has been surprisingly little conflict between archaeologists and tourists, between the objectives of scientific archaeological research and the use of research as an educational experience. Based on the small percentage of visitors I canvassed whilst in the field at Beidha, they are intrigued by all aspects of the experimental project and the archaeology. Perhaps this is because, unlike the larger Classical sites in Jordan, Beidha is a site that mainly attracts those visitors with a strong interest in archaeology, and not mainstream tourists. Many of the visitors had a well developed understanding of both archaeology and conservation practices. However, as these tourists were led in large groups whose visits to the site were very brief, there was little opportunity for the local Bedouin to benefit from their visit.

The government's struggle to conserve and promote Jordan's cultural heritage to its people is influenced by the growing need to develop archaeological sites for their potential tourism, and hence economic, benefit. The monumental sites of Jordan, such as Petra and Jerash, are promoted as essential visits for tourists to Jordan. They therefore receive large government investment at the expense of the less readily understood prehistoric sites. Beidha remains, until now, largely unfunded and to a great extent overlooked by the government bodies. The Beidha Project is in part an attempt to investigate how to promote prehistoric sites, especially early ones where the archaeological evidence in Jordan is amongst the best in the world for a crucial phase in human development. The Department of Antiquities has provided significant resources to assist this experiment and to preserve the site.

**Conclusion**

The experimental reconstruction project at Beidha has been established to explore the archaeological data of the PPNB architecture and construction techniques. It is also designed to present the site to the public and to refocus community awareness of past and place. As the project develops over the next three years, these experimental reconstructions of Neolithic structures will help provide the continuing debates concerning structure size and organisation, function of individual buildings, site location, organisation of interior space, and intersite variability over time. They will further help our understanding of significant patterns of social organisation of settlement types, domestic activities and storage space, and settlement population.

Scientific experimental reconstructions not only provide researchers with a means of testing interpretations but also provide a direct, interactive and visual portrayal of prehistory for education and tourism. Prehistoric sites in Jordan warrant further attention in cultural resource management terms. They represent a valuable and non-renewable resource that has to be protected. The sites in Jordan include key sites for the history of humanity. The nature of these sites means that special attention needs to be paid to the cultural resource management plans to be implemented, not only in terms of protecting relatively fragile remains, but also in how to interpret them for the public.
Acknowledgements

I am grateful to Brian Byrd for access to as-yet-unpublished material on Beidha. I would like to thank the British Embassy in Amman, Ammanite Bedouin camp, all the individuals who have volunteered at Beidha, and the hospitality and interest of the local community.

Bibliography


Appendix 1.4

Neo-lithics 2/03: 37-8

PhD Dissertation Project: The use of experimental archaeology to explain and present Pre-Pottery Neolithic architecture at Beidha in southern Jordan

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Experimental archaeology, although popular in Europe in the form of open air museums and archaeological parks (for example Butser Ancient Farm and Ljere Forsøgcenter) and occasionally found in the Near East (for example in Cyprus), is as yet unknown in Jordan.

The aim of the experimental research at Beidha is twofold:
- to test theories on construction methods and techniques of Middle Pre-Pottery Neolithic B architecture from Beidha, informing the archaeological understanding of settlements, and
- to provide a visual aid to present the early Neolithic site to visitors

Now in its second year, the experimental research at Beidha has already broadened our understanding of the early Neolithic architecture from the site. The experiments have included the full-scale reconstruction of two circular structures based on evidence from Building 48 and 49, and one ‘pier’ structure based on the evidence from Building 10.

Experiments are being carried out at every stage of the construction process including the acquisition of raw materials, the durability of different mixes of mud plasters and mortars, and roof designs (including one pitched roof and one flat roof). Careful monitoring is taking place of all the structures including interior temperature changes, the effects of changing weather, maintenance needs, and the accumulation of exterior and interior deposits.

The experimental reconstruction of a series of Neolithic structures will help inform the continuing debates concerning structural techniques, size and organisation, function of individual buildings, site location, organisation of interior space, and intersite variability over time. They will further help our understanding of the use of space for storage and domestic activities; population size; and the development of social organisation, providing essential information on the material conditions within which people exacted their social strategies.

If you have any comments or suggestions please contact me at beidha@cbrl.org.uk
Website: www.brit.ac.uk/institutes/cbrl/projects/beidha.html
Appendix 1.5

CBRL Newsletter 2005

Burning Beidha

Samantha Dennis
University of Edinburgh

“…The third little pig always did everything properly, even if it took him a long time. He built a house of bricks at the bottom of a steep hill. It was snug and warm and stood firm and strong… The wolf huffed and puffed until he was quite out of breath but the bricks stood as firm and as strong as a mountain… He could not blow it down.”

After spending months of building the three circular structures at Beidha it was time to experiment with burning one down. On November 2nd 2004, with help from Professors Bill Finlayson and Ian Ralston, I set fire to Experimental Building 48 in an attempt to replicate the archaeological evidence.

Experimental Building 48 is a semi-subterranean circular structure built using evidence from one of the earliest Pre-Pottery Neolithic B structures at Beidha (Byrd 2005). This experimental structure forms part of a series of reconstructions built adjacent to the excavations of the early Neolithic village at Beidha (Dennis 2003). These experimental structures provide a visual tool for visitors and an open-air laboratory for archaeological interpretations and theories.

According to the archaeological evidence “…E130 [Building 48], was destroyed by a very fierce fire and the resultant baking and solidifying of the mass of clay, mortar and plaster from walls and roof supplied a magnificent series of plant imprints. In addition, a heap of carbonized pistachios, which may have totalled some five gallons originally, were found in perfect condition…”(Kirkbride 1966:25). How fierce really was the fire that destroyed Building 48? What story does the evidence tell us? What evidence is missing from the excavation? Was it an intentional fire or an accident? By piecing together the fragments of evidence and staging a conflagration experiment I hoped to answer these questions and more.

The preparations for the conflagration took just a couple of days. A collection of domestic objects were made and collected to place inside the structure. These included baskets, clay pots and figurines. The clay pots were crude, handmade and baked in the sun and/or in the ashes of a fire. In addition, six baskets were placed inside the structure, all containing a collection of nuts (including pistachios) and/or seeds. Two of the baskets were lined with bitumen.

Other preparations included work to the structure. We plastered a portion of the interior wall of the structure and placed flat stones in a fresh layer of mud on a portion of the roof. These stones were numbered and recorded with the aim to observe the resting position of the stones in relation to the rest of the collapsed roof debris. All the timbers in the roof and wall were tagged using small numbered metal discs. This was done to ensure that each timber could be identified and its position could be recorded even if completely charred. And lastly, interior and exterior temperatures and wind direction were recorded. The conflagration event was recorded through sketches, notes, digital cameras, and video camera.
The structure was reluctant to catch light. Six small fires were lit before the roof finally went up in flames. Fuelled by the wind the roof then steadily burned until it finally collapsed after nearly an hour. Burning roof material fell into the structure and smouldered for a further hour. The fire was not fierce, and did not oxidise the stones. Based on preliminary results the experiment did not succeed in replicating the archaeological evidence. This would suggest that either

a) more combustible material was used in construction, furnishings, and storage, or
b) the fire was intentional fuelled to achieve a sufficient level of ferocity


Acknowledgements
Once again I would like to thank CBRL for making this research possible. And also a very warm thanks to Bill and Ian for their continued support, love of pistachios and pyromaniac tendencies.

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Appendix 1.6

Abstract for a paper given at: Studies of the History and Archaeology of Jordan, Jordan 2004

Prehistory at Beidha: past, present and future
Samantha Dennis, Dr Bill Finlayson and Dr Mohammad Najjar

The Pre-Pottery Neolithic site at Beidha was excavated by a British team of archaeologists in the 1960s and 1980s. They revealed one of the earliest and most important villages in the world. Unfortunately, in the past no attempt was made to conserve or present the site to the public and therefore the early village has suffered from exposure and neglect.

Communicating the importance of the Pre-Pottery Neolithic site at Beidha has been a main objective of the Beidha Project since it was initiated in 2001. At present, the Project is attempting to stabilise the archaeological remains by carrying out work on site including selective backfilling, repairing fences, building retaining walls, and laying-out pathways.

The Project is now looking to the future. The management of such an archaeological site benefits not only us, the archaeologists, but also the public and tourists. In taking steps to conserve and present the remains the Project has engaged in such issues as the interpretation of the site through the use of experimental reconstructions. These reconstructions are valuable tools not only for archaeological science but also for education and tourism. The future of the site can not be evaluated purely on its archaeological value but also its economic value within the cultural heritage industry (tourism).
Appendix 1.7

_Antiquity_ 76: 933-34 (2002)

Conservation and presentation of Neolithic Beidha, southern Jordan

SAMANTHA DENNIS, BILL FINLAYSON & MOHAMMED NAJJAR*

The early Neolithic in the Levant, and specifically within Jordan, is critical to our understanding of the transition from hunter-gatherers to farmers, the beginnings of agriculture, the birth of religion and the emergence of community life. One of the most important changes directly documented in the material evidence is the rapid development of architecture associated with increasing sedentism and community size, both central to most models of the transition. Despite remarkably good preservation on some sites, construction techniques, overall form and function of the buildings remain poorly understood, severely limiting our understanding of important social developments.

One of the key early Neolithic sites in southern Jordan is Beidha, just 5 km north of Petra (Figure 1). It was excavated in the 1950s, 1960s and 1980s by British archaeologist Diana Halbaek-Kirkbride (Kirkbride 1966a; 1966b; 1967; 1968; Byrd 1994). This revealed a series of complex occupation horizons from the Natufian and early Neolithic (Pre-Pottery Neolithic B). Unfortunately no conservation measures were taken during or after excavation and therefore the site, including standing walls and fragile plaster, is collapsing under the strain from livestock, tourists and weather. The Beidha Project was initiated in 2001 to conserve the site and present the complex remains to the public. The project is a joint collaboration between the Council for British Research in the Levant (CBLRL) and the Department of Antiquities in Jordan with a strong emphasis on community involvement. Two local Bedouin tribes, the Ammarine and the B’dul, are involved at many levels from providing labourers to skilled craftsmen, accommodation and site guards. Both have an interest in the long-term future of the site as a tourist attraction.

In addition to the routine conservation and presentation, a series of experimental reconstructions of Neolithic structures, based on evidence from the excavation, is being made. The first will also serve as a visitor centre (Figure 2). The project will examine the problems of conflicting interpretations made by archaeologists and of adapting these interpretations for a wider audience. These structures can help provide insights regarding the continuing debates concerning structure size and organization, function of individual buildings, site location, organization of interior space and inter-site variability over time. They will consequently help our understanding of significant patterns of social organization of settlement types, domestic activities and storage space and settlement population.

The first of a series of reconstructions is based on one of the earliest PPNB structures at Beidha. The semi-subterranean structure is 5 m in diameter with walls 1.2-2.0 m high and 0.50 m thick. The wall, built of stones from the wadi bed, consists of three main parts: inner wall, mud and stone fill and the outer wall, all built simultaneously to allow the mud and stone to bond (Figure 3). The timber roof, yet to be constructed, will be lashed to the upright timbers that have been placed within the stone wall (Figure 4).

Acknowledgements. We are grateful to the British Embassy in Amman for their support. We would also like to thank the many volunteers that helped carry hundreds of stones and a thank you to the Ammarine and B’dul for all their efforts and hospitality.

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_ANTiquity_ 76 (2002): 933-4
Figure 1. The early Neolithic site of Beidha, southern Jordan.

Figure 2. This aerial view of Beidha shows the experimental reconstruction in the foreground and the Neolithic remains behind, with pathways guiding visitors around the site.

Figure 3. Experimental reconstruction of an early Neolithic wall, showing the timber framework, inner wall, and mud and stone fill.

Figure 4. The experimental reconstruction before the roof was added.

Figure 5. Aerial view looking south over Beidha.
Appendix 2.1

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Appendix 8.1

Beidha Management Plan

Beidha is an internationally important prehistoric site, famous as an important location in our understanding of the fundamental change from mobile hunting and gathering lifestyles to settled farming societies. Jordan is a key area in this transition, and Beidha's reputation and location near Petra make it an ideal place to provide a stimulating visitor experience. The antiquity of the site makes this a greater challenge than for the interpretation of more recent monuments, but its importance to the human story means that such sites need to be explained. Jordanian heritage tourism is presently narrowly based. Experience elsewhere, including within the region, particularly in Cyprus, suggests that this base could be broadened.

A range of architecture is preserved on the site, illustrating the change to a permanently settled village. Excavations started by Diana Kirkbride in 1958 to 1983 have produced a substantial volume of research data. These are relevant to the beginnings of many aspects of modern human society - how to live in large settled communities, how to farm, how to hold property, and how to invest labour. CBRL is currently supervising the process of analysis and final publication of these results. Unfortunately the site itself has been largely left to deteriorate with minimal protection, no conservation, and no interpretation. The importance of the site would by itself argue that some measures should be taken to protect the remains. That it falls within the Petra region and has therefore become something of a showcase for the early prehistory of Jordan makes it all the more important that positive measures are taken before deterioration of the remains proceeds much further.

Aims of the Beidha Project

There are two critical issues. The first is how to preserve the site, the second is how to present it to the public.

Preservation

Provision of a secure fence, designed to be unobtrusive
Provision of a guard
Designation of a route around site to reduce people walking across fragile areas
Conservation of walls, removal of old baulks that are collapsing

Presentation

Minor excavation works to tidy site up
Provision of display panels with information
Construction of experimental Neolithic houses to test and demonstrate theories of architecture, and to use as a visitor centre

Appendix 8.2

Article 7 of the Charter for the Protection and Management of the Archaeological Heritage

Presentation, information, reconstruction
The presentation of the archaeological heritage to the general public is an essential method of promoting an understanding of the origins and development of modern societies. At the same time it is the most important means of promoting an understanding of the need for its protection. Presentation and information should be conceived as a popular interpretation of the current state of knowledge, and it must therefore be revised frequently. It should take account of the multi-faceted approaches to an understanding of the past. Reconstructions serve two important functions: experimental research and interpretation. They should, however, be carried out with great caution, so as to avoid disturbing any surviving archaeological evidence, and they should take account of evidence from all sources in order to achieve authenticity. Where possible and appropriate, reconstructions should not be built immediately on the archaeological remains, and should be identifiable as such (Cleere 1990:404-405).

Appendix 8.3
A Neolithic Heritage Trail proposal

Proposal for the development of the presentation of early prehistoric remains in southern Jordan

Bill Finlayson, Samantha Dennis, Hans-Georg Gebel, Charlott Hoffman Jensen, Mohammad Najjar, Alan Simmons, Ingolf Thuesen, Talal Hamad al-Amarin

Introduction
This is a proposal to develop a Neolithic Heritage Trail in the Greater Petra Area (to include the Neolithic sites of the Wadi Faynan) covering the following sites:

Baja, Basta, Beidha, Ghuwayr 1, Shkarat Msaied, Wadi Faynan 16

The objective of the project is to increase national and international understanding and awareness of the importance of the Neolithic of Southern Jordan and to enable the local community to be involved and benefit in the presentation of cultural heritage. This proposal has been produced following an invitation by HE Dr Fawwaz al-Khraysheh to develop the concept.

A scientific committee has been formed from the Project Directors involved. We believe that it is important for the Department of Antiquities to be formally represented on this committee and hope that a DoA representative will be appointed. Talal Hamad al-Amarin, a representative of the local community and an experienced archaeologist, was appointed as advisor to the Committee. Mariam Bshesh was appointed as marketing advisor. The Committee will coordinate the project and as necessary co-opt additional members to the committee. We envisage a larger committee with representatives from all the stakeholders being established in due course (including PNT and representatives of local communities). We anticipate that once the project is up and running the Committee will hand the project over to the local community and dissolve itself.

The Committee considers that its role is to design and set-up the project, to include the training of local people in the various roles required (management, guiding and
and that its role is complete once the project is running in a self-sustaining manner.

Archaeological Background

Archaeology, heritage and tourism are closely connected in Jordan, but most of resources and publicity are devoted to the already well-known sites such as Petra and Jerash. The majority of sites promoted are broadly speaking classical or early Islamic and can generally be described as monumental. Jordan is rich in some of the world’s most important early Neolithic sites but there appears to be a belief amongst the archaeological and heritage community working in Jordan that such sites are not appealing to tourists. However, there is a great potential in presenting early prehistoric sites using successful examples from other countries and going on to outline plans for developing a Neolithic trail that will run from Wadi Faynan (WF16 PPNA, Ghuwayr 1 PPNB) up the Wadi Nimla (Shkarat Msaied) to Baja and Beidha and ending at Basta. This trail will help to diversify the range of cultural heritage experiences available in Jordan and promote the international importance of these early sites.

These archaeological sites are important because they provide a direct record of one of the major shifts in human behaviour, one that is often seen as the most crucial shift towards modern society and economy. People stopped surviving solely on wild foods, and began to live on plants and animals that they had domesticated. People began to live together in settlements, staying in one place for longer and longer periods of time, in larger and larger groups. It is the period when the first real signs of religion began to appear, with special buildings, complicated burial rituals, and many symbolic artefacts; famously in Jordan the statues from Ain Ghazal. Arguably it is the moment when people’s entire vision of the world and their place in it changed. People no longer saw themselves as part of nature, but increasingly as something different, controlling their environment, a change that may be connected to the beginning of farming. Without the Neolithic there would be no modern society, no urbanism, world population levels could never have risen beyond a few million, and perhaps even our ability to live together in large communities would never have developed. Even the modern pastoralist lifestyle of the Bedouin could not have developed without the domestication of animals first achieved by the pre-pottery Neolithic people.

In Jordan the preservation of Neolithic sites is exceedingly good, the story is of great interest to humanity, and it is set in some of the greatest landscapes imaginable. Initial efforts have already been undertaken at several sites, including conservation works, paths, fencing and information panels at Basta, Beidha, Ghuwayr 1 and Shkarat Msaied. There are already large numbers of visitors who pass by Beidha, and not only as part of tours to little Petra. However, as yet there has been no real investment in resources or effort.

One great possibility for the south of Jordan would be to develop a Neolithic trail. There is a distinct concentration of spectacular Neolithic sites that are now all connected by road. It is possible to go on a surfaced road from Wadi Faynan 16, the earliest of these sites, see Ghuwayr, enjoy the amazing scenery up from the Wadi Arabah, to Shkarat Msaied, pass Baja, reach Beidha, and finish at Basta. The RSCN wilderness lodge in Faynan and the many tourist facilities in Wadi Mousa and its region make the logistics of the trip relatively easy. There is also an option of walking through the landscape with Bedouin guides. Many of the local Bedouin groups have been involved in the excavations at the various sites, some of them becoming enthusiastic and well-informed. They already lead small walking groups in the area. The Neolithic sites are very much part of their landscape and in an area with few economic possibilities it would be very useful to provide some economic return from the archaeological sites. In addition, given the remote location of these sites it is extremely important that local population are sympathetic to the conservation of the sites and any
information panels, or their promotion may well lead to a faster deterioration. The involvement of the local population provides a greater probability that the project will be sustainable. There is a UNESCO project regarding the intangible heritage of the Bedouin, and although this relates to recent and contemporary Bedouin culture, it has included discussion of open air and living museums. The archaeological sites would fit well within such a wider approach.

**Site Preservation**

The Neolithic sites are all fragile. The older excavations at Beidha and Basta indicate this very clearly as the exposed remains are damaged by the weather, visitors, the local people and their animals. Even the more recently exposed remains at Ghuwayr 1 and Wadi Faynan 16 already shows signs of weather damage, despite the much less severe weather experienced in the lower part of the trail area. Encouraging more visitors to the sites has the potential to increase the rate of damage, unless we ensure that the sites are protected. We recommend the followings steps be taken:

1: Any areas not needed for the site presentation should be backfilled.
2: Clear paths should be marked out to keep visitors off the actual remains.
3: Presentation should be designed to help protect the site and to make visitors aware of how fragile they are.
4: The local population should be educated to help protect the sites.
5: A system of monitoring should be introduced to ensure conservation can be undertaken as required.
6: Consolidation and conservation should be undertaken where required. This should be undertaken as minimally as possible, and as far as possible avoid the use of intrusive materials.
7: Conservation techniques should be developed, based on the experiences of conservation at several of the sites and the experimental work undertaken at Beidha. A set of standard procedures should be developed to be applied throughout the trail.
8: Conservation should not be seen as a one-off process, but as an ongoing task that will require routine and regular maintenance.
9: If possible we should avoid the use of covers, as an important aspect of the sites is their landscape location.
10: Site fences and walls should be established or refurbished where necessary, but should be designed not to detract from the landscape location.

**Site Presentation**

Unfortunately, presenting prehistory is not easy. Most of the sites are not spectacular in scale, or even when they cover large areas, such as the 14 hectares of Ain Ghazal, the buildings remain small. As complicated archaeological remains they are often unintelligible, appearing simply as a mass of walls, neither evocative nor informative. Visitors generally know very little about the Neolithic, or why it is important. The sort of history that is taught rarely goes as far back as the Neolithic. It tends to focus on the sort of history that can be used to explain modern cultures or states and in that sense is local history. Neolithic archaeology is a global history that affects the deep roots of our societies and economies.

This means that we have much more work to do to present the sites. We have to start at the beginning and explain what the Neolithic is, what the change is, and why it is important. We have to explain how long ago it happened and how, although a ruin may look much like a badly ruined village it is the first village and the significance lies in its age, in what it represents. We have to go beyond the site, to explain the significance of the material that has been recovered, the bones of domesticated animals, or the seeds of domesticated plants.
There is therefore something of an intellectual exercise to be undertaken before the significance and interest of the sites can be appreciated.

This is not an impossible task. And indeed, one of the fundamentals of much archaeological presentation has been that an aspect of archaeology that visitors like the most is understanding the whole process of discovery; they like the detective nature of archaeology. They like knowing about the hands on, practical, process of discovery.

Fortunately there are many examples of successful presentation of early prehistory outside Jordan and we do not need to start completely from the beginning. Several examples exist, that are both popular sites to visit and have been recognised as world heritage sites. Khirokitia is a famous early village site in Cyprus, representing an important point in Cypriot cultural history. It has been added to the world heritage list and attracts visitors in large numbers. There is a well laid out walkway through the site, equipped with extensive information panels and the understanding of the site is enhanced by the use of experimental reconstructions. It is generally a success, and is on the same tour routes as many more recent monuments, although there are two other early prehistoric sites along the same coast line at Lemba and Tenta which receive significant numbers of visitors. Being prehistory has not put anyone off. An interesting feature of Lemba is the increasing involvement of the local village community council, keen to increase the number of visitors coming to their area.

1: Site presentation should be undertaken in a standardised manner for the whole trail, making use of a recognisable logo to help establish the identity of the trail.

2: On-sites signs should be kept to a minimum.

3: Various key locations should be established as information points. These are likely to include
   - The RSCN Eco-Lodge in Wadi Faynan
   - The experimental village at Beidha
   - An Amarin museum

   These locations will have posters providing basic information about the sites and the trail as a whole. They will also have stocks of simple leaflets to be taken away by visitors. Various simple, economic and easily replaceable hands-on materials such as flint nodules should be provided.

4: The landscape is an important part of the trail and will be included in the information provided. This will include both information on the past landscape and the present environment.

5: Guides should be trained with the specific information relating to the site. Ideally these guides should come from the local community. The possibility of some training course at university in Wadi Musa should be considered.

**Educating Locals**
It is vital for the success of the project and the preservation of the sites that the local population are persuaded that the trail has an economic benefit for them, for them to identify with the remains as being part of their own heritage, and for them to have a sense of ownership regarding the trail.

A number of the local population have worked on the sites and already have an understanding of the archaeological interest. This should be encouraged and, where
possible, the local population should be trained to work in various roles such as guides and conservators.
Options such as open-days for local schools should be developed to help bring the local population to the sites and to be shown round them with Arabic speaking guides.

Guidebook

A guidebook to the Neolithic Heritage Trail should be produced. This should be designed around the trail and the sites along the trail. A set of standardised information will be produced by each project concerning the individual sites. The guidebook is described in greater detail in a separate proposal.

Marketing

A study project by Maryam Bshesh, a member of the Ba’ja Neolithic Project at Cottbus Technical University, Germany, has concerned a marketing strategy for the Neolithic Heritage Trail, following sustainable principles. The results of this marketing study may become part of further discussions, subject to the general approval of the DoA for the NHT proposal. The Scientific Committee are not experts on marketing and believe that much of the detailed work on marketing should be undertaken by members of the wider committee. It is however fundamentally important that the development of marketing should include the local populations as a key constituency as we do not believe that either the trail, nor the archaeological remains, will be sustainable without their active participation.

Funding

Funding to establish the trail will be of central importance. We understand that MOTA/DoA may be able to fund some aspects of the work, especially regarding site presentation. Members of the Scientific Committee undertake to investigate sources of funding to cover training, education, and the guidebook. These sources may include the EU, UNESCO, National Geographic, individual national sources and various private trusts.

Conclusion

We seek approval for the project from the Department of Antiquities. We also seek the active participation of the Department in the further development of the project. In particular we understand that the Department has a key role to play in gaining the full support of MOTA, and that both MOTA and DoA involvement is absolutely crucial to the project.

Once approval has been gained we will begin to work to develop the plans, seek funding, commence work on the guidebook and leaflets, and begin to prepare individual sites. A formal meeting of the Scientific Committee with the other stakeholders in the project should be held.
Planning the Interpretation for Beidha

What we wish to interpret, and why
• What the Neolithic is and why Beidha is so important
• The visible architectural features of the early Neolithic settlement
• Aspects of conservation and preservation
• The purpose of experimental archaeology at Beidha

Why
To increase people’s understanding of the Neolithic period and related conservation issues

How will we do it:
using multilingual on-site signs, leaflets, webpages and a visitor’s centre

Who it is for:
Local visitors, foreign tourists and academic bodies

How it will be managed:
Through hired local specialists and volunteer work from archaeologists, historians etc.

*
Beidha Project
S. Dennis, B. Finlayson, & M. Najjar
CRBL & DoA

CONSERVATION AND PRESENTATION PLAN

N (not to scale)

entrance

sign

sign

EXPERIMENTAL SITE

terrace walls

steps

EXCAVATIONS

← new fence line

Backfilling

move spoil heaps
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The use of experimental archaeology to examine and interpret Pre-Pottery Neolithic architecture: a case study of Beidha in southern Jordan

Samantha Dennis

Volume II: figures

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The University of Edinburgh
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Gradual undercutting was noted on mud structures in Western Africa (McIntosh 1974:167 figure 14) and on the plaster walls of exB-49 at Beidha

Mud plaster erodes to form lips at the base of the walls

Fragments of roof mud plaster from exB-49 showing impressions of reeds

Drawing illustrating the organisation of space within exB-49 during the experimental process

Debris (mostly reeds) gathered inside a) exB-49 and b) exB-48

Monitoring sketch (a) and photograph (b) showing the gulleys that formed at the entrance to exB-49 after heavy rain

A line of erosion at 0.25 m marks the height of water that collected in the structure during flooding

The occasional clump of mud and reeds accumulated under the eaves of the roof of exB-49

Charring the end of a timber in a camp fire (a); erecting a charred timber (b)

Plaster test patches between T8 and T12 in exB-48, a) during and b) after

Sketch plan for the construction of exB-48

The foundation pit of exB-48

Timbers were numbered with metal identity tags

One timber, T23, was placed in the middle of the entrance way

Upright timbers were secured by the wall construction

The central post hole of exB-48 was packed with ash and rubble

The positions of the foundation stones and the height of the outer wall face varied because of the sloping ground

Alternative wall construction technique when stretchers were not available

Capping stones were placed on the wall head of exB-48

The location of the capstones between timber (1-8) in the construction of exB-48

An attempt was made to construct a flat radiating roof on exB-48

Covering the uneven roof with reeds was awkward

Flat stones were placed in the mud on the roof of exB-48

Sketch showing the locations of flat stones on the roof of exB-48

Sketch showing the locations of flat stones after the roof collapses

Exploratory trench dug at the base of an upright timber of exB-48

Exploratory trench dug at the base of the central post of exB-48

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The floor plan of exB-18 was an irregular shape

Upright timbers of exB-18

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Sketch showing the position of roof rafters of exB-18

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A lip formed at the base of the wall during plastering

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central post
placed in the middle of the inner line of the
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Post - 2.80 m 0.12 m wide
Post hole ± 0.20 m diameter 0.80 m deep
through, initially, compact seal from mixing mud,
then mixed compact-loose patches
Small wedges

Timber roof frame - first, 4 main timbers resting
directly on central post.
$ tied to uprights with
simple knots, some resting
on the wall, some protruding
beyond the outer wall
then T13, T8, T4, T2, etc.

Most timbers were tied at the top, central post, though some
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piece of rope.

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b) Similar gradual undercutting was noted on the plaster walls of exB-49 at Beidha.

Figure 6.46

Layer 1: plaster from the original construction phase (May 2003)
Layer 2: erosion (mostly Aeolian) of the plaster in the summer of 2003
Layer 3: thin layer of mottled orange brown silty sand containing decomposed reeds that corresponds to the initial post-construction and post-abandonment event, i.e. debris accumulated in the winter of 2003

Note: The wall plaster (layer 1) was buried under debris at the base of the wall (Layer 2) and was not washed away in the flood.

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Figure 8.11a  An example of a temporary sign placed on site during the programme of experiments
Early Neolithic Architecture

This village grew over many 100s of years and each structure is built slightly differently, but generally they fit into two categories: the earlier circular houses and the later rectangular 'corridor' structures.

The circular post houses are semi-subterranean and are clustered into 'honeycomb' arrangements.

You can see the remains of these circular structures to your right.

The 'corridor' houses were built over, and sometimes destroying the earlier circular houses. It is thought that the small rooms were used for storing food and tools.

The transition from circular to rectangular houses may have been a result of a successful start to a farming lifestyle. More tightly clustered houses, perhaps with upper floors, would be needed for the growing population in the village.

You can see remains of the rectangular houses to your left.

plan from PEQ 1995

Thanks to the support from the Jordanian Department of Antiquities, CBRL and the British Embassy, Amman

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