HOW TO BUILD A MISSISSIPPIAN HOUSE: A STUDY OF DOMESTIC ARCHITECTURE IN WEST – CENTRAL ALABAMA

by
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A THESIS

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Table of Contents

List of Tables

List of Figures

Abstract

The purpose of this project is to establish a typology and improved chronology of Moundville domestic structures that takes into consideration both excavated floor plans and above-ground architecture. Ethnohistory, ethnography, wood science technology, excavated floor plans, and experimental archaeology will be employed in an attempt to determine what these domestic structures looked like above-ground; a project investigated in other regions but never at Moundville. In establishing the typology and chronology, the study will shed new light on the idea of a flexed pole dwelling rather than a rigid pole dwelling associated with small pole, wall trenched contexts. More importantly, it will establish a history of architecture at Moundville and the surrounding areas and investigate possible reasons for changes in architecture during the Mississippian stage.

CHAPTER 1
Introduction

Shelter is one of the most elementary requirements of humankind. Repeatedly, humans have modified their housing structures to better suit their needs, or to adapt to changing technologies. An area of interest to archaeologists is the domestic architecture of the Mississippian stage of the Southeastern United States. A variety of domestic floor plans have been discovered, the two most common being a small closely set pole design and a large widely spaced post design. Archaeologists in the early twentieth century speculated that the small closely set pole design of the Native Americans during the Mississippian stage represented a curved roof structure covered in bark, cane matting, or grass thatching, referred to as a flexed pole house (Lewis 1937; Lewis and Kneberg 1941, 1946; Webb 1938). The same archaeologists believed that the chronologically later form, the large widely spaced post design, was a different architectural form that possessed a hipped or gabled roof as opposed to a bent or flexed roof. However, the majority of recent depictions and museum diorama recreations of Mississippian domestic architecture portray a rigid post construction method rather than the flexed pole method for both architectural layouts, the small closely set pole structures and the large widely set post structures. This work advocates that the earlier view was correct.

Hypotheses and Back Research

There are two primary hypothesis in this work, to which are associated several subsidiary concerns. The first hypothesis relates to the most frequently documented

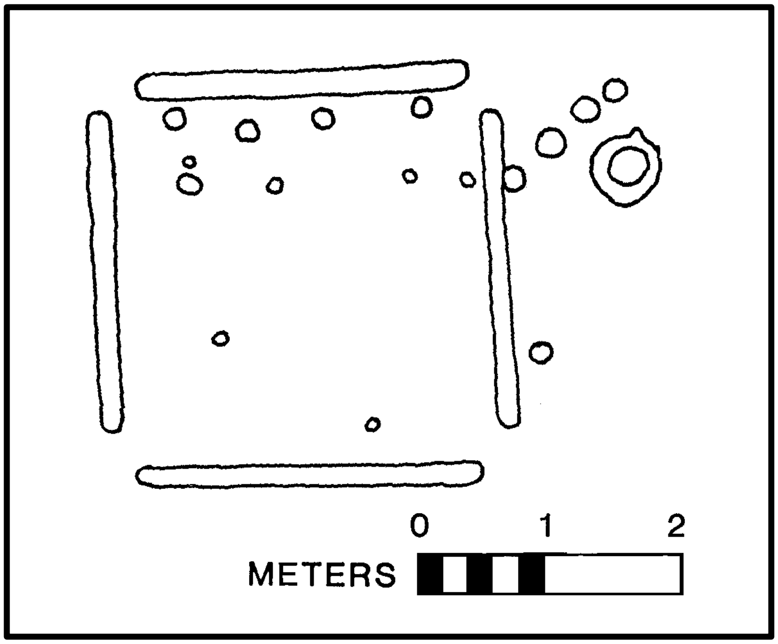


Figure 1. A floor plan of the most common structure type found at Moundville and surrounding areas (traced from field notes on file, Alabama Museum of Natural History).

Mississippian house forms found in west-central Alabama (Figure 1). These ordinary domestic structures were constructed on a square or rectangular floor plan with closely-spaced, narrow poles set either individually or in discontinuous wall trenches. The hypothesis is that of the Mississippian houses of west-central Alabama, the small closely set pole structures will more frequently indicate a flexed pole construction method than those that have large widely spaced individually set posts.

As a background to the study, relevant ethnohistoric and ethnographic accounts will be consulted in order to determine the varieties of historically documented above-ground architecture that might correspond to the archaeologically excavated floor plans of prehistoric structures in the Southeast. These results are presented in Chapter 2. For further background, an examination of the history of archaeological interpretations of Mississippian domestic structures is presented in Chapter 3.

Wood science technology and experimental archaeology will inform on the issues of flexed pole construction. Consequently, it is believed that the information generated from these sources will confirm that the flexed pole method of construction is structurally appropriate to archaeologically excavated floor plans of the small closely set pole form. This conclusion draws heavily on wood science technology and principles of structural engineering, whose results are presented in Chapter 4. The results from building an experimental flexed pole structure based in part on this information are described in Chapter 5.

Because little research has examined the quantitative differences between the two methods of construction, my second hypothesis is that the examination of Mississippian housing in west-central Alabama will indicate that there is a positive relationship between post diameter and the degree of post spacing. In other words as post diameter increases, so does post spacing. Based on the posts' method of insertion, whether individually set, set in a wall trench, or composite in form, data will indicate two distinct methods of house construction with no evidence of transitional forms. This examination also will demonstrate that there are no clear patterns of internal roof support posts in those buildings whose wall posts are small and closely spaced, while the few roof supports that do occur are indicative of a flexed pole construction method, not a rigid post method. If this prediction is validated, it will lend support to the idea that the common, narrow pole, closely set form lacked a separate roof component. These data are presented in Chapter 6 of this thesis.

Subsequently, it is proposed that the primary structure type considered in this thesis falls within a chronological sequence of forms. One goal of this research is to develop a typology followed by an improved chronology of the various forms of domestic architecture at Moundville and in surrounding areas, by examining changes in size, construction methods, and materials used during the Mississippian stage. I predict that the particular form of architecture characterized by narrow, open corner wall trenches was preceded locally by composite form and small individually set pole structures, and was followed by rigid post structures with separate roof components as the dominant architectural form in the Black Warrior Valley. The typology and chronology are presented in Chapter 6. This research also will examine the possible cultural, social, and environmental factors that may have contributed to such an architectural shift, such as material availability, possible changes in the environment, or an alternation in the domestic unit. This information also is presented in Chapter 6.

Study Specifications

This study will be focused specifically on Mississippian domestic architecture. For this purpose, “structure” will be defined as a building that possessed wall posts and a roof. Therefore, palisades and stockades are excluded from this research. The examination also will be focusing on domestic housing rather than public or ceremonial buildings. For the purposes of this study “domestic” will be defined in terms of size, location, and internal features within the structure. Only structures that are less than 37 m^2 (400 ft^2) of roofed space, and which are neither located on earthworks nor in the possession of specialized internal features such as clay seats or specially prepared clay floors will be considered domestic buildings (Lewis and Kneberg 1946).

Because the focus of the study is Moundville, the architecture that will be examined there will be only that of square and rectangular structures, omitting consideration of ones that possessed a circular or oval foundation shape. Many Mississippian societies and historic Southeastern tribes used circular structures, and there is no evidence to suggest that these structures were limited to rigid post techniques. However, no evidence of circular structures has been found at the Moundville ceremonial center and they are of rare occurrence at Mississippian sites in the surrounding areas. In the immediate region, they are found only at the Bessemer site (DeJarnette and Wimberly 1941) and in the Pickwick Basin of the Tennessee River in northern Alabama (Webb and DeJarnette 1942). Therefore, they will not be considered other than in ethnohistoric and ethnographic accounts.

Thus, seventy-five excavated square or rectangular domestic structures will be analyzed including fifty-two from Moundville (Alabama Museum of Natural History; McKenzie 1964; Scarry 1995), thirteen from the Lubbub Creek site (Peebles 1983), four from the Bessemer site (DeJarnette and Wimberly 1941; Welch 1994), two from the Powers site (Redwine 2002; Welch 1998), two from the Big Sandy Farms site (Ensor 1993), and two from the Pride Place site (Johnson 1999, 2001). Examination of these structures will focus on variables of size, shape, wall form, post hole size and spacing, evidence of roof supports, and chronology of dwellings at Moundville and surrounding sites. There is little evidence to suggest that transitions in Mississippian architecture are broadly uniform across time and space. Therefore, this research will be a region-specific contribution to the prehistory of domestic architectural techniques and their social correlates in the Southeast.

CHAPTER 2
Ethnohistoric and Ethnographic Accounts

Ethnohistoric Evidence

Across the Southeast, Mississippian structures were variable in their floor plans, dimensions, roofing material, and method of wall and roof construction. Nonetheless, the principle types of domestic construction can be distinguished from ethnohistorical reports as belonging to two main architectural classes; rigid post, in which the wall and roof are separate architectural components and flexed pole, a structure in which the walls and roof are of the same component.

The flexed pole method of construction involved the use of long, thin flexible saplings, which were planted closely together in the ground and then bent in a strategic manner to form a series of arches. These arches intersect creating the internal framework. Architecturally, such structures possess a domed roof, with a basket-like integrity eliminating the need for internal supports.

Du Pratz described a Natchez flexed pole house as they appeared in 1725 in the Lower Mississippi Valley. He stated that,

> The cabins of the great village of the Natchez, the only one I saw, are in the shape of a square pavilion, very low, and without windows. The top is rounded much like an oven. The majority are covered with the leaves and stalks of corn; some are built of clay mixed with cut straw, which seemed to me to be tolerably strong, and which were covered within and without with very thin mats. That of the great chief is very neatly plastered on the inside…

> The cabins of the natives are all perfectly square. There is not one which measures less than 15 feet each way, but there are some more than 30. This is their method of constructing them:
>
> The natives go into the young woods in search of poles of young walnut [hickory] trees 4 inches in diameter by 18 to 20 feet long. They plant the largest at the four corners to fix the dimensions and the size of the dome. But before planting the others they prepare a scaffold. This is composed of four poles fasted together above, the ends below resting at the four corners. On these four poles they fasten others crosswise 1 foot apart, all making a four sided ladder or four ladders joined together.
>
> That done they plant the other poles in the earth in straight lines between those at the corners. When they are thus planted they are bound firmly to a cross pole on the inside of each face (or side). For this purpose they use great cane splints to bind them at the height of 5 or 6 feet, according to the size of the cabin. This is what forms the walls. These erect poles are not more than about 15 inches apart. A young man then mounts to the top of the corner posts with a cord between his teeth. He fastens the cord to the pole, and as he mounts inward the pole bends because those who are below draw the cord to make the pole curve as much as is needed. At the same time another young man does the same to the pole forming the angle opposite. Then the two poles, bent to a suitable height are firmly and smoothly bound together. The same is done to the poles of the two remaining which are made to cross the first. Finally all the other poles are joined at the top, giving the whole the appearance of a bower in a greenhouse such as we have in France. After this work canes are fastened to the lower sides or walls crosswise about 8 inches apart, as high up as the poles which I have spoken of as determining the height of the walls.
>
> These canes being fastened in this manner, they make mud walls of earth mortar (mortier de terre) in which they put a certain amount of Spanish beard. These walls are not more than 4 inches thick. No opening is left except for the door, which is but 2 feet wide at most by 4 in height, and some are much smaller. Finally they cover the framework I have just described with cane mats, placing the smoothest on the inside of the cabin, and they fasten them to each other carefully so they will join well.
>
> After this they make many bundles of grass, of the tallest they can find in the low grounds, which are 4 or 5 feet long. They are laid down in the same manner as the straw with which cottages are covered. They fasten this grass by means of large canes and splints also made of cane. After the cabin has been covered with grass they cover all with cane mats well bound together, and below they make a circle of lianas all the way around the cabin. Then the grass is clipped uniformly and in this way, however high the wind may be, it can do nothing against the cabin. These coverings last twenty years with repairing [Swanton 1911: 59-60].

The account by Du Pratz demonstrates several important details. First, he indicates grass and corn stalks as a source of thatching material as well as the use of clay in some structures. In addition, he points out that the houses were covered with thin cane mats on both the interior and exterior of the structure. This is important to note, especially with regard to the discussion of my experimental construction featured in Chapter 5. These mats not only added protection from rain, but also made the structure more flame resistant. The most important aspect of this account is the process in which the structures were erected, with the roof and walls being of the same architectural component; that is, the roof was created from the same poles as the walls. Du Pratz gives information concerning the size, length, diameter and material of poles, house dimensions, and method of interior scaffolding. More key architectural details were reported including the possession of horizontal supports determining the height of the walls, their height, the use and spacing of cane horizontals for the purpose of holding the thatch, the presence of very small doors and the lack of a centralized smoke hole.

Lawson observed the process of a flexed pole house assembly in the Carolinas in 1700. Although this account describes a structure with a circular or oval floor plan, it demonstrates the process and materials used during a flexed pole assembly. In his account, Lawson stated,

> These savages live in wigwams, or cabins, built of bark, which are made round, like an oven, to prevent any damage by hard gales of wind. They make the fire in the middle of the house, and have a hole at the top of the roof right above the fire, to let out the smoke. These dwellings are as hot at stoves, where the Indians sleep and sweat all night. The floors thereof are never paved nor swept, so that they have always a loose earth on them.
>
> The bark they make their cabins withal, is generally cypress, or red or white cedar; and sometimes, when they are a great way from any of these woods, they make use of pine bark, which is the worser sort. In building these fabrics, they get very long poles of pine, cedar, hickory, or any other wood that will bend; these are the thickness of the small of a man’s leg, at the thickest end, which they generally strip of the bark, and warm them well in the fire, which makes them tough and fit to bend. Afterwards, they stick the thickest ends of them in the ground, about two yards asunder, in a

> circular form, the distance they design the cabin to be (which is not always round, but sometimes oval) then they bend the tops and bring them together, and bind their ends with bark of trees, that is proper for that use, as elm is, or sometimes the moss that grows on the trees, and is a yard or two long, and never rots; then they brace them with other poles to make them strong; afterwards cover them all over with bark, so that they are very warm and tight, and will keep firm against all the weathers that blow [Swanton 1946: 410-411].

Speck (1909) visited and wrote on the structures of the Yuchi in eastern Oklahoma, former residents of Tennessee and Georgia. In his work, he described three types of architecture that were, or had been utilized, by the Yuchi. The first was the domestic construction techniques of the Yuchi of recent history, which consisted mostly of rigid post architecture. The second type of recent architecture Speck discussed was that of temporary hunting and gathering shelters used during that time that possessed a single or shed pitched roof. The third type was a flexed pole method said to have been used by the Yuchi before European contact. Speck did not witness a structure built in this manner first-hand, but was informed that,

> The Yuchi remember still another type of family dwelling house which seems to show that the common house type of the Algonkian tribes bordering the Atlantic coast farther north was known to the Yuchi as well. We are informed by the Yuchi that the framework of this type of house, [the] yu, consisted of poles stuck in the ground in parallel rows at certain distances apart. These were bent over and lashed together at the top, forming an arched passage underneath. The whole top and the sides were then covered with strips of bark cut entire from cypress trees and attached in overlapping layers to the cross pieces connecting the upright poles. Matting is also said to have been used as house covering material. Such structures are commonly remembered to have been about ten feet high and about sixteen feet square on the ground. The roof slabs were weighted down with halved logs secured at the ends of the framework. The fireplace was in the center of the floor space. It was excavated about six inches below the surface of the ground. A hole was left in the roof directly above the fireplace for the smoke to escape [Speck 1909: 40].

In contrast to the flexed pole form, the rigid post form was the other dominant tradition of architecture described in ethnohistorical accounts of the Southeast. This method involved the use of short, yet rather thick timbers, spaced farther apart than in a flexed pole assembly.

The rigid post form is constructed with the roof as a separate component from the walls, and it usually correlates with the presence of four strategically placed internal roof supports. These internal supports were included in order to compensate for the increased roof weight and decreased lateral support in comparison to the flexed pole structure. The result was a structure that possessed a hipped or gabled roof, created independently from the walls. Adair (1968), an Irish trader among the Cherokee and Chickasaw from 1735 to around 1768, described the process of rigid post house construction and the necessity of using internal roof supports in both the summer and winter houses of the Chickasaw of northeast Mississippi,

> They first trace the dimensions of the intended fabric, and every one has his task prescribed him after the exactest manner. In a few hours they get the timber ready from the stump: every piece being marked, it is readily applied to the proper place, in a great hurry, and so very secure, as if it were to screen them from an approaching hurricane. Notwithstanding they build in this hasty manner, their houses are commonly genteel and convenient. For their summer houses, they generally fix strong posts of pitch-pine deep in the ground, which will last for several ages – The trees of dried locust and sassafras, are likewise very durable. The posts are of an equal height; and the wall-plates are placed on top of these, in notches. Then they sink a large post in the center of each gable end, and another in the middle of the house where the partition is to be, in order to support the roof-tree; to these they tie the rafters with broad splinters of white oak, or hiccory, unless they make the choice of such long saplings, as will reach from side to side over the ridge hole [pole?], which, with a proper notch in the middle of each of them, and bound as the other sort, lie very secure. Above those, they fix either split saplings, or three large winter canes together, at proper distances, well tied. Again, they place above the wall-plates of both sides the house, a sufficient number of strong crooks to bear up the eave-boards: and they fasten each of them, both to one of the rafters and the wall-plate, with the bandages before described. As the poplar tree is very soft, they make their eave-boards of it, with their small hatches: having placed one on each side, upon the crooks, exceeding the length of the house, and jutting a foot beyond the wall, they cover the fabric with pine, or cypress clap-boards, which they can split readily; and crown the work with the bark of the same trees, all of a proper length and breath, which they had before provided. In order to secure this covering from the force of the high winds, they put a sufficient number of long split saplings above the covering of each side, from end to end, and tie them fast to the end of the laths. Then they place heavy logs above, resting on the eave-boards, opposite of each crook, which overlap each other on the opposite sides, about two feet a-top, whereon they fix a convenient log, and tie them together, as well as the laths to the former, which bind it together, and thus the fabric becomes a savage philosopher's castle, the side and

> gables of which are bullet proof. The barrier towns cut port holes in those summer houses, daubing them over with clay, so as an enemy cannot discover them on the outside; – they draw a circle round each of them in the inside of the house, and when they are attacked, they open their port holes in a trice, and fall to work. But those, that live more at ease, indulge themselves accordingly… The Indians always make their doors of poplar, because the timber is large, and very light when seasoned, as well as easy to be hewed; they cut the tree to a proper length, and split it with a maul and hard wooden wedges, when they have indented it a little, in convenient places with their small hatches. They often make a door of one plank in breadth, but, when it requires two planks, they fix two or three cross bars to the inner side, at a proper distance, and bore each of them with a piece of an old gun barrel, heated and battered for the purpose, and sew them together with straps of a shaved and wet buffalo hide, which tightens as it dries, and it is almost as strong as if it were done with long nails, riveted in the usual manner. Thus, they finish their summer house of pleasure, without any kind of iron, or working tools whatsoever, except a small hatchet of iron (that formerly was a long sharpened stone) and a knife; which plainly shews them to be ingenious, and capable of attaining all the liberal arts and sciences, under a proper cultivation [Adair 1968: 417-419]

Adair also described the Chickasaw winter house, which was circular but erected with rigid posts as was the rectangular summer house.

> The clothing of the Indians being very light, they provide themselves for the winter with hot-houses, whose properties are to retain, and reflect the heat, after the manner of the Dutch stoves. To raise these, they fix deep in the ground, a sufficient number of strong forked posts, at a proportional distance, in a circular form, all of an equal height, about five to six feet above the surface of the ground: above these, they tie very securely large pieces of the heart of white oak, which are of a tough flexible nature, interweaving this orbit, from top to bottom, with pieces of the same, or the like timber. Then, in the middle of the fabric they fix very deep in the ground, four large pine posts, in a quadrangular form, notched a-top, on which they lay a number of heavy logs, let into each other, and rounding gradually to the top. Above this huge pile, to the very top, they lay a number of long dry poles, all property notched, to keep strong hold of the under posts and wall-plate. Then they weave them thick with their split saplings, and daub them all over about six or seven inches thick with tough clay, well mixed with withered grass: when this cement is half dried, they thatch the house with the longest sort of dry grass, that their land produces. They first lay on one round tier, placing a split sapling a-top, well tied to different parts of the under pieces of timber, about fifteen inches below the eave: and, in this manner, they proceed circularly to the very spire, where commonly a pole is fixed, that displays on the top the figure of a large carved eagle. At a small distance below which, four heavy logs are strongly tied together across, in a quadrangular form, in order to secure the roof form the power of envious blasts. The door of this winter palace, is commonly about four feet high and so narrow as not to admit two to enter it abreast, with a winding passage for the space of six or seven feet, to secure themselves both

> from the power of the bleak winds, and of an invading enemy. As they usually build on rising ground, the floor is often a yard lower than the earth, which serves them as a breast work against the enemy: and a small peeping window is level with the surface of the outside ground, to enable them to rake any lurking invaders in case of an attack… [Adair 1968: 420-421].

Another description of a rigid post hot house at a Lower Creek Town in 1813 is given in an anonymous account.

> The town house is a large building built round at the bot[t]om for three or four feet high out of sticks & mud with large post[s] of the same h[e]ight which support a plate. Inside of this wall is other large post[s] set round which support other plates on which two rest the rafters. On the last plates rest a large beam which supports another large post in the center against which rest the remainder of the rafters so as to bring the roof to a point in a conical form. On these rafters are tied small lathes which support the bark of which the roof is made. There is only one door which makes it as dark as midnight [Swanton 1946: 392].

These various ethnohistorical accounts demonstrate that either basic type of construction method, flexed pole or rigid post, could be applied to any shape of floor plan, whether round, oval, square, or rectangular. They also give adequate information concerning the construction assembly and materials, as well as data on the geographical range of forms of architecture in the Southeast. Most importantly, they confirm that the two dominant forms in the Southeast were the flexed pole assembly, and rigid post structures that possessed internal roof supports for a separate roof component.

Ethnographic Accounts from Africa and Mesoamerica

Unfortunately, there are no ethnohistorical accounts of Moundville's inhabitants. The chiefdom had collapsed and the greater part of the site had been abandoned before European contact (Knight and Steponaitis 1998). One way to attempt to establish the architectural forms of the unpreserved, above-ground components is to examine the ethnohistorical accounts of Native Americans in the Southeast, as previously described. Another way is to examine ethnographic data from other cultures around the world in search of relevant analogies. Yet, it is important to note that ethnographic and ethnohistorical reports seldom provide all the information needed for a particular archaeological study. As Robbins (1973: 209) points out, the four most overlooked details in ethnographic accounts include "1) the number of individuals items present in a specific inhabited settlement or dwelling area, 2) the distribution of items according to specific human activity areas, 3) percentages of kinds of raw materials used by the inhabitants for their artifacts, and 4) what happens to the contents of the residence when it is abandoned."

Ethnographers, especially the earlier ones, tend to make broad generalizations about a particular form of material culture. Consequently, ethnographic and ethnohistorical accounts are not the most adequate for systematic data, but they can illuminate peoples and activities of the past by analogy through the examination of contemporary behavior. This information is beneficial to the study because it aids in the interpretation and structural understanding of the various architectural forms by showing a range of possibilities for pole and thatch architecture.

Some of the houses of African tribes are constructed in a similar manner, with similar materials, as those described in ethnohistorical reports from the southeastern United States. The basic framework of several of these types of houses involves a circular or rectangular layout of thin, closely spaced poles that are planted firmly in the ground vertically. These poles are then bent inward until their tops can be bound together (Frescura 1981: 123). The structures are then thatched, with the most common materials being reeds, grass, bamboo, banana leaves, and palm leaves (Denyer 1978: 95).

In the African data, the bending of the members to create a domed roof is accomplished in two ways. One method is to bend the wood into a series of arches that intersect each other at right angles. This method creates a structure that resembles an upside-down basket referred to as a beehive dome shape structure, and possibly very similar to the flexed pole method used in the Southeast. The Somali hut of Somalia, the agal, is a perfect example (Figure 2). This method is also utilized by the Galla, Hottentots, Massai, Nguni, Nyika, Swazi, Xhosa, and Zulu. The other method is to bend all the poles to meet at the center of the structure, referred to as a radial beehive cone shape dwelling. The latter method is similar to historically documented Caddo houses, west of the Mississippi River, which are known for their beehive appearance (Bushnell 1922; Swanton 1942). However, one must be cautious when examining African houses for potential analogies. Many structures are architecturally deceiving because they possess a beehive-shaped roof, but are actually constructed with a rigid wall and roof framework, which is hidden under its domed exterior (Andersen 1977; Denyer 1978).

These two flexed pole forms, the basket-like dome form and the radial beehive cone shape form, are used mostly by nomadic or semi nomadic African tribes because they can be easily dismantled, transported and rebuilt. The structural form of the Swazi of Swaziland is an example of the interwoven basket-like form. A depiction of their construction method, recorded in 1945, is shown in Figure 3. When the Swazi relocate, the houses are stripped of their thatch, and the framework is carried to the new site. However, unlike other pastoralists who utilize the same construction and transportation methods, such as the neighboring Hottentots (Figure 4), the Galla of Kenya (Figure 5), and the Somali of Somalia, the Swazi do not traditionally use cattle as beasts of burden. Therefore, when the tribe relocates, the

Figure 2. A hut utilized by the Somali nomads of Somalia referred to as an agal (Guidoni 1975: 84).

Figure 3. An Illustration of Swazi house construction as of 1945 in Swaziland (Kuper 1946: 20).

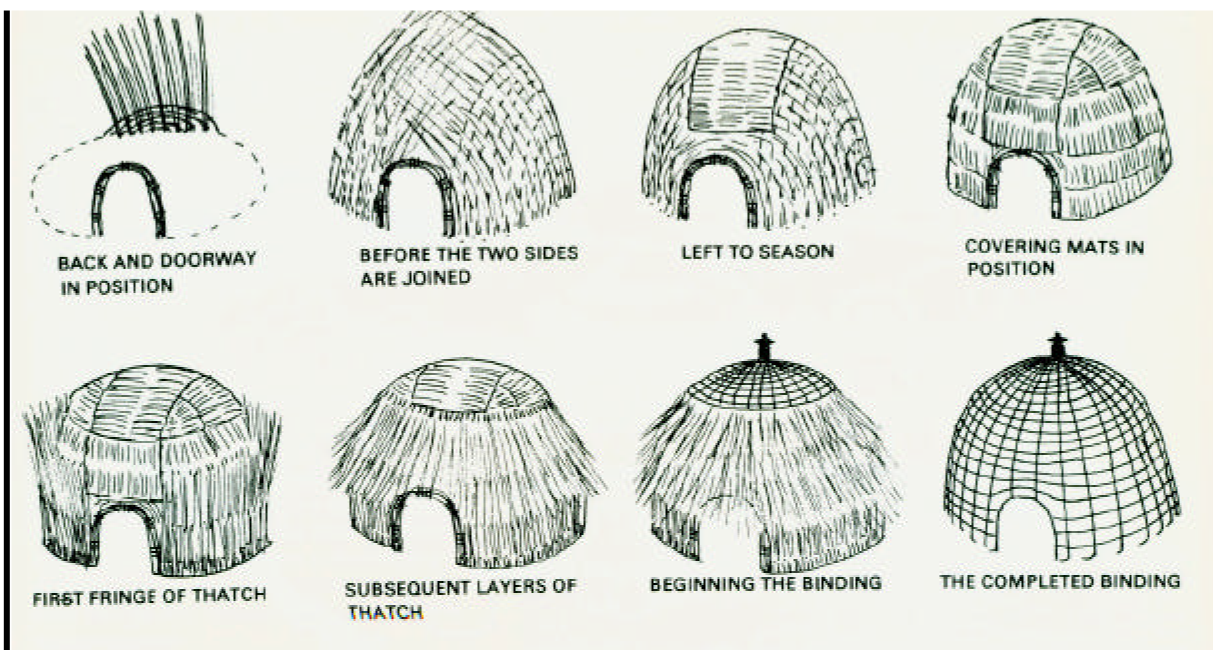


Figure 4. An illustration of Hottentot house construction in South Africa (Peter Kolbe 1727: 73).

Figure 5. An illustration of Galla house construction in Kenya (Andersen 1977: 36).

assembled framework of the houses would be carried on wooden posts by 20 to 30 men (Kuper 1946).

On the other hand, there are several sedentary tribes that also utilize a flexed pole assembly. The domestic houses of the Tutsi are constructed using the same method as the portable structures of nomadic pastoralists, simply on a larger scale. From the fifteenth century to the mid 1950s, the Tutsi were the pastoralist overlords of Rwanda. Figure 6 shows a domestic Tutsi house, witnessed in Rwanda in 1910.

The Nyika of southwestern Tanzania utilized both rigid post and flexed pole assemblies simultaneously. Figure 7 shows a Nyika homestead at the turn of the twentieth century, with a flexed pole house in the foreground. However, in the same photograph one will notice a conical roof, rigid post structure in the background. The Zulu of South Africa also built two types of houses; one in a rigid post style and the other in a flexed pole style (Biermann 1971). Figure 8 shows a village landscape of the Zulu in the 1950s. Notice that almost all the houses are built with flexed poles, with the exception of one rigid post structure with a conical roof in the foreground of the village. A close-up of the construction techniques of a small domestic form of Zulu flexed pole house is shown in Figure 9.

Frescura (1981) divides African architecture into two forms, those that use flexed pole grass orientated huts such as the Swazi, Zulu, Xhosa, and so forth, and the rigid post wattle and daub construction method utilized by the Tswana, Venda, and Sotho groups. Incidentally, the flexed pole grass thatched houses seem to occur in areas where the settlements are located along the rain and grass rich coast lands. Although there are several examples of flexed pole house construction in Africa, the majority of African domestic structures are constructed in a rigid post assembly. This method of assembly with thatched

Figure 6. A Domestic Tutsi House in Rwanda in 1910 (Denyer 1978: 126)

Figure 7. A Nyika flexed pole house in south-western Tanzania around 1900. Notice the rigid post structure in the background (Denyer 1978: 115).

Figure 8. A Zulu settlement in the 1950's in South Africa. Notice the circular rigid post house in the foreground, amid flexed pole houses (Guidoni 1975: 97).

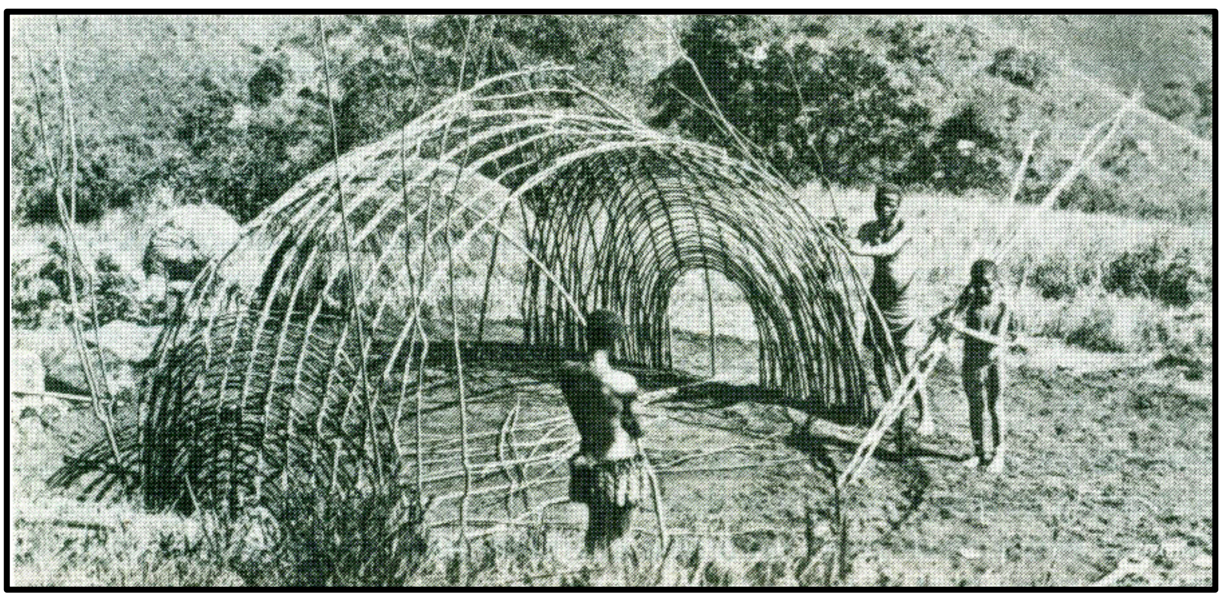


Figure 9. A Zulu flexed pole house in South Africa referred to as an indlu (Frescura 1981: 40).

roofs has the greatest variation in shape, materials, and construction techniques. Some roofs rest on pillars and are independent architecturally from the walls, while others are completely supported by the walls. The majority of rigid post structures rest on wall plates supported by forked upright supports in the walls. The shape of the roof is directly related to the shape of the walls. Rigid post roof construction above a circular floor plan would have been conical, while the roofs of rectangular buildings would have been hipped or gabled, with the latter being more common (Denyer 1978). The rigid post houses that used wattle and daub technology seem to be concentrated in the drier highland regions where there is less rainfall to erode exposed walls and less of a demand for sophisticated waterproofing techniques (Frescura 1981: 11).

One important note on the variety of African flexed pole architecture is that some forms utilize internal roof supports. The idea of internal roof supports is typically associated by many Southeastern archaeologists with the presence of a separate hipped or gable roof component. This philosophy of some Southeastern archaeologists will be further elaborated on in Chapter 3. However, a variety of flexed pole analogies, usually the larger forms of the houses of the African tribesmen already described, use several combination of internal roof supports (Biermann 1971). The flexed pole construction techniques for large Zulu houses make use of two internal supports to prop up a ridge pole in the center along the longitudinal axis of the house (Figure 10). This method is also found among the New Hebrides of Melanesia (Figure 11).

Another variation can be found in the traditional bamboo houses of the Sidamo, sedentary farmers and pastoralists of eastern Ethiopia (Gebremedhin 1971) and the Kamba, farmers and cattle raisers of Eastern Kenya (Andersen 1977). The characteristics of these

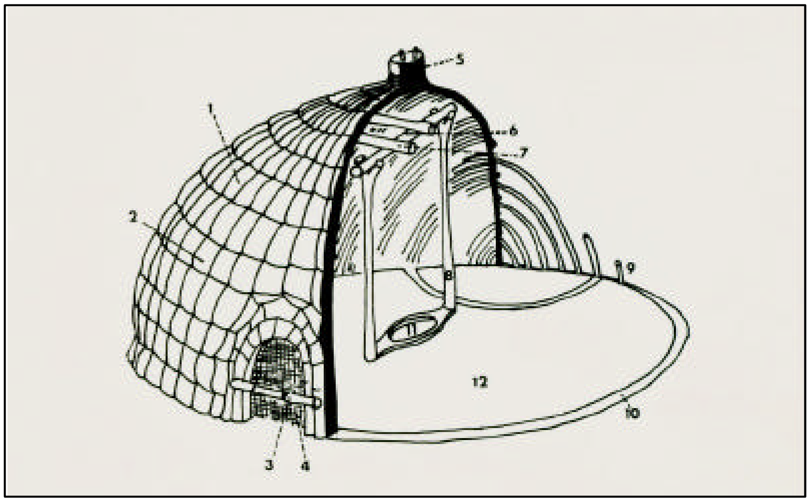


Figure 10. A Zulu flexed pole house constructed with two internal supports used to prop up a ridge pole (Biermann 1971: 105).

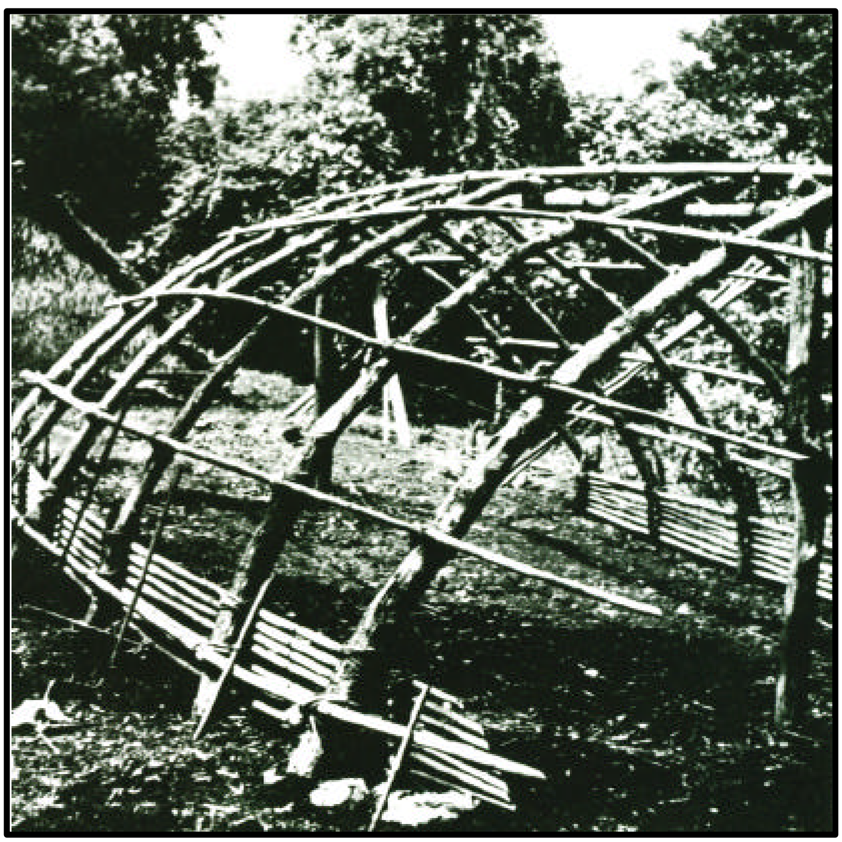


Figure 11. A New Hebridian flexed pole house in Melanesia that possesses two internal roof supports used to hold up a ridge pole in the center of the structure (from Guidoni 1975: 122).

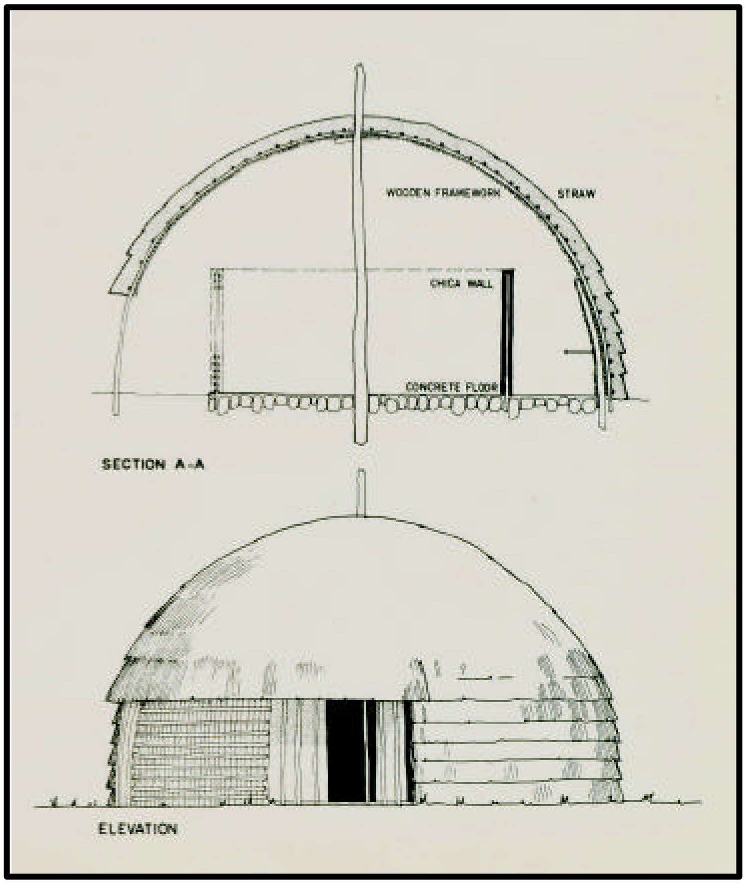


Figure 12. A depiction of a Sidamo house in Ethiopia. Note the one roof support placed in the middle of the structure (Gebremedhin 1971: 123)

houses are similar to that of the Zulu, Nyika, Swazi, Hottentot, Tutsi, and Somali which have just been described. However there is one important difference, which is that the Sidamo and the Kamba houses are constructed in the radial beehive fashion possessing only one central roof support where all radial members come together and are bound (Figure 12). The houses are then thatched in honchie leaves placed between two layers of bamboo matting (Gebremedhin 1971: 119).

These ethnological accounts demonstrate that among the African tribesmen, as in the southeastern United States, there are two main forms of architecture, flexed pole and rigid post, with each form possessing a variety of sub-types. These accounts exhibit a variety of roof and wall thatching possibilities, such as cane, and so forth, while others are covered entirely with clay. These accounts also document that flexed pole forms are constructed with small, thin, poles while the rigid post forms are supported by larger timbers, spaced farther apart. Many of these structures use central roof supports, in a variety of fashions but the majority of flexed pole techniques are free from the possession of internal roof supports.

In contrast to the architecture of the African tribesmen, the traditional architecture of the Yucatán and Guatemala in Mesoamerica lack a major flexed pole form. Even though some of the structures of the Nicteha of the Yucatán incorporate flexed poles, most possess a rigidly supported ridge pole. The main architectural type of Mayan peoples consists of rigid post buildings that can be separated into two roof types; hipped and gabled. The hipped roof is pitched back on four sides, as in the top of a pyramid. Hipped-roof styles in Mesoamerica vary according to dimensions such as the ratio of roof angle to height of walls, however most Mayan structures have quarter pitched roofs, meaning they are pitched at 42 to 60 degrees. The other prominent roof form is the gabled roof in which the roof pitch slopes in only two directions. Other forms included single-pitch or shed roofs, but this form is usually limited to temporary shelters. The most common wall types in the area include very closely-spaced vertical posts, which are supported at their tops by the wall plate, or horizontal wattle, which is interlaced between the more widely spaced upright posts arranged between larger, weight-bearing posts. In either case, hipped or gabled, the widely-spaced weight bearing posts supported a upper wall plate. Materials used for thatching the roof include palm, grass, sugar cane, and corn blades, in order from most to least favored (Wauchope 1938).

Housing in the Yucatán and Guatemala consists of mostly smaller domestic forms constructed in a flattened-end (rectangular with rounded corners), apsidal (rectangular with rounded ends), or rectangular floor plans, all three such forms usually possessing internal roof supports. There is a slight difference in the placement of these internal roof supports compared to the ones that are found in the southeastern United States. Southeastern domestic rigid post structures have internal roof supports that are placed closer to the center of the structure, whereas the supports of the Mayan houses are situated very close to the corners (Figure 13, 14). This distinction does not make much of an architectural difference, except that in Southeastern houses the roof load or weight is supported by the internal roof supports as well as large, widely spaced wall supports, whereas the roof weight of the Mayan houses is mainly concentrated on the four corner internal roof supports.

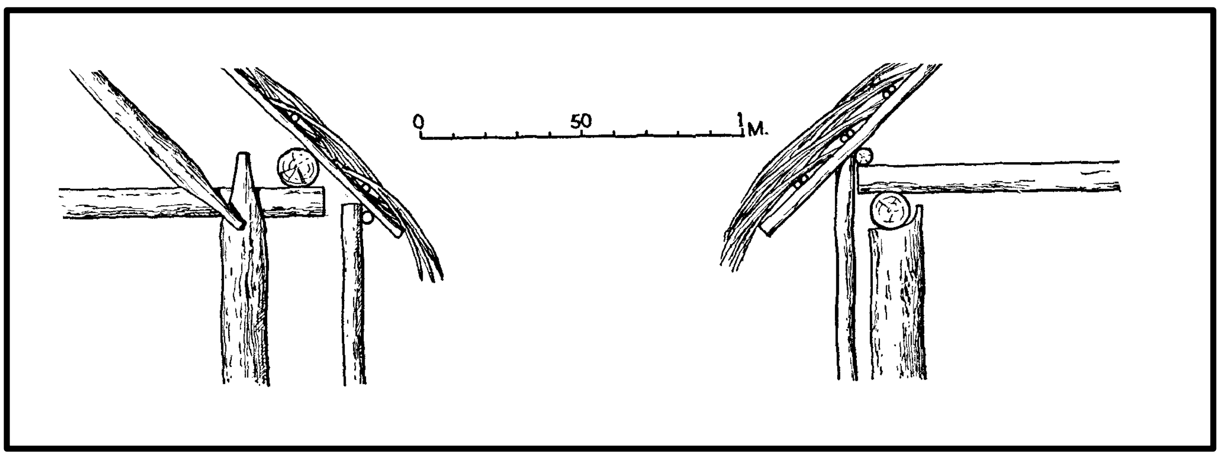


Figure 13. A depiction of two forms of roof supports and their arrangement of the pole plates and wall plates. The illustration on the left is a Yucatán house and the right is a picture of a Campeche and Guatemalan roof structure. The largest vertical posts represent the internal roof supports, while the smaller vertical poles represent vertical wall posts. Note the roof plate which consists of large poles running horizontally. This plate, supported by the internal supports, maintains the weight of the roof. The smaller vertical poles are either placed tightly together or spaced out and interlaced with horizontal wattle (Wauchope 1938: 37).

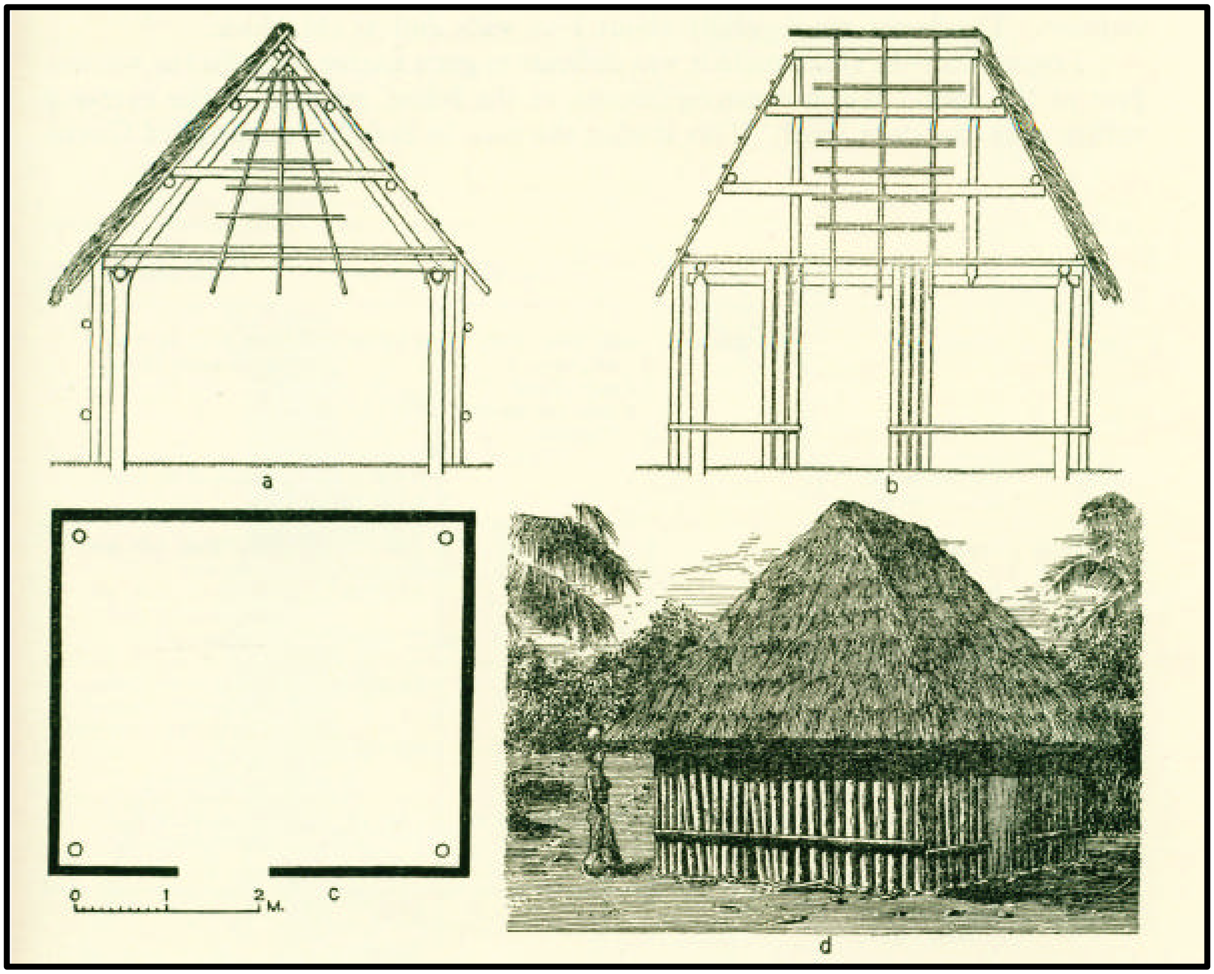


Figure 14. An illustration of a Mayan rigid post structure in Guatemala. Notice in the elevation views (*a*,*b*) and the plan view (*c*), that the roof is supported by four internal roof supports, represented as unfilled circles in plan (*c*). The black line in the plan view represents the wall line of the house. In this particular illustration (*d*), the house is shown using vertical posts as a wall covering method. These postmolds align themselves with the outline of the structure in figure (*c*). Yet, since supported at the top in the connection to the wall plate, these vertical covering posts do not need deep holes in order to stabilize them (Wauchope 1938: 95).

Mesoamerican domestic structures that do not have internal supports usually have walls created from relatively large, widely spaced posts that provide maximum support for the wall plates (Figure 15). The walls are covered either with smaller vertical posts notched at the top to fit the wall plate or horizontal wattle. When closely-spaced vertical wall posts were used as wall covering materials, the postholes would have been either relatively shallow or non-existent, as they were supported at the top with their connection to the wall plate and not their depth in the ground. The alignment and spacing of these vertical posts would not have to be as strictly adhered to as they are non-structural and non-weight-bearing.

In sum, there are great differences in the domestic architecture of African tribesmen as compared to the Maya of Mesoamerica. Whereas the African houses consist of a variety of both forms of architecture, flexed and rigid, the Maya seem to overwhelming utilize the rigid post method. This contrast and comparison of ethnographic accounts from two widely separated cultural areas is beneficial to this study. In flexed pole architectural analogies, the building techniques of African tribesmen reveal that there are a variety of forms that fall under the category of flexed pole house. Not only can a flexed pole form be circular or rectangular in its foundation, but the houses can be constructed in a radial beehive cone shape or an interwoven basket-like dome shape with either form possessing up to two internal roof supports.

In terms of rigid post architecture, the accounts demonstrate that even in an area that utilized rigid post structures almost exclusively, two basic architectural principles still apply. First, posts that support a wall plate must be relatively large and widely spaced. Domestic African and Mayan rigid post houses that lack internal roof supports possess only a few load-bearing posts per wall, not more numerous closely spaced supports. Secondly,

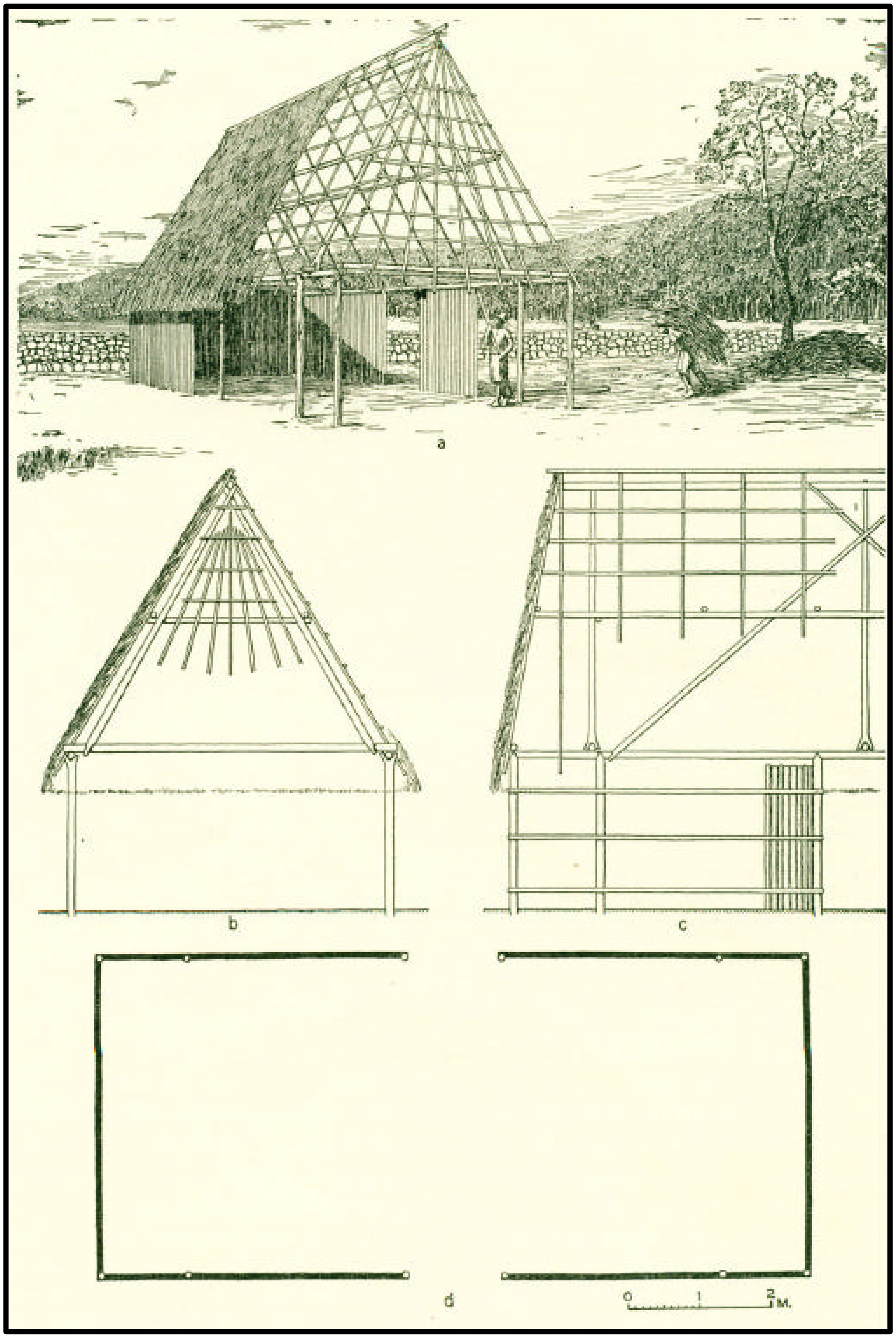


Figure 15. An illustration of a house in Campeche. This house-type was constructed with long vertical wall posts and palm thatch. Notice the lack of central roof supports in this structure type. However, major weight bearing wall posts, (depicting as uncolored circles) are large, widely spaced, with the principle supports being in the corners and by the entrance way (Wauchope 1938: 66).

these accounts illustrate that there are a variety of rigid post assemblies, but all forms possess separate roof components, some of which have four strategically placed internal supports. This reinforces that the architectural forms described in the southeastern ethnohistorical accounts are not only conceivable but are based on principles that are widely utilized elsewhere.

CHAPTER 3
History of Above-Ground Reconstructions and Museum Depictions

Current museum depictions, as paintings, dioramas, and full-scale reproductions, tend to show Mississippian domestic houses as rectangular structures possessing thin, closely-spaced poles, yet having a hipped or gabled roof, an assemblage of elements not found in either the ethnohistorical or the ethnographic data examined for this study (Figure 16). This perspective on the early form of Mississippian domestic houses has not always been dominant. There have been two major traditions of thought concerning the above-ground appearance of Mississippian small pole, closely spaced, wall trench structures. In this chapter, a brief history of these architectural conceptions is presented, in order to more adequately comprehend the changing views of these small pole domestic structures over the last 75 years. For the purpose of this chapter, this history is organized into three partially overlapping phases. These phases are presented in chronological order.

Tradition One (1937 – 1946): Early Flexed Pole Reconstructions

Thomas M. N. Lewis and William S. Webb were two of the first archaeologists to conjecturally reconstruct an above-ground architectural form on the basis of excavated floor plans in the Southeast. Lewis (1937), in his report on the Mississippian cultures of Eastern Tennessee, distinguished between two distinct floor plans that appeared in both public and domestic construction; a small pole wall trench form, and a large post, individually-set form.

Figure 16. Current full-size reconstructions of structures at various Mississippian sites. From top to bottom, Town Creek, the Pfeffer site outside of Cahokia, and Moundville.

The small pole structures were usually constructed using a narrow wall trench in which wall poles ranging from three to four inches in diameter were spaced four to twelve inches apart. In the large post architectural form, there was no indication of wall trenches. These structures were built with individually set posts, much larger in diameter and more widely spaced than those of the small pole structures.

Specifically in the small-pole designs, Lewis (1937: 11) recognized the presence of horizontal poles used as wedges, which were placed atop or within the wall trenches on the interior and exterior side of the wall poles. The ground-level horizontal poles placed on top of the trench on the interior side of the wall poles were staked down using wooden wedges. Other times horizontal wedges were found on the exterior side of the wall poles at the bottom of the wall trench, as well as being found on the interior side of the wall poles placed slightly higher, to perhaps create a fulcrum during the bending process. The presence of trench wedges has not been recognized in any of the Moundville structures excavated thus far. However, the presence and position of these horizontal supports, whether or not they were universal to this house form, do indicate the direction of stresses that the builders were attempting to overcome.

Lewis (1937: 11) speculated that the small pole wall trench architectural form was constructed with saplings, the bases of which were planted in the wall trench, with the top of each pole being pulled inward and bound to the pole on the opposing side. Following this process, two poles from the adjacent walls were bent and bound together, and the process was repeated until the framework was complete. This network of poles, crossing at right angles, created a sturdy dome-shaped roof. Charred remains on the floor of these excavated structures demonstrated that Mississippian houses in Eastern Tennessee used grass thatching on the roofs, which were covered with split and whole cane mats, and in some cases, clay (Lewis 1937: 11). These covering materials in addition to the thatch served a dual function, not only as added protection against wind and rain, but making the structure more resistant to sparks and flame.

Webb (1938: 191-192), in his work in the Norris Basin of Eastern Tennessee, also drew an archaeological distinction between “small-log” and “large-log” construction techniques. The small-log forms were rectangular, rounded-corner assemblies, which were constructed using a wall trench. Posts within the trench varied in size, yet none were larger than four inches in diameter, set four to eight inches apart. Webb presumed that most of the structures possessed only one door, located in the corner of the structure. On the other hand, the individually set posts of the large-log layout in the Norris Basin ranged from ten to fourteen inches in diameter, and were spaced two and an half to four feet apart. Webb speculated that the small-log construction techniques of the Norris Basin were similar to a type of prehistoric Yuchi house described by Speck (1909). In this account, reviewed in Chapter 2, Speck describes the process in which the upper ends of the wall poles were pulled towards its opposite wall, spliced, and tied together to form a continuous wall-roof frame.

Since Lewis and Webb’s initial writings on the subject, both small-log and large-log architecture of the Mississippian stage corresponding to their descriptions has been uncovered in a large portion of the Southeastern United States. In their excavations of the Chickamauga Basin in East Tennessee, Lewis and Madeline Kneberg (1941) described several small pole and large post floor designs. In a comparison of the three prehistoric cultures that inhabited the Chickamauga Basin, the Hiwassee Island, Dallas, and Mouse Creek cultures, the authors noted that unlike the rigid post architecture of the Dallas and

Mouse Creek cultures, the Hiwassee Island culture, the first Mississippian culture to inhabit the island, constructed their homes using small poles, set relatively close together and usually constructed using a wall trench. Lewis and Kneberg assumed that the poles of these structures were interwoven to form the roof, by bending two poles opposite each other towards the center and splicing them together (Lewis and Kneberg 1941: 23), therefore reiterating what Lewis (1937) stated generally about the form of small pole Mississippian housing in Eastern Tennessee.

Perhaps on the basis of these findings, in 1938 the Division of Motion Pictures for the National Park Service produced a movie entitled "Temples and Peace," depicting a diorama recreation of a Moundville domestic house located on the top of Mound B, the so-called "temple mound." This reconstruction consisted of small, closely spaced poles that were bent into a dome-shaped frame. However, this model was constructed more in the radial beehive cone shape form, with wall poles joining together at the top, than an inverted basket shape with poles interwoven at right angles. A cutaway picture of this recreation (Figure 17) was reproduced in Fundaburk and Foreman's (1957: 22) publication, *Sun Circles and Human Hands*. Structures located on mounds were excluded in the data collection process, as they are outside the scope of this study. However, this illustration is useful to examine what archaeologists were thinking about architecture during this period.

Webb and DeJarnette (1942) described a reconstruction of a house at the Seven Mile Island site in the Pickwick Basin of Northern Alabama. The structure is a public building that has an unusual floor plan compared to other houses in the Southeast. The layout consists of small, individually set, closely spaced poles surrounding four large internal roof supports, which were placed very close to the corners of the structure (Figure 18). According to Webb

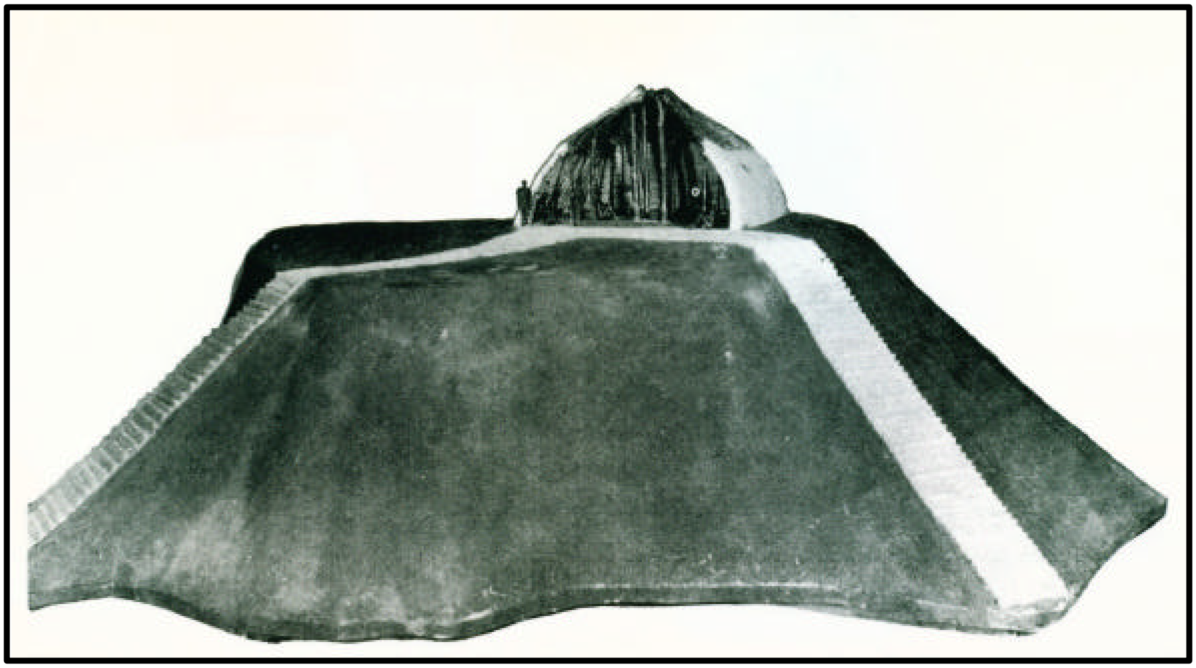


Figure 17. An illustration of the diorama featured in the video *Temples and Peace* (1938). The depiction can also be found in *Sun Circles and Human Hands* (1957: 22). Note how the walls are bent, but only to meet at the center forming a radial beehive form as oppose to the interwoven dome form. The building also possesses internal roof supports.

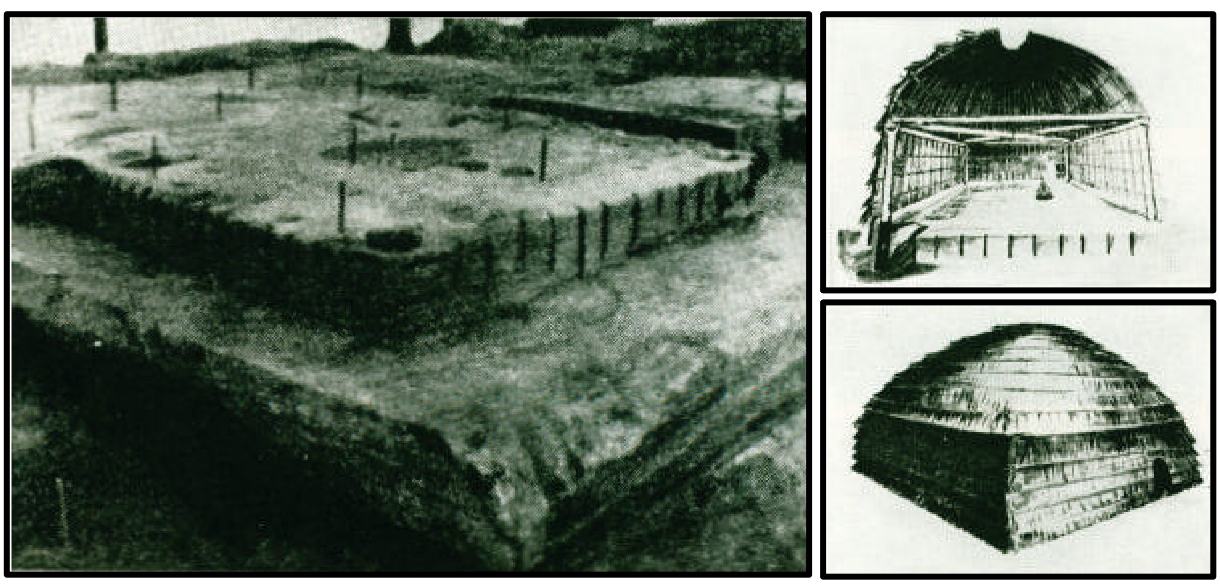


Figure 18. The floor plan and the reconstruction of a house excavated at Seven Mile Island in Northern Alabama featuring flexed poles used with a rigid internal frame (Webb and DeJarnette 1942: 46-48, Pl. 50, 69).

and DeJarnette's reconstruction, this type of floor plan results in a public structure that utilized a rigid internal frame, in which the wall poles were bent over a fixed wall plate and then bound together at the top, forming a dome-shaped roof. Granted, as a public structure also located on a mound, this too is outside the scope of this study, yet I mention it for its comparative value to the later architectural forms of the second tradition, yet to be discussed.

The most important published study of this early tradition of reconstructions is Lewis and Kneberg's (1946) examination of the Hiwassee Island site in the Chickamauga Basin. In this study, the authors examined three chronologically distinct prehistoric cultures and one historic culture that inhabited the island. In this publication, the authors worked out in greater detail the architectural forms inferred from their previous studies, and they proposed and presented several reconstructions of both small pole and large post buildings. The authors also noted that with the exception of ambiguous data from the Norris Basin, their excavations yielded the first solid evidence that the two most basic architectural forms were chronologically superimposed. Earlier, both Lewis (1937) and Webb (1938) speculated that the small pole assembly preceded the large post assembly, but it was not until the publication of the Hiwassee Island report site that concrete data were provided in support of the chronological relationship.

In *Hiwassee Island*, Lewis and Kneberg continued to argue that the small pole assembly was erected with thin saplings, the basal ends of which were planted in a wall trench. The tops of the poles were bent over and bound to the opposing complement. This process was repeated, alternating between the two opposing sets of wall posts until all poles were interwoven to form the internal framework (Figure 19). This is a form the authors stated as being similar to the small-log method Webb described, while citing Speck's (1909) architectural account of the Yuchi.

The wall trenches of the domestic houses at Hiwassee Island were approximately one and a half to two feet deep and were extremely narrow. Lewis and Kneberg believed that the purpose of the wall trench in the houses they described was to facilitate the process of erecting numerous, closely-spaced vertical wall poles. They also noted that the poles with the smallest diameter were found at the ends of the trenches, while the larger diameter poles were generally found in the middle of the arrangement. This evidence supports the notion of flexed pole architecture for this type of floor plan because in the bending process, the poles at the end of each wall would have to endure the greatest degree of bending.

It should be noted that cases of small, closely-spaced pole structures also have been found that were constructed by the individually-set post method. However, to Lewis and Kneberg (1946: 61), the presence or absence of a wall trench does not affect the outcome of the structure. In other words, wall trench or no wall trench, if the poles utilized were small and closely-spaced, it is believed to be a flexed pole house. Therefore, the presence of wall trenches in these small, closely-spaced pole structures is predominant, but not universal to this form of architecture.

Evidence in support of flexed pole architecture included charred remains of horizontal poles, which indicate that the vertical wall poles were braced horizontally, presumably at close intervals (Figure 20). In addition, several of the wall post molds excavated at Hiwassee Island were angled inward towards the center of the structure, indicating that the poles were bent inward. This evidence is supported by the presence of charred horizontal poles placed in the wall trenches on the exterior side of the wall poles (Figure 20). Initially, the

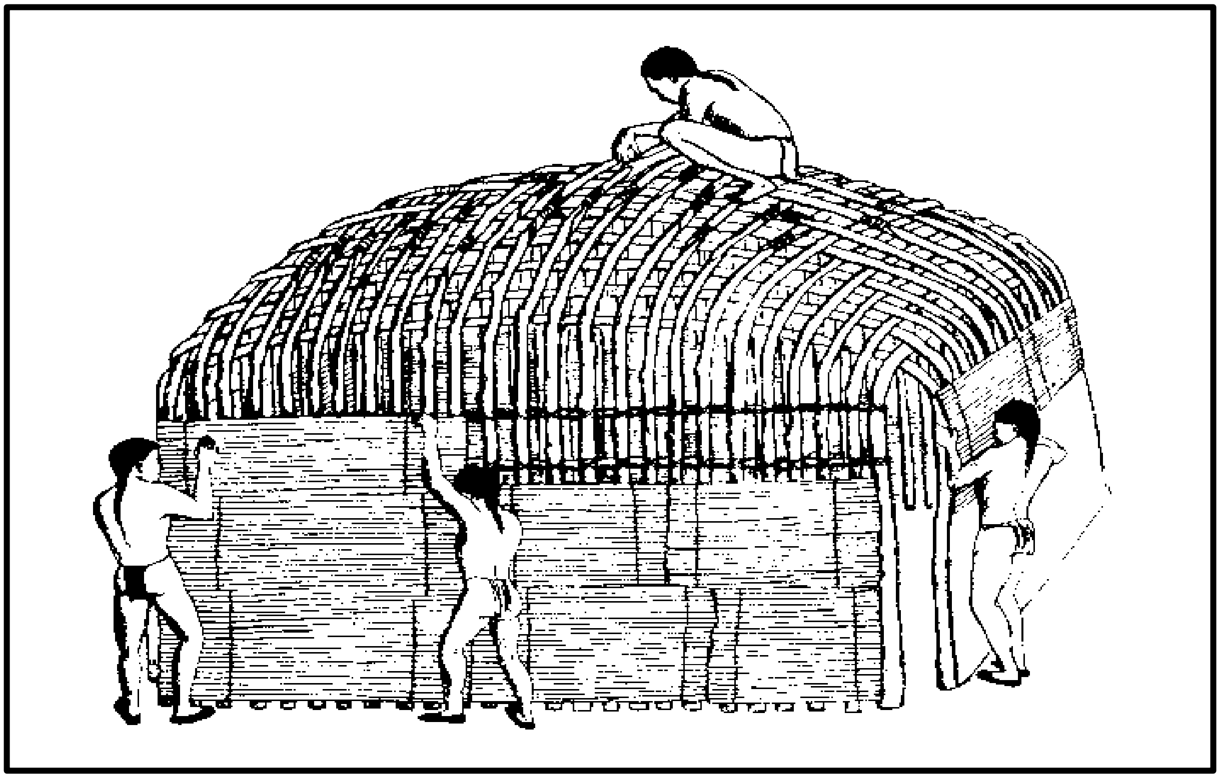
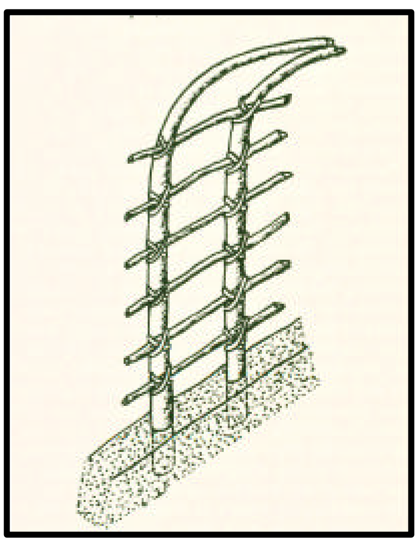
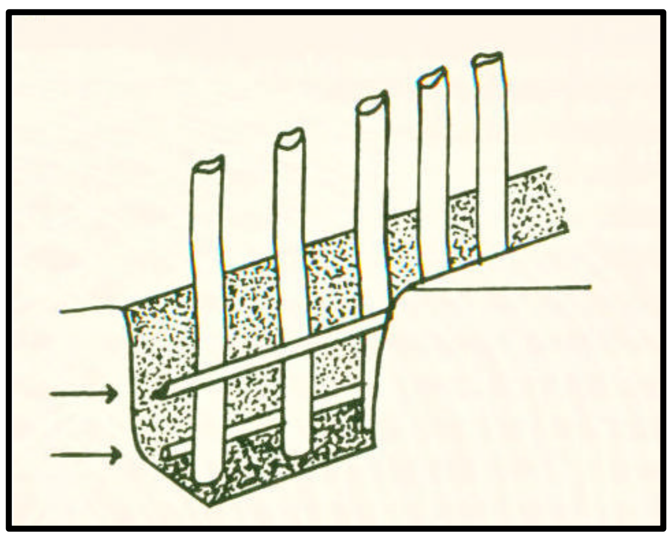


Figure 19. A reconstruction of a flexed pole house. Note the open corners and lack of internal roofing supports (Lewis and Lewis 1995: 57).





Figures 20. Reconstruction by Lewis and Kneberg of wall elements and wall trench wedges from Hiwassee Island (Lewis and Kneberg 1946: 50-51).

horizontal poles were used as a fulcrum in bending and later prevented vertical wall poles from excessive leaning. *Hiwassee Island* was also the first published evidence of horizontal wedges placed on the interior side of the wall poles in the wall trench, which were placed higher than the poles on the exterior side, to assist in keeping poles vertical. However, several cases at various sites in the Chickamauga Basin did not appear to employ horizontal wedge poles in their wall trench structures. Therefore, the presence of horizontal wedge supports was not universal to the small pole wall trench house type, or perhaps some horizontal wedges were too small to preserve archaeologically. The presence or absence of horizontal wedges might also depend on the soil matrix; therefore, in mound related construction in particular, wedges were noted by Nash, Lewis, and Kneberg more often in mound and public constructions as opposed to domestic village structures.

Additional evidence that supported a flexed pole form were twenty-five-foot long, very thin charred poles that were excavated at the Hixon site in Chickamauga Basin. Lewis and Kneberg (1946) believed that poles this long could only have been used to create a continuous wall-roof framework. In contrast, large-log domestic construction techniques of the chronologically later Mouse Creek and Dallas inhabitants of Chickamauga Basin constituted an architectural form involving thick, short, individually set posts roughly eight to ten inches in diameter and spaced one to three feet apart. This large post form did not utilize a wall trench. Charred evidence found at Hiwassee Island indicated that logs used in this form of construction were large, heavy timbers usually seven to eight feet in length. Presuming that these timbers constituted the wall posts, there would be no way to bend such large diameter posts at such a short height. Therefore, the roof would have to be a separate component. This form of architecture possessed either a hipped or gabled roof, indicated by

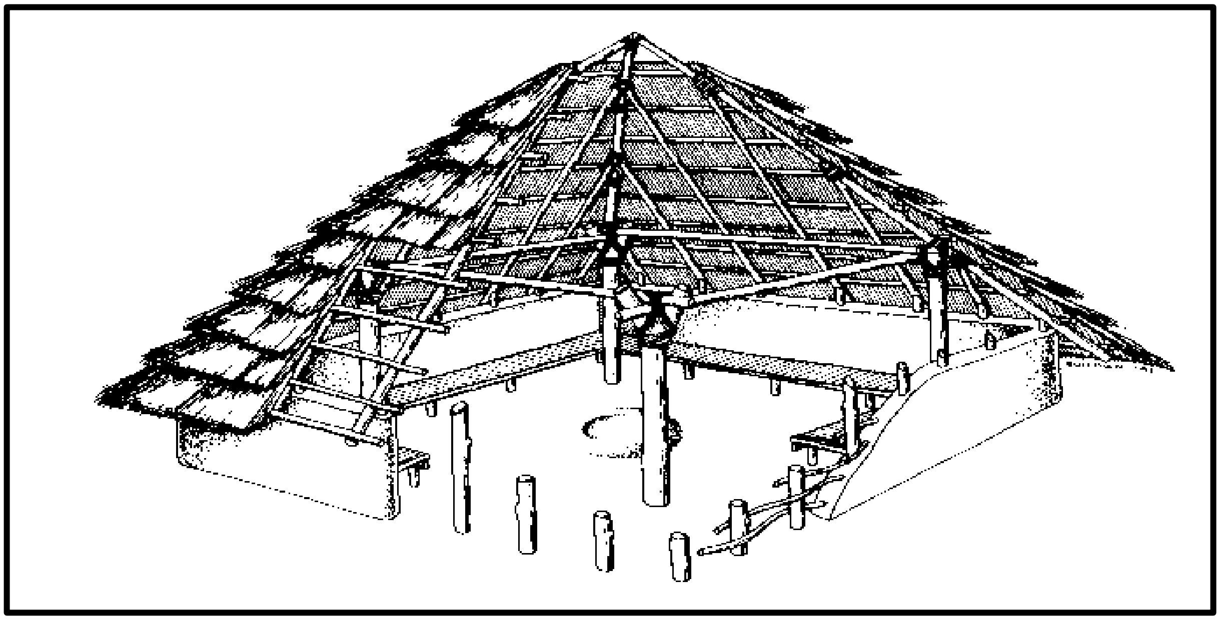


Figure 21. A reconstruction of a rigid post house with a hipped roof. Note the widely spaced posts and the four internal roof supports (Lewis and Lewis 1995: 68).

large, charred rafters found at Hiwassee Island (Figure 21). The large wall posts of this form were not only spaced at uneven intervals, but they also are not aligned in perfectly straight lines as are the post molds of the small pole assembly. The roof was finished with cane wattle, grass thatch, and in some instances clay.

Near the end of this tradition of architectural reconstructions, the flexed pole form of thinking began to take a back seat to the proposed rigid post method for small pole as well as large post buildings. However, the concept of a flexed pole Mississippian house did not entirely disappear. The last attempt in this tradition to argue for a flexed pole design for a small pole structure was made by Charles H. Nash (1968), in his thesis published posthumously with editing and additional notes by Charles H. McNutt. The excavations of the sites were undertaken in 1936, and were not published until thirty years later.

In his thesis, Nash (1968) examined two Mississippian sites on the bluffs of the Duck River in west- central Tennessee, the Link site (Hs.1) and Slayden site (Hs.6). At these sites, he focused on the small pole to large post transition in Tennessee, during a time when most archaeologists had abandoned the idea of chronologically transitional architectural forms for a universal Mississippian rigid post form. Nash (1968: 40) stated that the houses found at these two sites provide evidence of a transitional form of architecture between small pole and large pole construction techniques, dating around 1400 AD. Baked daub found with the small pole structures indicated that the walls, but not the roof were covered in clay. Evidence for this inference consisted of a lack of daub found on the inside floor, in contrast to large amounts recovered surrounding the outside walls of the structures. There was also no evidence of any wattle and daub used in the roof construction or any indication of a central smoke hole in the roof. Evidence to suggest this is the lack of baked daubed found in the center of the structure.

Most small pole structures of the Link and Slayden sites had either square or rectangular floor plans, a majority of which were constructed in wall trenches. The wall poles were small in diameter and spaced seven to eight inches apart in continuous wall trenches. Nash (1968: 38) argued that the wall poles were bent over and interwoven to form a roof like an inverted basket, the same method that Lewis, Kneberg, and Webb had proposed. Smaller poles were used as horizontal supports for the vertical wall poles, and were placed at regular intervals up the side of each wall. He also presumed that there was probably a narrow door placed in the corner of the structure.

According to Nash, small pole architecture became a thing of the past beginning around the 1400s. The later large log form possessed posts that were twice the diameter as those in the small pole forms and were individually set, with irregular spacing and alignment. Nash argued that the structures at Chucalissa, another Mississippian site in western Tennessee, did not possess a bent interwoven roof, but instead had a large wall plate surmounting the wall posts in order to support roof rafters, yet they possessed no internal roof support posts. Nash (1968: 38) identified a third type of architecture that he believed was intermediate in form between small and large log architecture. This intermediate form had no clear-cut pattern, but was demonstrated by a trend toward increasing wall trench width and post mold size in comparison to the small log form. Nash (1968: 44-45) argued that this transitional form could be found at Chucalissa, Hiwassee Island, the Gray site, the Harmon's Creek site, the Bowan site, the McCarty site, the Hill Farm site, the Lea Farm site, the Cox site, Moundville, the Angel site, Seven Mile Island, and the Ausmus site. Nash did not specify whether the roof was flexed, rigid or a combination of the two, stating that there was insufficient evidence concerning this intermediate form to identify its roof form.

Nash was one of the first southeastern archaeologists to attempt experimental reconstructions of both a flexed and rigid post house (Figure 22, 23). Both forms were constructed without internal roof supports (Nash 1968: 41-42). One can see in the rigid pole house shown in Figure 23, that there is a slight sag on the left side of the roof. This sag would have only become worse with the added weight of thatch, indicating that the span is too large for these rafters without the use of internal supports. However, with the exception of photographs documenting these reconstructions, Nash did not discuss building techniques, type of wood, or depth, diameter and spacing of wall posts in his construction. According to the Chucalissa Museum director Gena Hooton (personal communication), Nash used locust for the wall-roof poles in his flexed pole reconstructions.

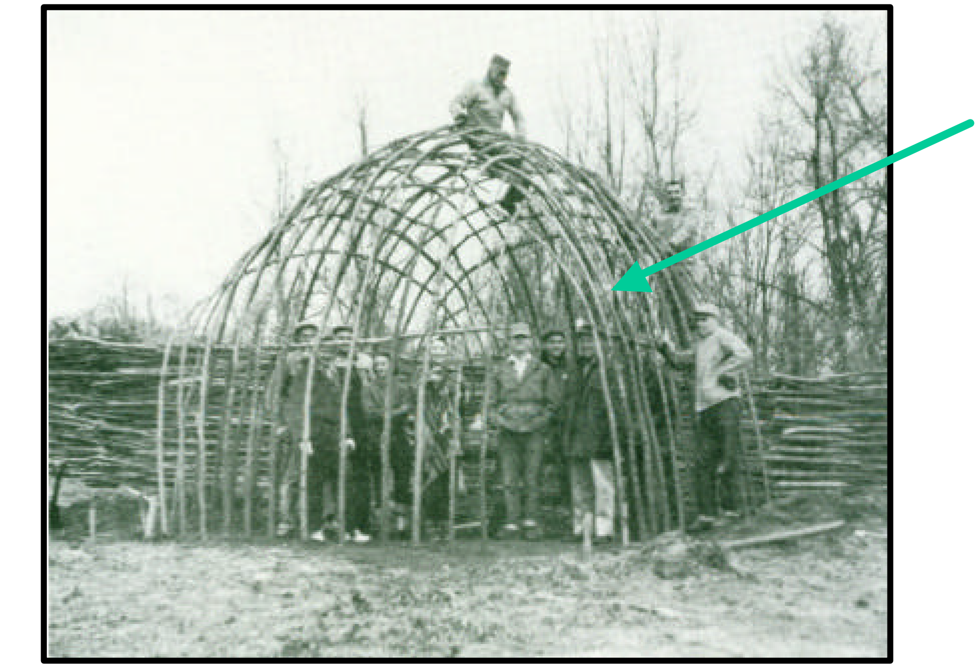
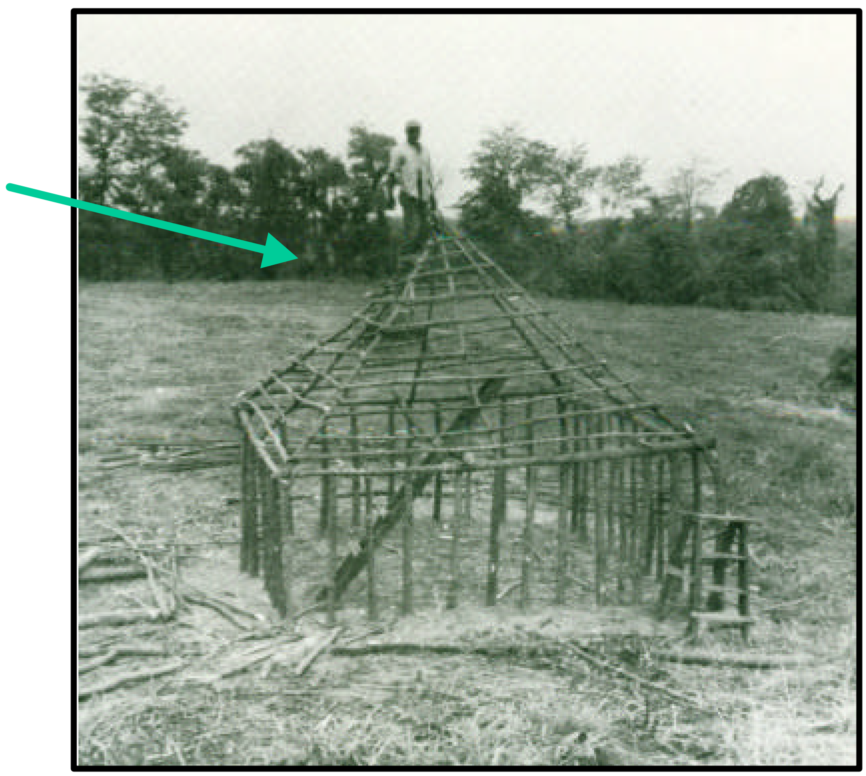


Figure 22. Charles Nash's experimental reconstruction of a flexed pole house. Notice how the horizontal supports are not connected at the corners (Nash 1968: Pl. 2a).



Figures 23. Charles Nash's experimental reconstruction of a rigid post house. Notice the slight sag in the roof, which would become worse with the added weight of the thatch. This indicates that the span is too large for these rafters with out using internal supports (Nash 1968: Pl. 3).

Tradition Two (1944 – present): Small Pole Rigid Post Reconstructions

Through his work at the Angel site in southwestern Indiana, and in contrast to the flexed pole tradition, Glenn A. Black (1944) concluded that small pole, individually set post and wall trench Mississippian structures were probably constructed in a rigid post manner. However, he neglected to account for several similarities between the structures of the Angel site and the early Mississippian structures of Eastern Tennessee. A majority of the Angel site structures, like the Hiwassee Island and Norris Basin structures, were constructed with small wall poles set at close intervals, which were usually placed in wall trenches. These trenches were dug in a variety of manners, some of which had open corners, while others had corners that met or were continuous (Figure 24).

Based on charred structural and other material remains, Black concluded that the structures at the Angel site were constructed with timber, cane, grass, and clay. In proposing an architectural form on the basis of the floor plans and materials, he stated that the wall posts of the small log forms were comparable to the studs of modern houses. Roof rafters were added to the wall plates, which were supported by the wall poles alone in smaller houses. In larger houses, the roof rafters were supported by the wall plate and by a roof plate, which was propped up by four large internal roof supports. The roof was provided with smaller poles running perpendicular to the rafters, which were used to support a grass thatch roof (Figure 25). However it should be noted that the factual basis for Black's idealized architectural model was disentangled from eight superimposed floor plans (Figure 26).

Black also failed to record the depth of the deposits. When on looks at the profile height, relative to the floor plans, it is evident that the only portions of later individually set

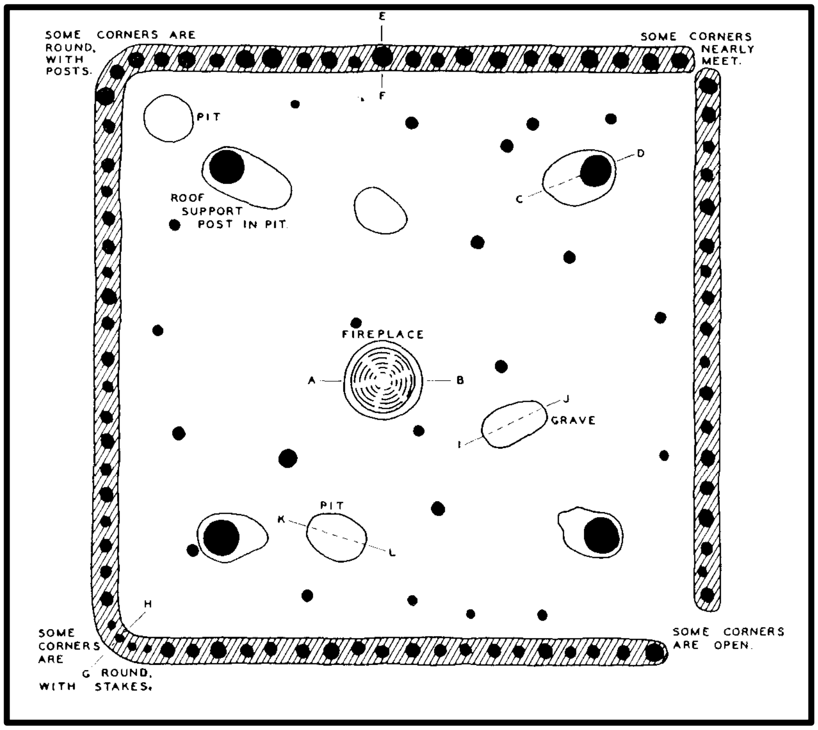


Figure 24. The idealized floor plan Black used to create his architectural reconstruction. Note the varieties of trench connections. Some are open with others meeting or continuous (Black 1944: 489).

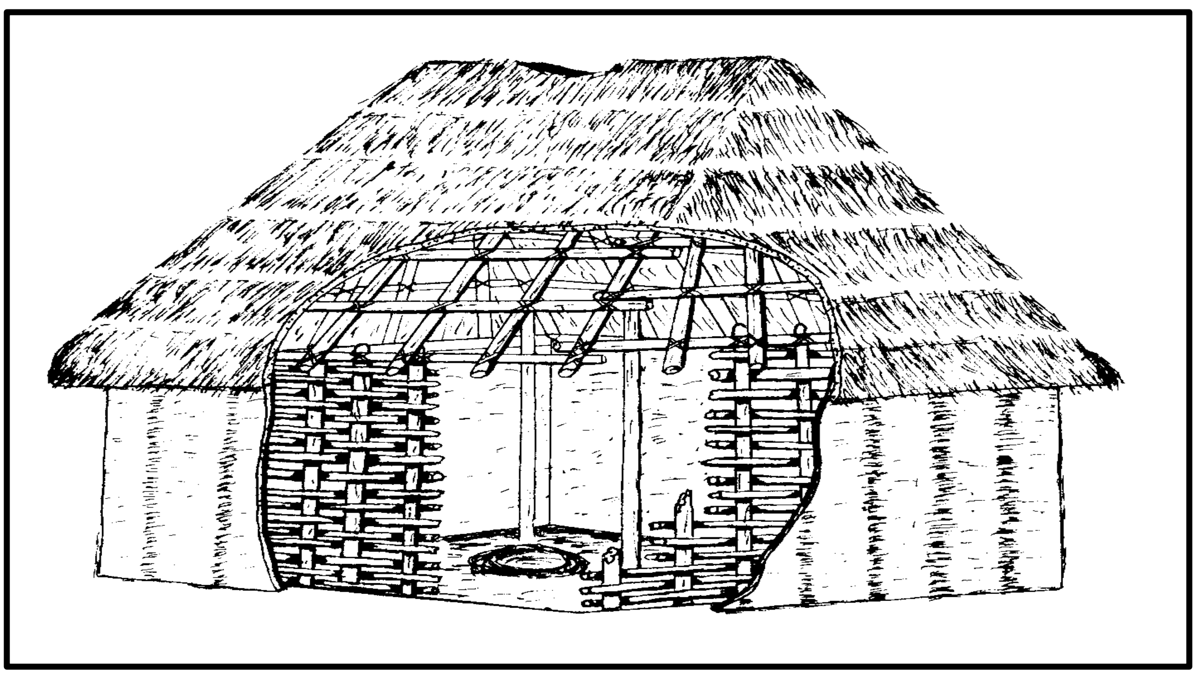


Figure 25. The highly influential cutaway drawing proposed by Black in 1944. This reconstruction possesses small poles in a wall trench and four internal supports to prop up the roof (Black 1944: 485).

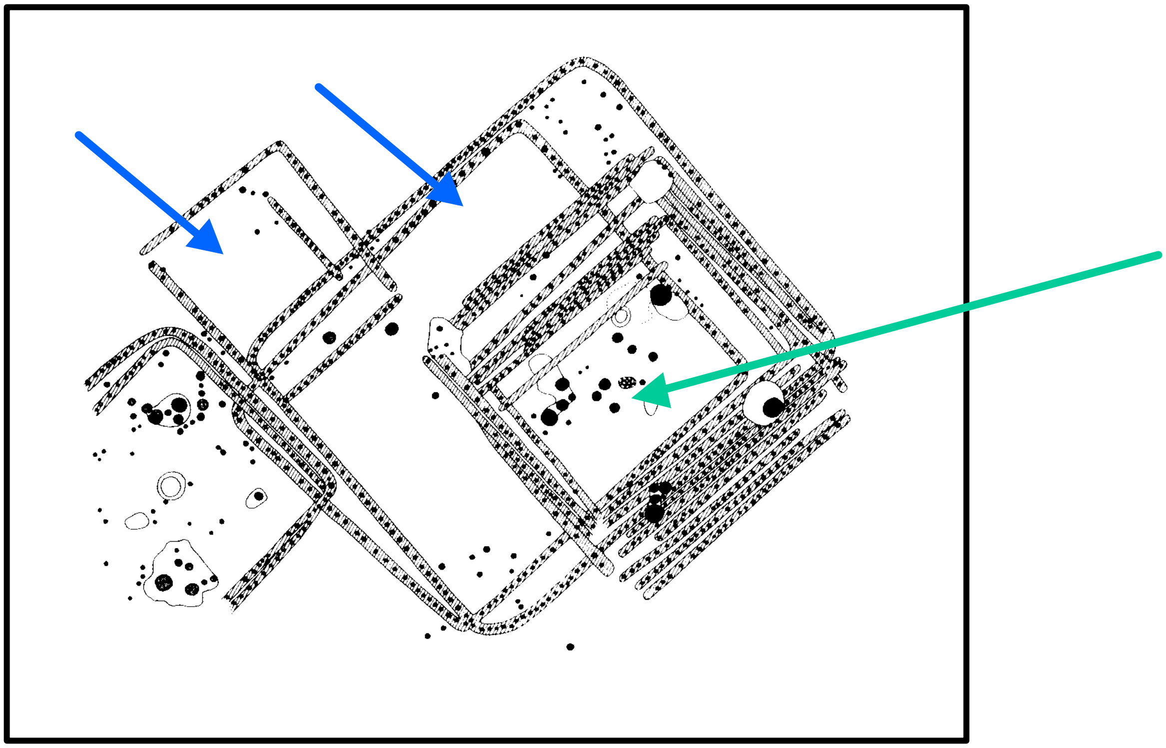


Figure 26. Plan view of eight superimposed structures at the Angel site that mostly predate the structure that Black used to create his model. Notice how both larger and smaller structures in this area do not possess internal roof supports (Black 1944: 491). The green arrow points to the center of the structure selected for Black's idealized floor plan shown in Figure 24. The blue arrows point to both smaller and larger structures that do not possess internal roof supports.

structures to extend into the floor of the excavation are the main roof supports and the occasional wall post. The Angel crew picked up on hearths at the upper levels, but rarely postholes until the "hard pan" or subsoil level was reached. There is the same problem in recognizing the late structures in Nashville Cumberland area.

The impressions from daub fragments indicated to Black that a majority of the houses at the Angel site possessed cane mats placed on the inside and the outside of the dwellings. Concentrations of daub fragments indicated that the structures possessed daubed walls, narrow doors and daubed centrally located smoke holes in the roof. Black presumed that the larger houses possessed four internal roof supports, which were positioned approximately three to four feet from the center of structure. The position of these internal supports was closer to the center of the structures than the position of roof supports in ethnographically documented Mayan houses (Compare Figure 14 to 24).

The highly influential cutaway drawing Black (1944) proposed, depicting a rigid pole, wall trench house was adopted by Martin, Quimby, Collier (1947) and Hoebel (1949) in their general textbooks as the prototypical model of Mississippian housing used in the Southeast. Paul S. Martin, George I. Quimby, and Donald Collier, in discussing middle Mississippian stage structures (1300-1700 AD), stated that these dwellings had rectangular floor plans and were constructed with either a wall trench or with individually set wall posts. The authors briefly acknowledged the variability in the styles of Native American architecture, but stated that most native houses possessed a steeply pitched roof, some of which had large central roof supports. The walls and roof were covered in cane matting, grass, and sometimes clay. Domestic structures ranged from ten to twenty-five feet in diameter, and it was assumed by the authors that the structures did not possess a centrally located smoke hole. The smoke would therefore seep out through the grass roof or the entranceway. Even though variation in house forms was mentioned, the authors only used Black’s (1944: 485) depiction to illustrate the small pole, four internal roof support form as the typical Mississippian house in the Southeast, neglecting to mention the flexed pole reconstructions of Webb, Lewis, Kneberg and DeJarnette.

E. Adamson Hoebel (1949) took Black's (1944: 485) illustration one step further in his text, and used the archaeological reconstruction to represent not only the housing of Native Americans in the Southeast, but the pole and thatch housing of native people throughout the world. By this time Black's depiction had been accepted as the typical Mississippian house for the Southeast by the Chicago Natural History Museum (Hoebel 1949: 120). Hoebel stated that some houses in South Africa were constructed with conical or semi-spherical shaped roofs, but argued that most native dwellings were oblong, gabled structures. According to Hoebel (1949: 120), these huts were most commonly covered in bark, hides, and woven mats.

In 1967, Black published his comprehensive report of the Angel site. The original cutaway depiction that had become so influential by its inclusion in popular textbooks and museums was not included in this later report. In this report, Black (1967: 496) now admitted to the possibility that the structures at the site may have been of a flexed pole form, but still maintained that the structures at the site were probably rigid post dwellings. He used ethnohistoric analogy to illuminate the architecture of these dwellings. In discussing Du Pratz's account of the historic Natchez, Black (1967: 496) stated that the size and materials mentioned by Du Pratz were almost identical to archaeological evidence found at the Angel site. However, he doubted that the poles at Angel were bent inward, as Du Pratz stated (Swanton 1911: 59-60).

In continuing contrast to the tradition of flexed pole ideas, James E. Price (1969) discussed the architecture of the Turner and Snodgrass sites of southeastern Missouri. In discussing two specific domestic structures excavated at these sites (Structure 4 and Structure 8), Price stated Structure 4 was constructed with a wall trench, possessing horizontal wedge supports in the trenches, while Structure 8 was a semi-subterranean individually-set post structure. In both structures, wall poles ranged from 1 ¾ to 2 ½ inches in diameter and were spaced twelve to fourteen inches apart. The design of Structure 8 was a bit unusual in that it was constructed neither in a wall trench nor an individually set post manner, but the wall poles sat on the semi-subterranean structure floor and were positioned between the pit wall and a horizontal log bracing (Figure 27). According to Price, these posts did not protrude into the ground.

Price (1969: 28) stated that the wall trench structure was similar to the structures at the Hiwassee Island site, in that the basal ends were planted in a wall trench with horizontal wedge supports, there was the presence of cane sheathing, and the roof component was a separate architectural unit. According to Price, all house features that were demonstrated at the Turner and Snodgrass sites can be found in the structures at Hiwassee Island. Price's conclusions on the architectural form of these structures are odd in that Lewis and Kneberg explicitly stated that wall trench houses did not possess a separate roof component, and were instead created in a flexed pole fashion. Another interesting detail is that both structures Price examined lacked significant amounts of daub, even though both structures were burnt to the ground.

Price (1969: 7) noted that structural members had their bark removed. He believed that there were two possible reasons for peeling bark, either for ceremonial or practical purposes. In practical terms, peeled wood would resist insects, decay, and weathering better than unpeeled wood. Charred evidence indicated that the walls were covered in cane sheathing and that the supposed wall plates surmounting the top of wall poles were larger than the poles supporting them, and it was the larger wall plate that supported the rafters. Price debated whether the structures possessed a hipped or gabled roof, and decided that was probably a hipped roof as he assumed most Native houses were hipped (Figure 28). He did not even consider the possibility of a dome shaped roof for either of the structures.

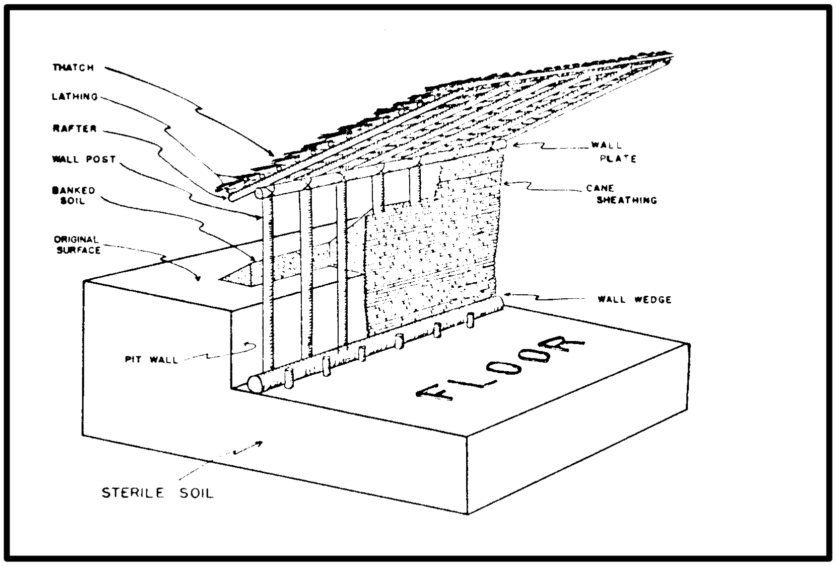


Figure 27. Cutaway drawing of a wall section of Structure 8, a semi-subterranean house in Southeast Missouri by James E. Price. Price inferred that the wall poles in the structure were not planted in the ground (Price 1969: 7).

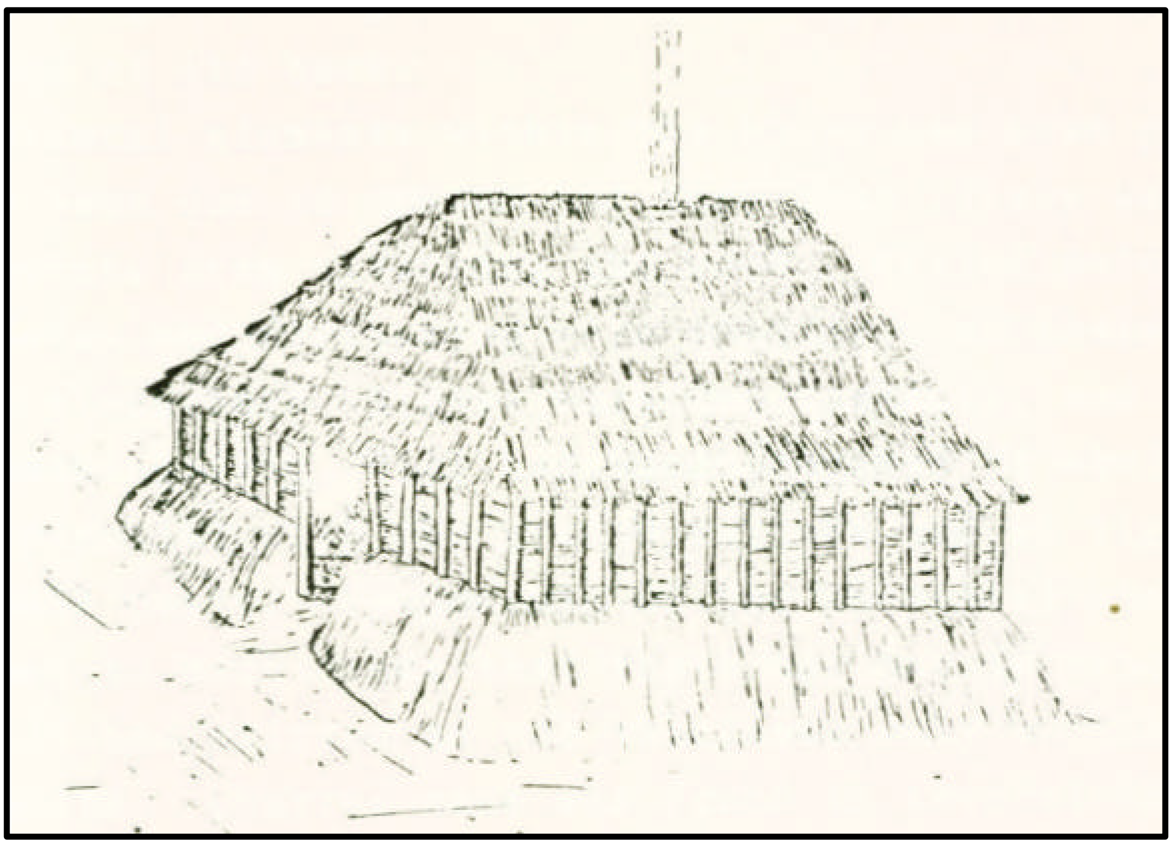


Figure 28. James E. Price's reconstruction of both structures, the semi-subterranean design (Structure 8) and the wall trench and horizontal wedge design (Structure 4) (Price 1969: 8).

In 1971, six full-sized reproduction houses were constructed as exhibits at Moundville, the Mississippian ceremonial center in west-central Alabama. These six structures include a house constructed on Mound B four years earlier. All six of the houses were constructed with tightly-spaced wall posts in a rigid post manner, the walls of which were covered in simulated clay and a separate roof component thatched with grass over a weatherproof tin frame (Figure 29, 30). As David DeJarnette and the University of Alabama had a field project in the Yucatán during 1965 – 1968, information for these reconstructions was collected in the Yucatán by observing modern folk architecture there (Vernon J. Knight Jr., personal communication). The floor plans of these structures do not, however, coincide with the archaeological evidence excavated at the site (McKenzie 1964).

McKenzie (1964) investigated domestic architecture at Moundville, based on Depression-era excavations, and determined that of twenty-two complete houses, twenty-one were constructed using wall trenches with small, closely set poles, while the remaining structure was a larger post, individually set structure. In discussing the wall trenches of the small pole structures, he noted that they were typically v- shaped in profile and approximately 15-25 cm (6 – 10 in) wide at the top. The wall poles were smaller in diameter than the width of trench, and there was no evidence that there were horizontal wedges in the wall trenches. The lone individually set post structure possessed slightly larger post holes that ranged from 30 – 50 cm (12 – 20 in) in diameter.

Based on this evidence, McKenzie stated that the most common domestic floor plan found at Moundville consisted of small pole, closely spaced, wall trench structures that possessed one or more open corners. However, McKenzie did not commit to an opinion of their above-ground appearance. Regardless, the structures erected by the Alabama Museum

Figure 29. The full scale recreation of a rigid post structure on top of Mound B, the so-called "temple mound" at Moundville, constructed in 1967 (Walthall 1977: 44).

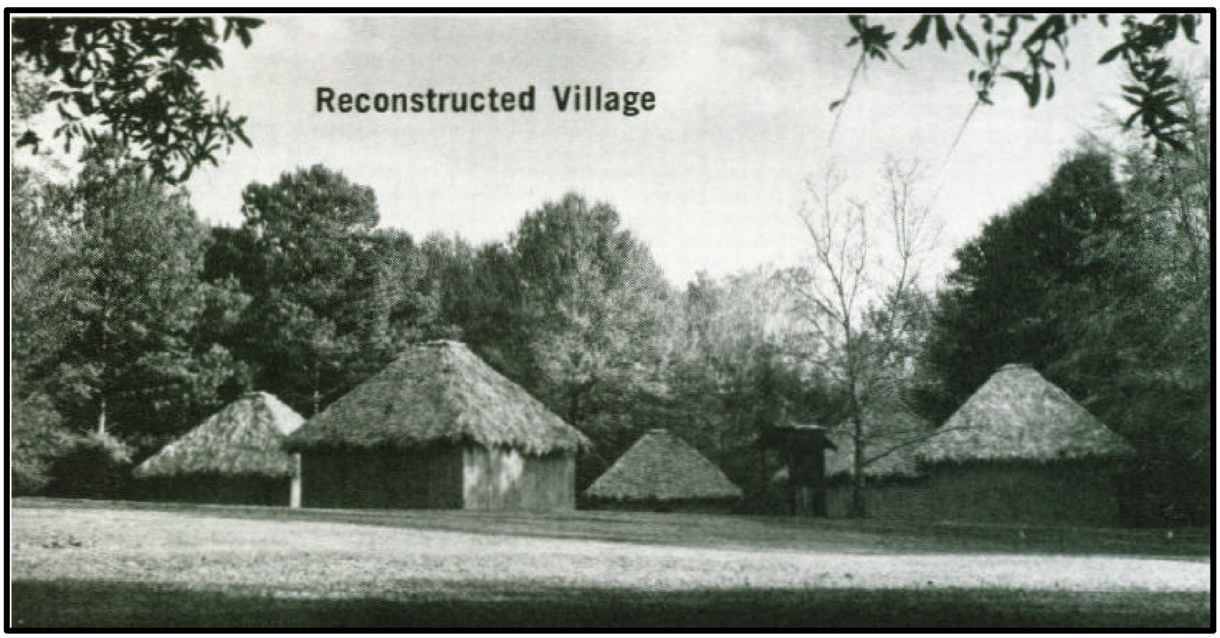


Figure 30. Five full-sized reconstructions of rigid post Mississippian houses at Moundville, created in 1971 (Walthall 1977: 45).

of Natural History were not of a type consistent with wall trenches with open corners and small, closely spaced poles, as reported by McKenzie. Instead the reconstructions were the by now stereotypical large post, hip roof structures, covered in daub and possessing a grass thatched roof but with closely-spaced posts.

John A. Walthall (1977), in a popular publication characterizing the Moundville culture, stated that domestic structures were built with timber, mud, and grass thatch. According to Walthall, domestic houses were typically square to rectangular ranging from ten to thirty feet in diameter. In keeping with the full-scale reconstructions at the site and the dioramas on exhibit in the site museum, he stated the archeological structures involved rigid post techniques, constructed either with individually set posts or with wall trenches. The building materials included cane wattle and clay daub which was placed on the inside and outside of the structure walls. The roof rafters were steeply angled to increase rain runoff, and were fitted with halved cane poles running perpendicular to the rafters. These poles supported layers of grass thatch. Walthall used Black's (1944: 485) Angel site cutaway drawing to depict the typical Mississippian house at Moundville.

McConaughy (1985) examined thirty-nine burned Mississippian structures in Illinois to better understand construction techniques and architectural forms. These structures were typically rectangular wall trench houses, for which McConaughy assumed rigid-post construction and a hipped or gabled roof. However, he acknowledged that there were variations in the architecture of these Mississippian dwellings including a flexed pole wigwam form. He concluded that thirty-five of the thirty-nine structures possessed a separate hipped or gabled roof component with rigid walls constructed in wall trenches (McConaughy 1985: 5). The wattle or horizontal cross members were not intertwined but instead attached on either on the outside or inside of the building. According to McConaughy (1985: 17), gable roofed houses possessed a ridgepole that was supported by two internal supports along the long axis of the house, while hipped roofs could utilize internal roof supports in a number of layouts, mainly four supports near the corners of the structure. However, he believed the absence of these roof supports may indicate a wigwam type house, but that a hipped roof house also could be constructed without roof supports.

A burned dwelling at the Rench site in Illinois, in contrast, indicated a wigwam form of architecture. The walls were constructed with hickory and oak poles, and horizontal beams were tied to support vertical poles using a three-strand braided rope made of basswood fibers. However, McConaughy's reconstruction of a flexed-pole house differed from that of earlier Southeastern archaeologists in that his had two flexed sides and two rigid sides. This architectural form (Figure 31), resembling a military quonset hut, possessed no internal roof supports, but like the small pole structures of Hiwassee Island the larger wall poles were found in the center of the wall trench. This form of house is similar to Algonquin houses, documented historically in Virginia in the paintings of John White (Figure 32). McConaughy believed that it was a possibility that these larger poles held a ridgepole over which the wall members were bent, but this seems unlikely because it was not really necessary.

Based on his inferred ratio of rigid post to flexed-pole wigwam houses in Illinois, McConaughy (1985: 15) stated that most unburned Mississippian structures probably possessed a hipped or gabled roof. He also proposed that Mississippian people built both flexed pole and rigid post structures simultaneously, living in a pitched roof house during the summer and relocating to a flexed pole wigwam in the winter. However, he stated that

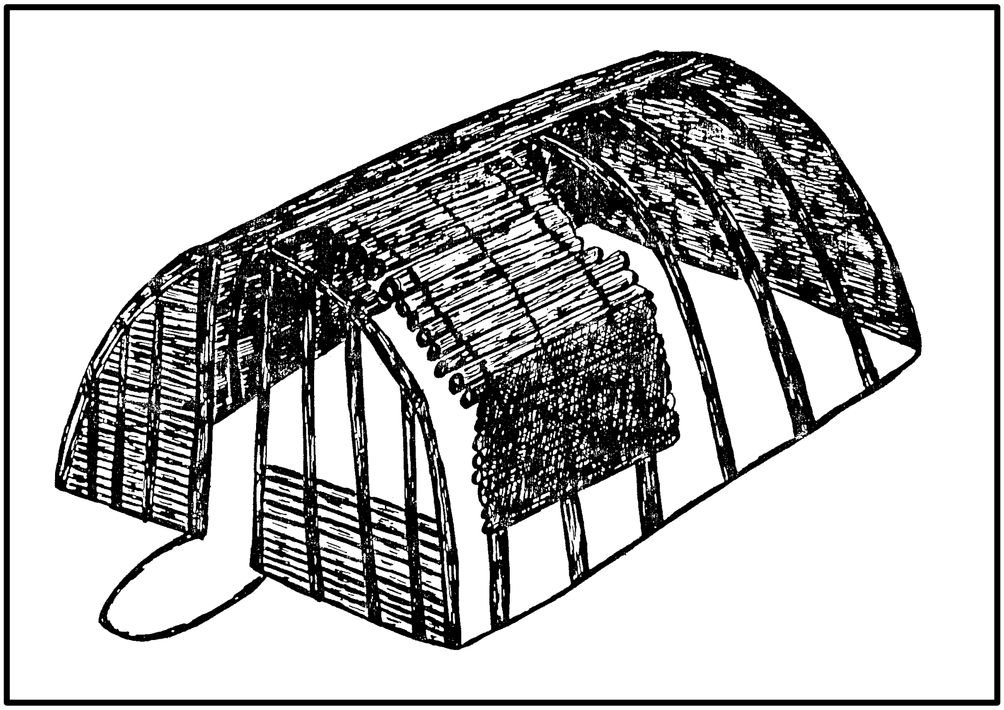


Figure 31. McConaughy's depiction of a flexed pole or wigwam-like Mississippian structure. Note how two opposing sides are flexed and the other two are rigid (McConaughy 1985: 53).

Figure 32. Illustration of an Algonquian village in Virginia (engraving by Théodore de Bry from John White's watercolor painting, 1585).

potential evidence of the flexed pole form, such as burnt curved poles, were unexpectedly found in structures he assumed to possess a hipped or gabled roof. McConaughy (1985: 17) therefore reasoned that the few houses he classified as flexed pole might have been instead hipped or gabled roof structures. He felt that more reliable evidence was based on the presence and location of internal roof supports. Large poles that were located internally along the long axis or in the corners would indicate hipped or gabled-roof architecture. A lack of corners and internal roof supports would indicate the possibility of a wigwam form.

Reconstructions of small pole wall trench structures in the American Bottom of Illinois have been classified by some archaeologists as either flexed pole or rigid pole depending upon whether the structure is in possession of roof support posts. However, most archaeologists of this region rarely consider the flexed pole form as a possibility, because wall trench structures with or without central support posts are assumed to have had a hipped or gabled roof, even if these supports were not strategically located within the structure. In many cases the central roof support consists of only one post, which does not appear to be centrally located (Figure 33). Previous discussion in this thesis has shown in the ethnographic analogies of African architecture, variants of the flexed pole form can be constructed with up to two internal roof supports. It is likely that the post molds that are being referred as internal roof supports in the American Bottom excavations may actually be remnants of a scaffolding system during construction and removed after the building process or perhaps these posts were simply internal partitions, furniture, or merely unrelated posts. In several cases at Toqua (40MR6) and Carden Farms (40AN44), where structure floors were intact, centrally placed post holes were located beneath the hearth, indicating a removal prior to the completion or use of the structure indicating the use of a scaffolding system. If the

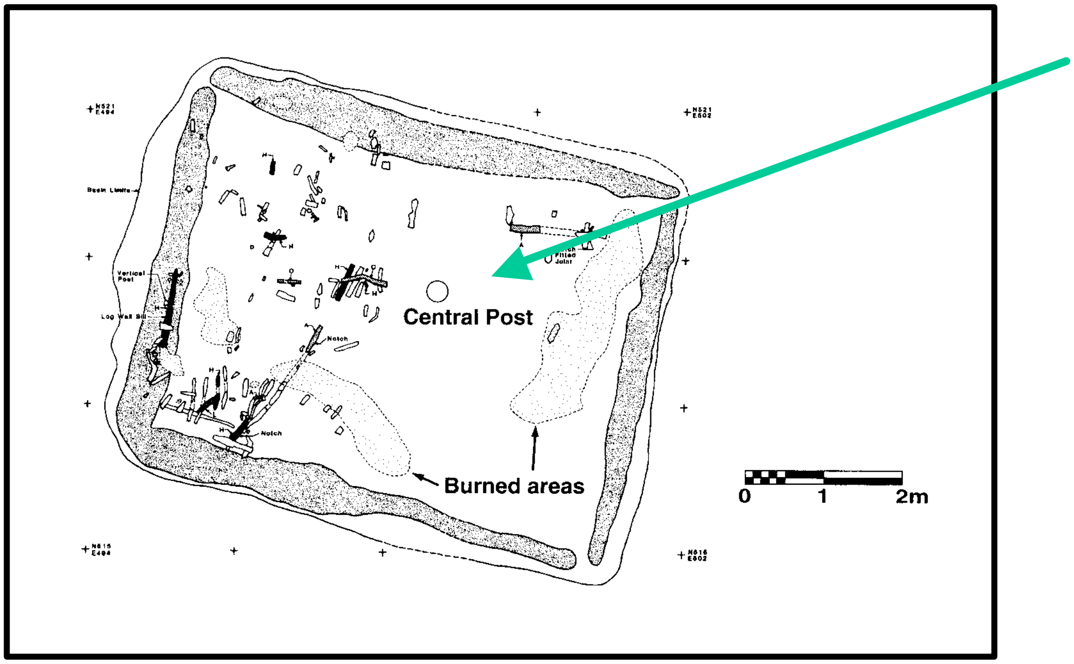


Figure 33. A typical example of a wall trench house located at the Lawrence Primas site in the American Bottom, that has been assumed to be a rigid post house based solely on an internal support post placed oddly off - center for an effective roof component (Simon 2001: 283).

hearth was truncated by plowing or disturbances, the post pattern would appear to be a single roof support (Polhemus 1987).

Mary L. Simon (2002) follows in this rigid post interpretive tradition. In her study, she examined the ethnobotanical remains of building materials of structures in the American Bottom. Of the twenty-seven burnt wall trench structures excavated in the American Bottom, she believed that only one was constructed in flexed pole manner. Criteria were not given in her report and were presumably based upon conceptions of other American Bottom archaeologists, whose notions usually can be traced directly back to McConaughy's (1985) publication. The other twenty-six structures Simon examined were claimed to be like Black's model – small pole, closely set, wall trench rigid post structures with separate roof components. Simon concluded that the most common woods used for construction were white oak and hickory. There was also evidence of cane, red oak, and several other wood types.

Return to Tradition One (1984 – present): Later Flexed Pole Reconstructions

A return to the flexed pole interpretive tradition is exemplified in the research of Dennis S. Blanton, Richard R. Polhemus, and Nelson A. Reed. Blanton (1984) revived and tested the architectural conclusions of Lewis and Kneberg (1946), by constructing a full sized replica of a rectangular flexed pole domestic structure at the Etowah site in Northwest, Georgia, using mostly hickory poles but also a few poles of oak, popular, maple, hornbeam and cedar, with clay daub, and a poplar bark roof (Figure 34). Modeled after Structure 4 located beneath Mound C, the experimental building possessed horizontal wedges in the wall trenches on both the interior and exterior side of the wall poles as well as three sets of horizontal supports lashed above ground on the wall poles. Blanton (1984: 66) noted several problems, one of which was with using clay on a flexed pole house because there were no eaves produced by the roof overhang; therefore the daubed clay walls would have needed frequent repair. Walls slanting inward from lack of horizontal support were also a problem, causing clay walls on the interior to collapse. He also discussed his failure in attempting to use pine poles, in which a majority of the poles snapped under the stress. Blanton (1984: 74) concluded that the design of the interwoven framework proposed by Lewis and Kneberg (1946) was not only feasible but was also a structural efficient method of house construction.

Polhemus (1985) examined the Mississippian structures at the Toqua site in Tennessee, where he encountered the same chronological transition of small pole to large post structures

Figure 34. A flexed pole reconstruction by Dennis Blanton in 1981 at the Etowah site. Note how there are piles of clay eroding off and accumulating on the sides (Kane and Keeton 1994: 113).

as did Lewis, Kneberg, Nash, and Webb. Yet he also noted four minor transitions of small pole structures that preceded the transition to rigid post domestic architecture. Polhemus (1985: 138) concluded that the initial structures at the site were constructed with continuous wall trenches, meaning that the trenches met at the corners, followed by a phase of individually set poles. This phase was succeeded by structures built with discontinuous open corner wall trenches, which was followed in turn by another phase of individually set pole structures before the final transition to rigid large post housing around 1250-1350 A.D.

Polhemus concluded that structures with small poles (wall trench or individually set), that had few to no roof supports, were created in the flexed pole manner described in ethnohistoric accounts. In contrast, the succeeding larger post structures had specifically designed central roof supports.

Reed (ND) has indicated that among archaeologists and historians there seems to be a resistance to the idea of a flexed wigwam-like structure for Mississippian societies, "as if there is a cultural preference for a European style house" (Reed ND: 16). In a brief unpublished paper on Mississippian houses, Reed documented the probability of the flexed pole form through ethnohistoric and ethnographic evidence, as well as structural engineering and wood science technology. His results suggested that open-cornered wall trench floor plans are an indication of flexed pole architecture among the numerous Mississippian houses found in the American Bottom and in the Illinois River Valley. He concluded that the flexed-pole technique takes advantage of the structural integrity of the dome shape and allows for the use of smaller diameter framing members carried over greater distances with the minimal amount of material and labor.

Discussion

In summing up the first tradition, early reconstructions strongly favored a flexed pole form for small pole domestic Mississippian structures in the Southeast. This work also advocates that this initial view of Mississippian small pole wall trench structures as correct. In comparing archaeological evidence to ethnohistorical analogies, it seems that Speck's (1909) description of Yuchi flexed pole architecture, although not a firsthand account, is a more appropriate ethnohistoric analogy in terms of goodness of fit than some of the other flexed pole analogies available. Lewis and Kneberg (1946) acknowledge the difference in form of Du Pratz's account of the Natchez structures in the Mississippi Valley, in which the largest poles were planted in the corners. Du Pratz also failed to mention the digging of wall trenches. Yet, when the temple mound actually witnessed by Du Pratz was excavated, it revealed that all summit structures in the mound possessed a wall trench open corner design (Neitzel 1965). Even before this information was published, Lewis and Kneberg (1946: 52) doubted the validity of Du Pratz's account because having the largest pole on the ends as stated in the ethnohistorical account would make bending very difficult, not to mention the fact that Du Pratz indicated that the corner poles were bent in a diagonal direction. Lewis and Kneberg (1946) believed that not only would this form present a different floor plan with large poles at the corners, but the stress created by bending members in a diagonal direction would defeat the purpose of the wall trench and horizontal wedge supports. These features function to resist perpendicular, inward bending of wall poles in relation to the wall trenches not diagonal stress (Lewis and Kneberg 1946: 52).

Considering the information from Neitzel's (1965) excavations, it seems that Du Pratz's account probably refers to a minor variant that used diagonally crossing corner poles only to establish the height and pitch of the roof as a guide for the subsequent wall poles, which were bent perpendicular to the wall line, not diagonally. Even though Du Pratz failed to mention wall trenches, it is argued that the use of wall trenches is a logical way to plant several rows of numerous wall poles. Neitzel's (1965: 66) report on the Natchez Fatherland site revealed that most excavated Natchez buildings were open cornered wall trench designs, and therefore probably used methods similar that which Lewis and Kneberg (1946) proposed. However, the idea of diagonally crossing members to establish the height of the roof is not without archaeological equivalents, as wall trench structures with four large corner posts have been excavated, such as the one at the Eveland site in Southern Illinois (Greenman and Bosen 1967: 140) (Figure 35). Reed (ND) argues that this particular floor plan represents a flexed pole house, whereas McConaughy (1985) states that the same floor plan is a rigid post structure. Personally, I believe that it is indeed a flexed pole house built with four larger corner posts used in the manner indicated by Du Pratz, but possessing wall trenches because the wall poles are bent in a perpendicular manner rather in a diagonal one.

The documented variation also demonstrates that the general flexed pole form, specifically the basket-type assembly, was variable in its architectural details. Not only could these houses be constructed with or without horizontal trench wedges, but they also could be constructed with or without wall trenches. In the Natchez case, diagonal poles were perhaps used as a shape template for subsequent perpendicular poles. The size of poles and their spacing was also variable in a flexed pole assembly. Most post holes nonetheless ranged from less than three to no more than four inches in diameter, and were spaced at intervals ranging from four to twelve inches apart. One thing that should hold true for all flexed pole structures is that they were constructed using narrow poles spaced at small intervals, especially in comparison to rigid post, large-log architecture.

It is important to note that some researchers confuse or unclear about which it is they are dealing with when it comes to difference between post holes and post molds. Posts and post molds provide a more explicit indicator of structural data, while post holes vary much more for a given purpose as they can be considerable larger than the actual post utilized. A more thorough discussion will be given in the Methods section of Chapter 6, however, this fact is important to keep in mind throughout the rest of this thesis.

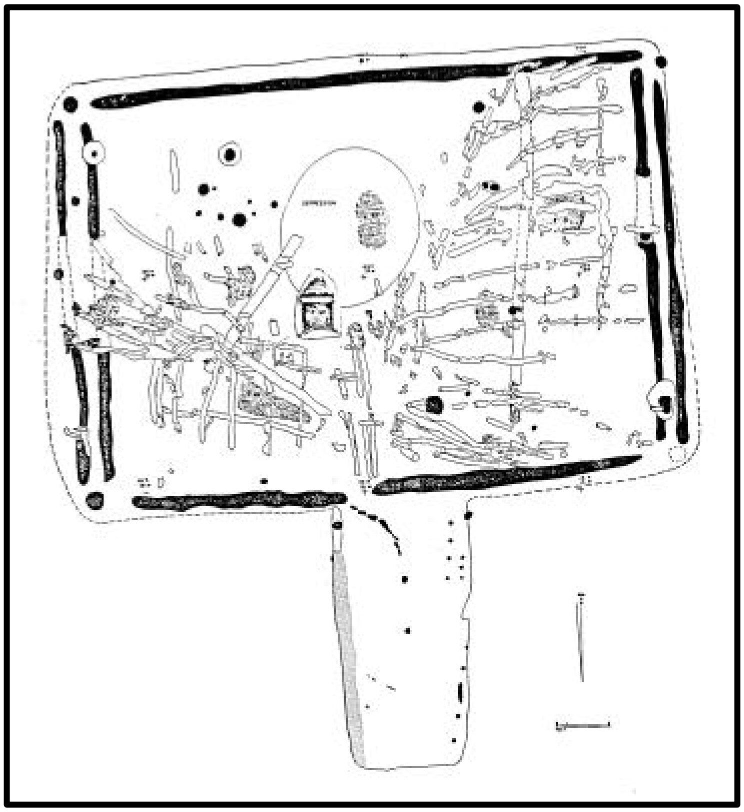


Figure 35. Plan view of the “Charcoal House” at the Eveland site in Southern Illinois. Note the four large corner posts together with the wall trenches (Greenman and Bosen 1967: 140).

In examining the evidence of tradition two, there seems to be several assumptions on which these architectural models were based, which need to be further explored. First, the extraordinary influence of Black's model has no doubt been demonstrated. I believe that it is not accidental that Black’s (1944: 485) model strongly resembles the houses depicted in Wauchope’s (1937) detailed study of Maya architecture, published just prior to Black’s work. Black’s model is extremely similar to Maya wattle and daub houses, right down to details such as the roof pitch and the detail of the interwoven wattle without cane mats (Compare Figure 14 to 25).

Black’s model, perhaps improvised from Wauchope’s Maya houses, was adopted in general textbooks as the stereotypical Mississippian house, and by the Chicago Natural History Museum in its diorama reconstruction of Southeastern dwellings. The model was later adopted by the Alabama Museum of Natural History for the illustration of domestic houses at Moundville (Walthall 1977: 25-26). However, it is important to realize that Black's (1944) architectural model was created from an unusual posthole pattern, the latest in a group of eight superimposed floor plans. Another problem was that in his drawing, he places four central roof supports in an ordinary domestic structure at the site with a floor area only approximately 2.1 m^2 (22 ft^2) (Black 1967: 197), but he stated elsewhere that internal supports occur only in larger houses (Black 1944: 486). This is something of a discrepancy. Clearly, there were several wall trench structures at the Angel site that were much larger but do not possess any internal roof supports.

Perhaps Black's architectural model was based on a rare late transitional form at the Angel site, similar to the transitional form proposed by Nash (1968) as having roof supports and a separate roof component but still preserving the earlier narrow pole wall trench arrangement. The same layout was uncovered by Webb and DeJarnette in the Pickwick Basin, however unlike Black, the authors speculated a flexed roof above a rigid framework. Perhaps, this transitional form never really caught on because of its ineffective nature in terms of material and labor. Another possibility is that there is a small to large log transition at the Angel site and Black’s model is a combination of two chronologically distinctive floor plans, an earlier wall trench design, and a larger rigid post design produced by methods that failed to take into consideration feature depth. Regardless, it seems that the entire tradition formed on the basis on this model lies on shaky ground. It seems that archaeologists adhering to the rigid post concept ignored the practical purposes of key characteristic features of the narrow wall trench house. From examining ethnographic evidence, it is clear that to support a separate roof component, a few large posts strategically placed at corners and weight bearing points were sufficient, rather than using multiple highly redundant small poles holding up a wall plate with no support in the corners. In Maya houses the wall posts placed between weight-bearing members to support horizontal wattle were not planted in the ground, as they were supported at their tops by the wall plates. The question is, why would someone dig a deep wall trench running the entire perimeter of a structure if only a few sturdy posts are necessary to support the roof? Also, placement of horizontal wedges in wall trenches essentially proves that the wall posts were braced against inward failure, not outward failure which was where the stress would have been if a separate roof component was attached to a wall plate.

In the early and middle 1980s there seems to have been a revitalization of Webb, Lewis, Kneberg, and Nash's concepts of Mississippian small pole architecture. Several people, such as Blanton (1984), Polhemus (1985), and Reed (ND) began testing the implications of this architectural form. Certain things were realized about the manner of construction of these houses, including observations on suitable materials and building techniques. However, this return to the thinking of the early flexed pole tradition seems to be geographically isolated to the archaeologists in the Southeast. Conceptions of architectural forms in the American Bottom seem to have never seriously considered the findings of Lewis, Kneberg, and Webb, only those findings of Black. The main difference in interpretation, it seems, has to do with the number and location of internal roof supports. To archaeologists in the Southeast, these internal supports must be located in strategic positions to yield a hipped or gabled roof, whereas the archaeologists of Illinois seem to believe that regardless of the size and spacing of wall poles or even the presence of wall trenches, if the structure possessed any internal support, regardless of its depth or position in the structure, the house must have possessed a hipped or gabled roof.

Chapter 4
Wood Science Technology and Structural Engineering

In order to determine the optimum type and size of wood needed to create a flexed pole wall trench structure, several tests were performed. To execute the tests, it first had to be decided which types of wood to collect. Obviously, the rigid chestnut or sycamore did not need to be tested, but what species did? Second, once the types of wood to be tested had been selected, it needed to be determined what size worked best for the construction of such a dwelling at the chosen size. Properties of wood specimens, which were believed to make the most suitable materials, include uniformity, flexibility, decay resistance, and availability. Principles of structural engineering also were examined to verify the integrity of the flexed pole form as opposed to a rigid post form constructed with small pole technology.

Wood Science Technology

According to ethnobotanical studies, hickory and white oak were the most common wood types associated with small pole, wall trench, and individually set pole structures in the American Bottom (Simon 2002). Other types of materials recovered that may have been used in the construction of the framework include ash, cedar, willow, and red oak. Polhemus (1985) compiled several publications on the characteristics of wood in order to compare the flexibility, decay resistance, strength, splitting quality, uniformity, and availability of different wood types. His sample included, but was not limited to, pine, cedar, ash, white oak, red oak, and hickory. According to his research, the most flexible of these woods included ash, white oak, and hickory. The decay resistance and availability of white oak exceeded that of both hickory and ash. However, the uniformity of white oak and ash were ranked better than hickory, suggesting white oak as perhaps the most suitable for flexed pole constructions.

The U.S. Department of Agriculture (1987) conducted tests on the strength and flexibility of wood as a building material in order to provide information concerning the properties of different species of wood. They also tested several mechanical properties concerning strength and elasticity, such as the modulus of rupture, maximum crushing strength, and so forth. However, there were only three measures that are relevant to the study of flexed pole houses. These are modulus of rupture, modulus of elasticity, and tensile strength perpendicular to the grain. Each of these tests will be described in detail, but first, it should be noted how these measurements were derived and how they should be used.

The pieces used by the U.S. Department of Agriculture (1987) in testing strength and elasticity were 2 x 2 x 24 in. wood pieces, perfectly free of deformities. Obviously, the woods used in the flexed pole construction during the Mississippian stage were not perfectly cut, wood batons. Therefore, the measurements from this study do not directly reflect wood properties of poles collected in the field, but give a relative mean for judging between degrees of strength and flexibility. A second disclaimer in using this type of information is that each individual piece of wood will have a different strength and elasticity based on its specific gravity, moisture conditions, soil conditions, and growing space. The U.S. Department of Agriculture (1987) has attempted to solve this problem by testing each type of wood repeatedly and reporting the mean. Again, these values cannot be used in any direct way, but they can give a good idea of what type of wood could be strong enough to make the necessary bend and still support a roof framework.

Modulus of rupture is a formula used for measuring strength perpendicular to the grain of the wood. In other words, it is an indicator of how much weight a particular type of wood can hold if the piece lies horizontal on two supports with the load or force being applied in the middle. The force or load is applied until the board breaks, and the resulting pressure at breakage is calculated in pounds per square inch (psi). The modulus of elasticity, on the other hand, measures the amount of stiffness in a piece of wood; the maximum amount of load applied until the wood member will bend no farther (U.S. Department of Agriculture 1987). This is a different form of test compared to the modulus of rupture. Modulus of rupture is a moment failure measurement in that when the piece fails, it fails completely under a given load. The modulus of elasticity is an endurance test, as the members do not fail completely in an instance, but instead slowly breaks until complete failure. Wood types that have a high modulus of rupture indicate that they are in a sense stronger, because it takes more weight (a stronger load) in order to break. Wood types that have a high modulus of elasticity are stiffer than woods with a lower modulus of elasticity, and are therefore not as easy to bend.

Tensile strength perpendicular to the grain is another measure, which plays a small but very important part in evaluating suitable wood types for flexed pole construction. In general, the grain of wood runs parallel to the longitudinal axis of the tree. Areas of the tree that have branches or deformities cause the grain to momentarily run perpendicular to the long axis of the tree, creating a natural weak spot in the wood when it is bent. The test for this measurement is similar to that of the modulus of rupture test, where the load is placed on a horizontally supported piece of wood, until the piece breaks. The only difference between the two tests is that the modulus of rupture involves the testing of deformity-free pieces of wood. The wood specimens tested for modulus of rupture did not have had any knots on them, whereas the wood tested for tensile strength perpendicular to the grain did possess knots or deformities (U.S Department of Agriculture 1987). As with modulus of rupture, tensile strength perpendicular to the grain is measured in pounds per square inch.

Two moisture conditions of wood were examined, green and dry. Wood that is "green" is still alive and still has a relatively high moisture content. Green wood was harvested, cut into the proper size, and tested immediately. Dry wood, on the other hand, was heated until a majority of the moisture had evaporated and the member had a moisture content of less than 14 percent of it's relatively weight. According the data of the Department of Agriculture (1987), most of the wood types that are green have a lower modulus of elasticity than they do when they are dry. This means that the wood is easier to bend green than it is after the wood had dried.

All of this information is important to note when examining types of wood for a flexed pole type construction. Poles would have needed to be strong in order to support the roof framework, thatch weight, and recurring live roof loads (for example the weight of thatchers), yet flexible enough to bend into the desired shape. Therefore, when consulting the data, the optimum type of wood would have both a high modulus of rupture and high tensile strength perpendicular to the grain but a low to medium modulus of elasticity. However, these qualities are desired during the bending process when the wood is green, but these same qualities are not the most optimum after the process is complete and the strength of the resulting framework is the remaining issue.

As previously stated a low modulus of elasticity is desirable, but this would probably only apply when green wood is used in the construction process. In contrast, once the wood dries, a higher modulus of rupture and elasticity would be desired. Having wood that has a low modulus of elasticity would be easier to bend, but if that number drops significantly as the wood dries, the structure will slowly become less and less stable. In structural engineering, this process is referred to as “creep,” which is increased deflection over time, causing members to weaken substantially (Breyer et al. 2003: 2.20). Therefore, the wood needed for the construction of a flexed pole building, would need to be flexible when green (low modulus of elasticity), and be stiff (high modulus of elasticity) after it was bent into the desired shape, therefore increasing the structure’s stability. However, high modulus of rupture would be needed in either case, green or dry. Ideally, the rupture strength should be higher when the wood specimen is dry. That way the building, for a brief time, grows stronger with age as the wood dries before decay occurs.

Table 1 is extracted from a table published by the U.S. Department of Agriculture (1987: 4.7-4.15). The species listed here are those that have been identified by ethnohistory, experimental archaeology, or ethnobotany as being species used in small pole construction, as well as being native to west-central Alabama. Examining Table 1, every species listed has an increase in strength and flexibility when the wood is dry compared to when it is green, but to varying degrees. Yet, not every species listed has an increase in tension perpendicular to the grain as the wood dries. For example, while a few species of oaks, as well as Virginia pine, decreases 5-10 percent in their tensile strength, the black locust decreases in strength 17 percent in areas where stress is placed perpendicular to the grain.

Type of Wood	Modulus of Rupture (Strength) *psi*	Modulus of Elasticity (Flexibility) *millions of psi*	Tension Perpendicular to Grain *psi*
	Green / Dry	***Green / Dry***	***Green / Dry***
Ash:	**9500/14550**	**1.42/1.70**	**590/820**
Green	9500/14100	1.40/1.66	590/700
White	9500/15000	1.44/1.74	590/940
Cedar:	**7000/8800**	**.65/.88**	**330/-**
Eastern Red Cedar	7000/8800	.65/.88	330/-
Hickory :	**11075/19400**	**1.53/2.13**	**-**
Mockernut	11100/19200	1.57/2.22	-
Pignut	11700/20100	1.65/2.26	-
Shagbark	11000/20200	1.57/2.16	-
Shellbark	10500/18100	1.34/1.89	-
Locust:	**13800/19400**	**1.85/2.05**	**770/640**
Black	13800/19400	1.85/2.05	770/640
Pine:	**7730/13530**	**1.40/1.75**	**350/440**
Long-leafed	8500/14500	1.59/1.98	330/470
Short-leafed	7400/13100	1.39/1.75	320/470
Virginia	7300/13000	1.22/1.52	400/380
Red Oaks:	**8250/14275**	**1.31/1.78**	**670/725**
Northern	8300/14300	1.35/1.82	750/800
Scarlet	10400/17400	1.48/1.91	700/870
Southern	6900/10900	1.14/1.49	480/510
Willow	7400/14500	1.29/1.90	760/-
White Oaks:	**9475/15460**	**1.39/1.79**	**800/868**
Live	11900/18400	1.58/1.98	-
Overcup	8000/12600	1.15/1.42	730/940
Post	8100/13200	1.09/1.51	790/780
White	9900/17700	1.59/2.05	860/830
Willow:	**4800/7800**	**.79/1.01**	**-**
Black	4800/7800	.79/1.01	-

Table 1. Extracted values for modulus of rupture, modulus of elasticity and tension perpendicular to the grain from the U.S. Department of Agriculture's (1987: 4.7-4.15) survey on the mechanical properties of wood. The numbers listed in bold are the average of the wood species for the genus. Individual species measurements are also given.

Wood types with a small decrease in tension strength around knots would not have made much of a difference after bending, but with an extreme decrease in tensile strength may have caused post-bending breakage. In other words, the tension strength perpendicular to the grain should be strong enough not to break during bending, but if any tension subsequently builds up, perhaps at a less than perfect bend, a pole could snap or crack after the building was framed and thatched. In structural engineering, this process is referred to as "creep rupture," which is increased deflection over time until the member breaks (Breyer et al. 2003: 2.20). However, having high tension strength and high modulus of rupture when the wood is dry as well as green would have a decreased the probability of post-bending breakage.

In terms of modulus of rupture in general, we have black willow as the weakest wood, followed in ascending order by cedars, pines, red oaks, white oaks, and ash, with hickory and locust being the strongest. The strength of the hickories and locust are three times that of the willow. We can simplify these absolute values by dividing the range by three, giving a high, medium, and low range. In so classifying woods based on the modulus of rupture, the intervals would be approximately 3,000 psi between each level. Therefore, wood with a low modulus of rupture would range from 4,800 psi to around 7,800 psi. This category of weak-strength woods would include willow, cedar, and pine. The intermediate woods in terms of strength would range between 7,800 psi and 10,800 psi. This middle level would contain both the red and white oaks as well as ash. The remaining woods hickory and locust, comprise the high-end level and range from 10,800-13,800 psi. It should be noted that these ranges were constructed using the averages of all the species under the border sub-category. For example, pine includes several species. The down side to averaging species is that some woods are stronger than the category in which they are classified. For example, white oaks in general, fall into the higher end of the medium category, but live oak, a form of white oak, actually ranks in the higher end of the distribution of modulus of rupture. Regardless, the woods in the lower end of modulus of rupture are not as strong, and may not be capable of supporting roofers or the weight of the thatch.

The wood used can be too strong, if its rigidity is also reflected in its modulus of elasticity. As stated before, the modulus of elasticity is a measurement of the stiffness of the wood. There is a strong correlation between the strength of the wood and how hard it is to bend. Therefore, a green wood with a slightly lower than average modulus of elasticity, which has a large increase once the wood is dried, would be desirable. This ideal wood would be easy to bend, but would become stronger after it was bent into shape. Wood types that are at the lower end of the modulus of elasticity scale are probably too flexible and would not provide enough support for the weight of thatchers (live or recurring load) or thatch (dead or permanent load). Woods that do not have a high modulus of elasticity are usually not very strong. Powerful winds would be a problem if the wood has a low modulus of elasticity. Strong winds would move members if they were not sufficiently supported by interconnected horizontal supports, which might lead to increased leakage during rains, the lost of thatching, and the possible warping and collapse of the building. However, wood types with a high modulus of elasticity would probably be too difficult to bend during construction. This leaves only the wood types in the intermediate level as acceptable solutions.

Following the same grouping procedure as used before in categorizing the modulus of rupture, the most flexible wood groups consist of cedar and willow which range from .65 to

1.05 millions of psi. The stiffest of the woods consist of the hickories and locusts. These would be the most difficult to bend, with values ranging from 1.52 to 2.26 millions of psi. The remaining wood types that consist of the intermediate level of flexibility include red oaks, white oaks, pine, and ash. This middle group ranges from 1.06 to 1.51 millions of psi.

Species measured for tension perpendicular to the grain were grouped in the same manner as the other measures. The category with the lowest strength perpendicular to the grain include cedars and pines, and probably willows though they were not tested, and range from 320-500 psi. The medium level of strength includes ashes and red oaks that range from 500-680 psi. The higher-level group consists of the locust, whites oaks, and probably the hickories though none were tested, and range from 680 -860 psi.

What does this all mean? First, we know that the species that rank low in any of these three dimensions would probably not have been heavily utilized in the creation of a flexed pole house. Woods such as cedar, willow and pine would not have been ideal. Cedar and willow also probably too weak, while pine seems to be too rigid. Pine is not very strong compared to the white oaks (white oaks are 16 percent stronger than pines), while pine is 3 percent less flexible than the white oak type. Pine seems contrary to everything that one would want in a wood for this type of architecture. The wood best suited would be strong yet flexibility, not weak and rigid as is pine. Blanton (1984) discovered the rigidity of pine in his first attempt at a full scale, flexed pole experimental construction, in which a majority of his pine poles snapped during the bending process. Thus, one can determine through wood science technology that woods such as cedar, willow, and pine might have been used in the construction of a building, but they would not have been the ideal members to use in constructing the flexed external framework. Woods that are ideal based on these measurements would include red oaks, white oaks, ashes, hickories, and locust.

Comparing these five types of wood, each according to its respective variable categories, white oak has the highest psi of any of the woods in terms of its tension perpendicular to the grain, meaning it is less likely to snap at a knot or deformity during bending. Therefore, one can conclude that white oak, although not the strongest of the woods, is indeed stronger around areas of knots and deformities, which would presumably make the selection process easier. Based on modulus of rupture and modulus of elasticity, we seem to be left with two categories, woods that are not as strong but more flexible (ash, red oak and white oak) versus woods that are strong but less flexible (locust and hickory).

In this middle group, ash is 4 percent stronger than the white oaks, but white oaks are 4 percent more flexible. The red oaks, compared to white oaks on the other hand, have 10 percent less strength and are only 4 percent more flexible than white oaks. In needing a strong yet flexible wood, the white oaks compared to the red oaks, have greater strength but are only slightly less flexible, indicating that the white oaks are perhaps slightly better suited for the task at hand. However, red oak would probably still have made a suitable building material. As for ash and the white oaks, there seems to be a direct ratio between their strength and flexibility making them both suitable choices. It is also safe to say that ash and white oak would be more similar to each other in their mechanical properties than of either compared to the red oaks.

Comparing the woods based on modulus of elasticity, we find that the greatest increase from green to dry wood include the white oaks, red oaks, and hickories, while locusts, cedars, ashes and willows have a smaller increase in strength as they dry out. This means that the oaks and hickories have larger ratio of flexibility compared to strength after being flexed and dried. Wood that is stronger after drying provides a more supportive framework that would remain structurally sound longer. Based on the similar mechanical properties of ash and the white oaks, and that white oaks are more common in the flood plains of the Black Warrior, a white oak (*Quercus alba*) was selected to represent the medium strength medium flexibility category for further wood bending tests.

In looking at the stronger woods, hickories and locusts, hickory is more flexible than locust when green and has a greater increase in strength after the wood has been bent and dried. In terms of modulus of rupture, locust is stronger than hickory when they are green, yet of the two, locust is 20 percent stronger than hickory but is 18 percent less flexible, making hickory are more preferred choice for bending of these two wood types. Shagbark hickory (*Carya ovata*) was therefore also selected for bending experiments.

In sum, based on the evidence provided by the U.S. Department of Agriculture, the two most suitable trees for bending in the manner proposed in the flexed pole model include white oaks and hickories. In order to test the values directly and determine an appropriate ideal diameter of wood poles, wood bending experiments were conducted on both groups, white oaks and hickories, in order to determine which of these woods and of what size were the most efficient for bending.

Wood Bending

Two wood types (hickories and white oaks) have been selected that have also been discovered in the archaeological record in burned house remains, and have suitable ratios of strength and flexibility. Both were recorded by ethnohistorical evidence, are indicated in ethnobotanical remains, and are native and relatively abundant in and around the Moundville area. Although ash also would have suitable bending qualities, as it is similar to white oak in its mechanical properties, it is as not abundant in the flood plains of the Black Warrior River and therefore not tested.

Several pieces of both types (white oaks and hickories) were tested. The purpose of these tests was to determine two things. First, in the range of tree diameters, it was important to discover how big was too big to bend. Secondly, it was important to see if there was a difference in the bending qualities between the two varieties of woods. Both species (shagbark and white oak) used in this sample were harvested using modern technologies such as chain saws, axes, and pruning clippers. The circumference of every tree was measured within the first two feet above the ground surface. The diameter was calculated, and if the specimen fit the particular size range needed for the sample, it was cut down within the first foot above the ground surface.

Wood for these tests was collected from three locations. The first location was Moundville Archaeological Park. However, most hickories, with the possible exception the water hickory (*Carya aquatica*), which is not is great abundance, do not grow well in flood plains making it difficult to acquire several good bending pieces. The second location was approximately 16 km (10 miles) upstream from Moundville, near the town of Fosters. This area was also in the flood plain of the Black Warrior River and yielded very few specimens of hickory. White oaks, on the other hand, were abundant in both areas. The third collection area was in the northeast corner of Tuscaloosa County. These lands, owned by the University of Alabama, were oak-hickory-pine forests in the uplands. Here, there were several very suitable oaks such as the live, overcup, and post white oaks, and hickories such as the mockernut, pig-nut, and shagbark.

The trees that were selected to be cut down were chosen based on diameter, length, and uniformity. Diameters at the base ranging from 3.8 – 10.2 cm (1.5 – 4 in) were tested. The range was cut off at four inches because anything larger seemed much too difficult to bend. In terms of length, trees that were judged to be at least 5.5 m (18 ft) or longer were preferred, as that was the minimum length calculated to make an efficient bend for a proposed structure of 4.25 m (14 ft) in diameter with an estimated roof height of 3.2 m (10.5 ft). Uniformity was another criterion on which the wood specimens were judged. Uniformity in a tree specimen meant that it was straight, non-divergent (meaning only one dominant trunk), and possessed few branches. Speaking from personal experience, these types of trees are best found in dense forests in which they have to grow fast and straight in order to compete for sunlight. Such trees would be long, slender, and uniform from rapid growth, making ideal bending members.

Thirty-two pieces of wood were collected, twelve (37.5%) of hickory and twenty (62.5%) of white oak. Based on the 4.25 m (14ft) diameter and the 3.2 m (10.5 ft) height for the proposed structure, a bending system was creating on the ground using 2 x 2 x 24 in. wooden stakes. The trees were fit into the stake frame and bent to replicate a flexed pole member. The wooden stakes were arranged to simulate the fixed conditions that would occur in a house of flexed pole construction. There was one stake placed at the base of the pole to simulate the bottom of the trench floor and to keep the pole from sliding out of the frame when bent and another stake was placed directly beside it on the exterior side to simulate the bottom exterior side of the wall trench. Another stake was placed 46 cm (18 in) up the base of the tree on the side that would have correspond to the exterior of the structure. This stake was used to simulate the top of the trench on the exterior. As there were no wall trench wedges found in association with Moundville houses, no stakes were placed between the stake representing the proposed bottom of the trench and the stakes representing the top of the trench. The next stake was placed on the interior side of the proposed structure, approximately 1.21 m (4 ft) from the stake representing the top of the wall trench. The last stake was placed in the area that would have been above the roof to hold the pole in the bent position (Figure 36). This stake representing the top of the structure was placed approximately 3.2 m (10.5 ft) from the stakes representing the top of the wall trench, and 3.65 m (12 ft) from the bottom of the wall trench.

After the staked frame had been positioned, the collected wood pieces were bent to fit the frame. A Shimano 150 lb. scale was attached in order to measure the pounds of pressure needed to make the bend. The smaller diameter poles were bent by hand. However, if the pole was too large to maneuver by hand, a Maadams Pow'r and Pull two-ton ratchet puller was used. Once the specimen had been bent to the fit the frame, the scale was used to measure three points of stress on the bent wood in three key places, Points A, B, and C, in each case with the other two points fixed in the frame (Figure 36). A nylon rope was attached at each place, followed by the scale and then, if needed, the puller. The tree was pulled just enough until the pressure was released from the supportive stake at each point.

The first point of stress was taken from the stake that represented the top of the roof. The wood specimen was pulled inward at Point A in order to estimate the amount of weight it would take to bend the top part of pole into a suitable flexed position. The second point of stress measured was from the stake that represents the horizontal support. For this measurement the pole was pulled outward at Point B, which measures the amount of inward stress that is placed on the horizontal supports at the wall. The third measurement represents

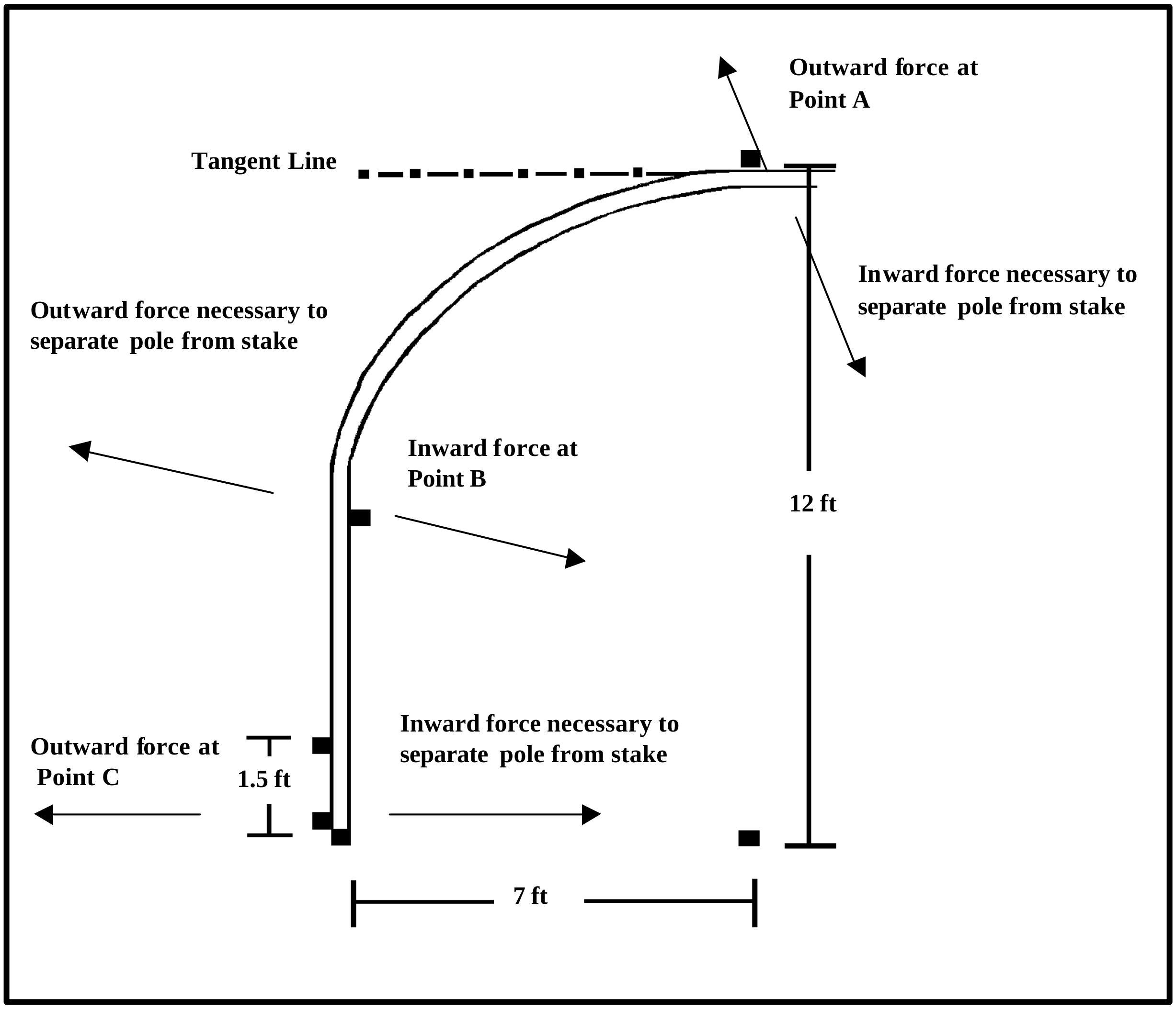


Figure 36. Bending frame for experimental poles showing forces at points A, B, and C.

the amount of outward stress on the bottom of the exterior side of the wall trench. The wood piece was pulled inward from the interior of the proposed structure at point C.

The results of the wood bending experiment indicated several important details. First, by graphing the forces acting on these three points by different sizes of wood, the evidence shows that the largest increase in force occurs in various size ranges corresponding to the point of the bent member. In examining Figure 37, Point A, the amount of weight needed to

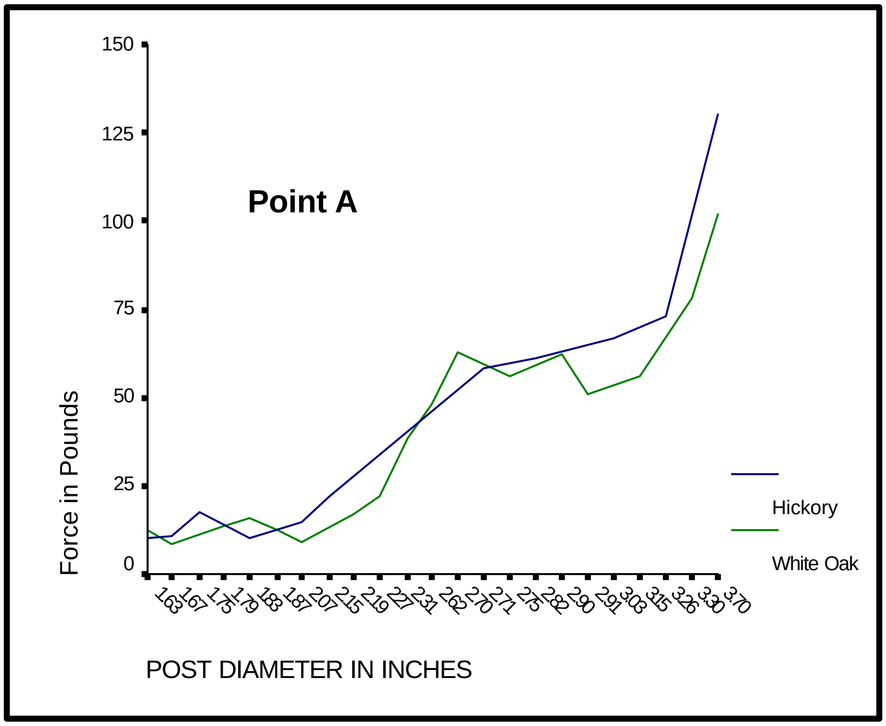


Figure 37. Line graph showing the amount of force necessary in pulling down the top of the pole by post diameter.

bend the wood into this shape seems to have two inflection points, one at about 2 inches and another around 3.25 inches. According to the information given previously in this chapter, a wood that is too easy to bend may not support the weight of the thatch or thatchers. Poles with a diameter of anything less than 5 cm (2 in) only have an individual capacity of roughly 56.7 kg (12.5 lbs) at Point A. If there are fifty poles in the structure, this would only amount to approximately 2,835 kg (625 lbs). As will be demonstrated in Chapter 5, this capacity would not support the weight of the thatch needed to cover the structure, which was estimated at approximately 9,000 kg (2,000 lbs) when the thatch was dry. This would not include the added weight of rain water absorbed by the thatch, or pressure from wind loads or recurring live loads. On the other side of the range, 7.6 cm (3 in) diameter members seem to represent the maximum size that could be bent by hand. In the bending experiments, a diameter larger than 8.3 cm (3.25 in) was extremely difficult to bend and contain inside the staked frame. If the amount of force was calculated, assuming fifty poles in the structures, the capacity could support the weight of the thatch and approximately the weight of six adult males, a capacity probably much larger than what is needed for flexed pole construction. This suggests that suitable diameter wall poles range from 5 – 7 cm (2 – 3 in) in diameter, based on the measurements derived from Point A.

Point B, the point representing the above ground horizontal supports, produced evidence of a much smaller size range. In examining Figure 38, it shows that this point endured more stress than any other point in the bending process. The amount of force that is displaced to the horizontal supports can be calculated based on post diameter. Assuming ten poles per wall, each less than 5 cm (2 in) in diameter, would amount to roughly 1,134 kg (250 lbs), a force that the horizontal support could realistically contain. This fact will be demonstrated in Chapter 5, in that the horizontal supports of the experimental structure easily supported the weight of two adult males (approximately 400 lbs). This measurement is highly estimated as the connections of wall poles to the horizontal support were not calculated. The capacity needed to support the force of 7.6 cm (3 in) diameter (assuming ten poles per wall) is approximated at 5,443 kg (1,200 lbs). This measurement is presumably too large for any reasonably sized horizontal support. It appears that the upper limit for this bend is probably in the 5 – 6.4 cm (2 – 2.5 in) diameter range, as 6.4 cm diameter poles would create an estimated maximum inward pressure of approximately 3,628 kg (800 lbs).

In examining Point C, the outward force exerted on the bottom of the wall trench, the measurements indicated that this force is not nearly as strong as that at Point B, but is

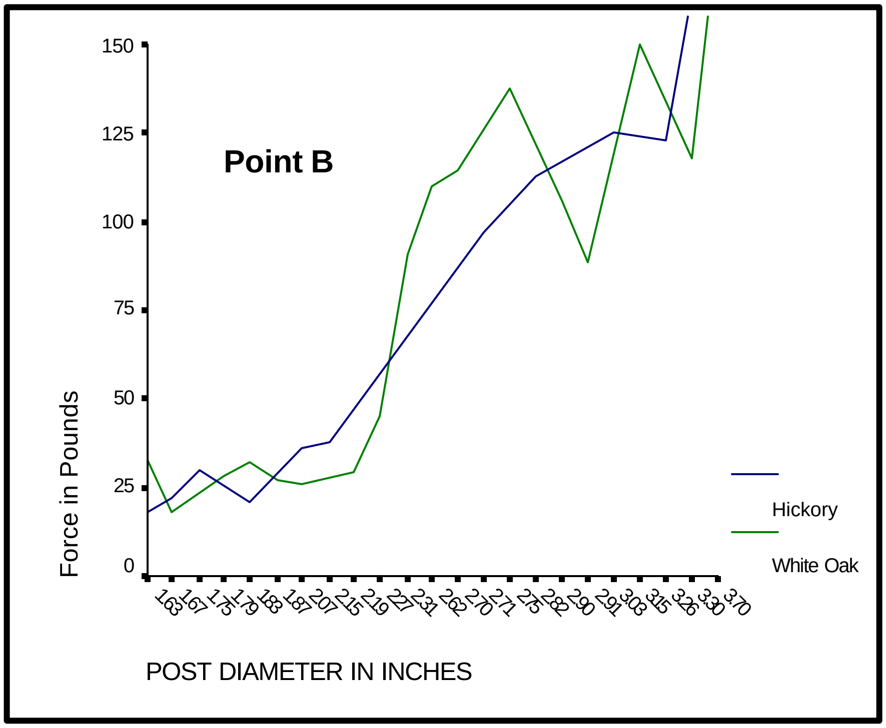


Figure 38. Line graph showing the amount of inward force at the point representing the horizontal wall supports by diameter.

significantly larger than that of Point A (Figure 39). This measurement is an important indicator, as archaeologically examined post molds are not usually slanted inward. This indicates that the size of wall pole being used did not produce enough force to create an impact on the bottom of the post hole, and therefore did not slant inward. The force measured at Point C indicates two inflection points, one at 5 cm (2 in) and another at about 7.2 cm (3 in). However even here, the outward force of 7.2 cm (3 in) wall poles on the outer wall of the wall trench is only 340 kg (75 lbs), pretty negligible as it is pushing against compacted dirt. A post of 6.3 cm (2.5 in) in diameter would push outward at about 50 pounds, which probably would not even leave a dent in the wall trench. However, anything

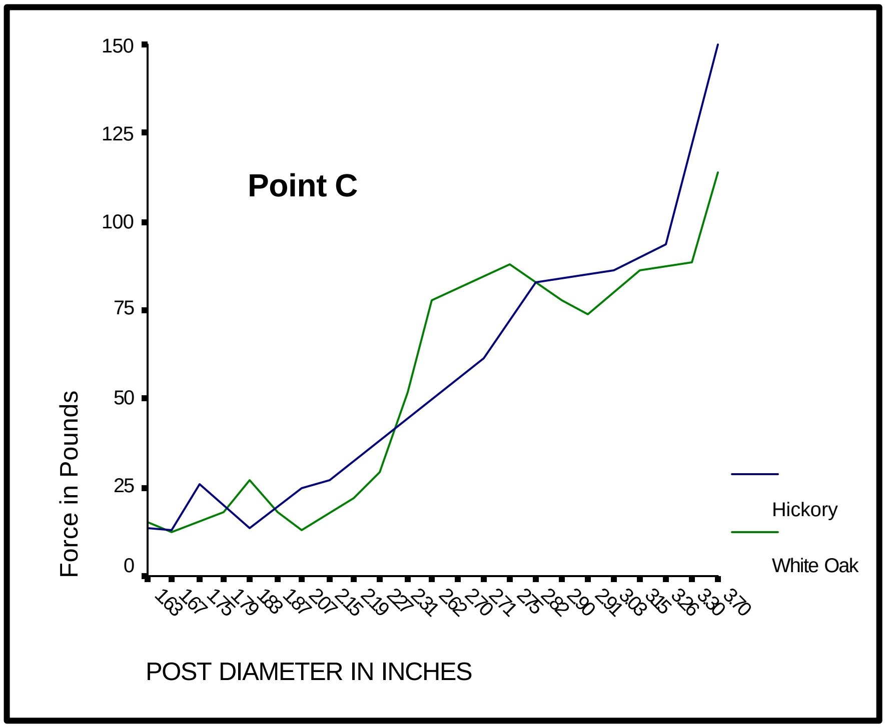


Figure 39. Line graph showing the amount of outward force at the base of the wall trench by post diameter.

over 8.2 cm (3.25 in) in diameter, with a calculated outward force of approximated 453.59 km (100 lbs) might have altered the shape of the post hole.

Structural Engineering

All previous text demonstrated information about bending wood, but what of the design in general as compared to the rigid post design. First, there is a logical argument. That is, why cut down several poles and plant them in a deep wall trench in order to support a wall plate that could much better be supported with a few large posts. Even with vertical posts added to either support wattle for the clay walls or for vertical post covered walls in general, these posts would not need to be weight bearing as they were attached to the above wall plate. So why would one dig a wall trench two feet deep for no purpose?

The interwoven roof frame work of the proposed flexed pole form has several advantages to the rigid pole form with a separate roof component. The interwoven frame work prevents creep or creep rupture from causing complete building failure. If a member breaks from creep, the building will still be well supported as other members would compensate the increased weight added as the result of the broken pole. In structural engineering this is refer to as load sharing. Heaver loads are distributed to stiffer members within the framework (Folz and Foschi 1988). If a separate roof component was supported above several small poles and one broke, then the stress of the roof would causing the building to become unbalanced and therefore lead to complete collapse of the building much quicker than in the broken member of the flexed pole structure. There is a much smaller degree of load sharing in this form, especially since it lacks weight bearing corner poles.

Another advantage to the interwoven network and single architecture component is that the form is more resistant to structural change from shrinking and swelling of the wood. As the wood dries it can change shape. If this were to occur in a flexed pole building the framework of the roof could compensate more than a separate component suspended from several short poles. If wall poles supporting a separate roof were to warp, the roof could bend and cause undue pressures on one wall over the other.

Another argument against a separate roof component placed on several small closely spaced poles is that of lateral force. Due to the load sharing capabilities of the flexed pole house, lateral forces and loads are distributed to wall poles. With a much lesser degree of load sharing, the structures with small closely placed poles supporting a separate roof component and no weight bearing corner poles, would have a high tendency towards vertical swaying due to the weight of the roof. This is important to note as winds in Alabama place the state in a wind region, in which winds can exceed 90 – 100 mph. Accordingly, any modern structure built in Alabama has to take into consideration a strong wind load in the design process (Breyer et al. 2003: C13). Strong wind loads would cause the walls to bend severely especially when placed in a wall trench that provides no support for members moving up and down within the wall trench. Assuming no measures were taken to support them from moving in that direction, one must assume that there was no stress in the architecture to warrant these supports, indicating a flexed architectural form. This assumption is supported in that the wall poles in flexed pole architecture only needs to be supported from inward pressure not outward pressure. There are no stresses in this architecture form to cause wall members to move towards one end of the trench or the other.

Additionally, a separate roof component on small closely spaced poles would cause the poles to lean outward away from the structure (Figure 40). Horizontal trench wedges found in many Mississippian wall trench houses in Eastern Tennessee are arranged in order to receive the exact opposite stress. With horizontal wedge support on the interior side of a wall trench placed higher than a wedge support placed at the based on the exterior side of the trench, indicates that the poles wanted to lean inward not outward (Figure 20). If the small closely spaced wall trench form was indeed true, then the wedge supports would need to be arranged in reverse, with the exterior support being placed higher than the one on the interior side.

In conclusion, it seems that architectural features indicate that these small closely set wall pole houses were probably best constructed in a flexed pole manner. Wood science and structural engineering data also confirm that the flexed pole form is not only structural efficient, but is a better architectural form than that of a small closely set wall pole design with a separate roof component.

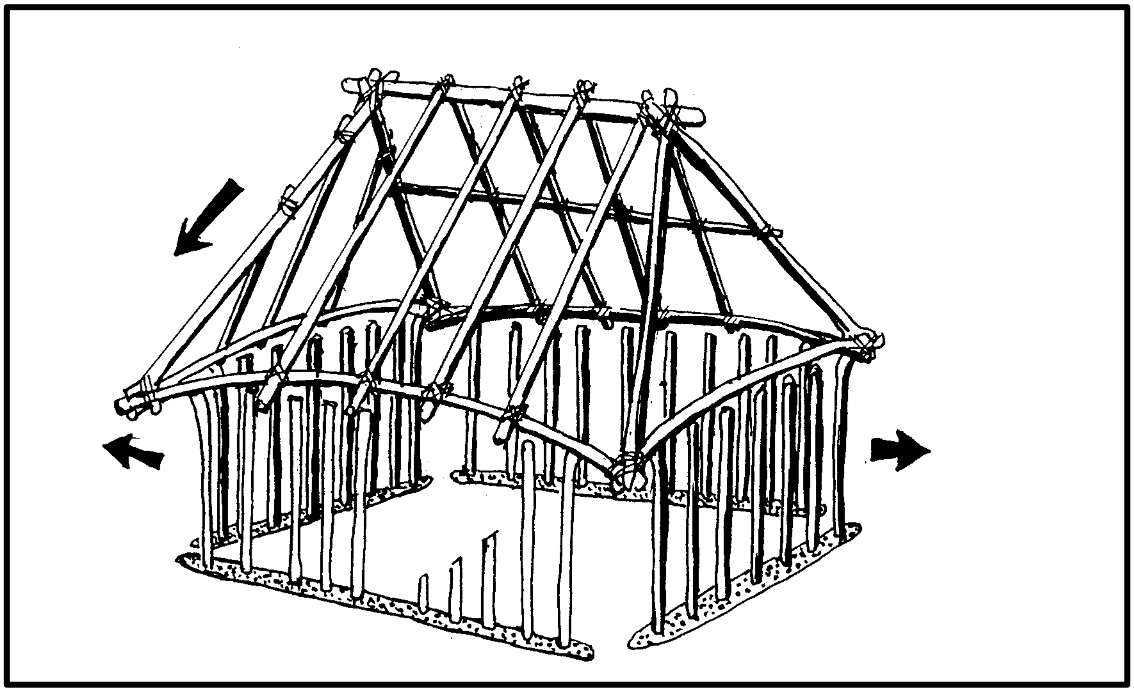


Figure 40. Illustration by Nelson Reed depicting the structural engineering problems encountered if a separate roof component is used on a series of closely placed, small poles. The arrows represent the direction in which the stress is distributed. (Reed ND: 23).

Chapter 5
The Experimental Construction

Experimental Archaeology

In the last few decades, there has been a rapid escalation in the field of experimental archaeology. Archaeology in general is concerned with the systematic inquiry of the relationships involving human behavior and its material remains. Therefore, the goal of archaeology is to explain human behavior of the past. Archaeology is unlike other social science disciplines in the sense that archaeologists cannot examine their population of study directly. Instead, they must make inferences about the population through the examination of archaeological data. Experimental archaeology is, then, one of many methods that can be utilized in order to study and systematically test inferences about past human behavior.

More specifically, Coles (1973, 1979) defines experimental archaeology as a field that attempts to understand what ancient humans were doing, as well as, the methods and reasons behind their processes. The practice of experimental archaeology is not only the study of the replication of an artifact, but a test of the methods and the techniques of its production. By reconstructing material culture such as houses, palisades, and villages, the archaeologist can better appreciate the scale of the ancient enterprise and the organization of labor that was required. It is with these ideas in mind that I proceeded to build a domestic small pole, wall trench structure.

Experimental Flexed Pole Construction

To enhance the understanding of the materials and construction techniques of flexed pole architecture, as well as to demonstrate that such a design is structurally plausible, I created a structure of the flexed pole form. The experimental house was erected at Moundville Archaeological Park along the river bank of the Black Warrior River in a previously excavated area. The floor plan of the proposed structure was based on Structure 4 of the Picnic Area (PA) tract excavations on the Northwest Riverbank area of the site (Scarry 1995, 1998) (Figure 41). Because Structure 4 was not burned, the number, size and spacing of its posts were indeterminable. The only discernible features of the floor plan were the wall trenches and the floor dimensions. Therefore, the spacing and size of the wall poles was loosely adopted from archaeological evidence of other, similar structures.

To begin the construction, the position of the wall trenches were outlined on the ground using nails and string, with the walls orientated in the cardinal directions. Like Structure 4, the wall trenches were laid out in a rectangular pattern, with the east and west walls measuring 4.25 m (14 ft) and the north and south walls measuring 4 m (13.1 feet) in length for a total roofed area of 17 m^2 (183.4 ft^2). Each wall trench measured 15 – 20 cm (6 – 8 in) wide and was dug to a depth of approximately 45 – 60 cm (18 – 24 in) (Figure 42). Determining archaeologically the depth of post holes and wall trenches can be slightly tricky. In excavations where the area to be excavated has been plowed, the plow zone is removed before the excavation of architectural features begins. Thus the depth of the post holes and wall trenches recorded in many publications only gives the depth below plow zone. Therefore to estimate an actual depth, the plow zone thickness has to be added to the depth of the post holes below the plow zone. In the Northwest Riverbank excavations at Moundville,

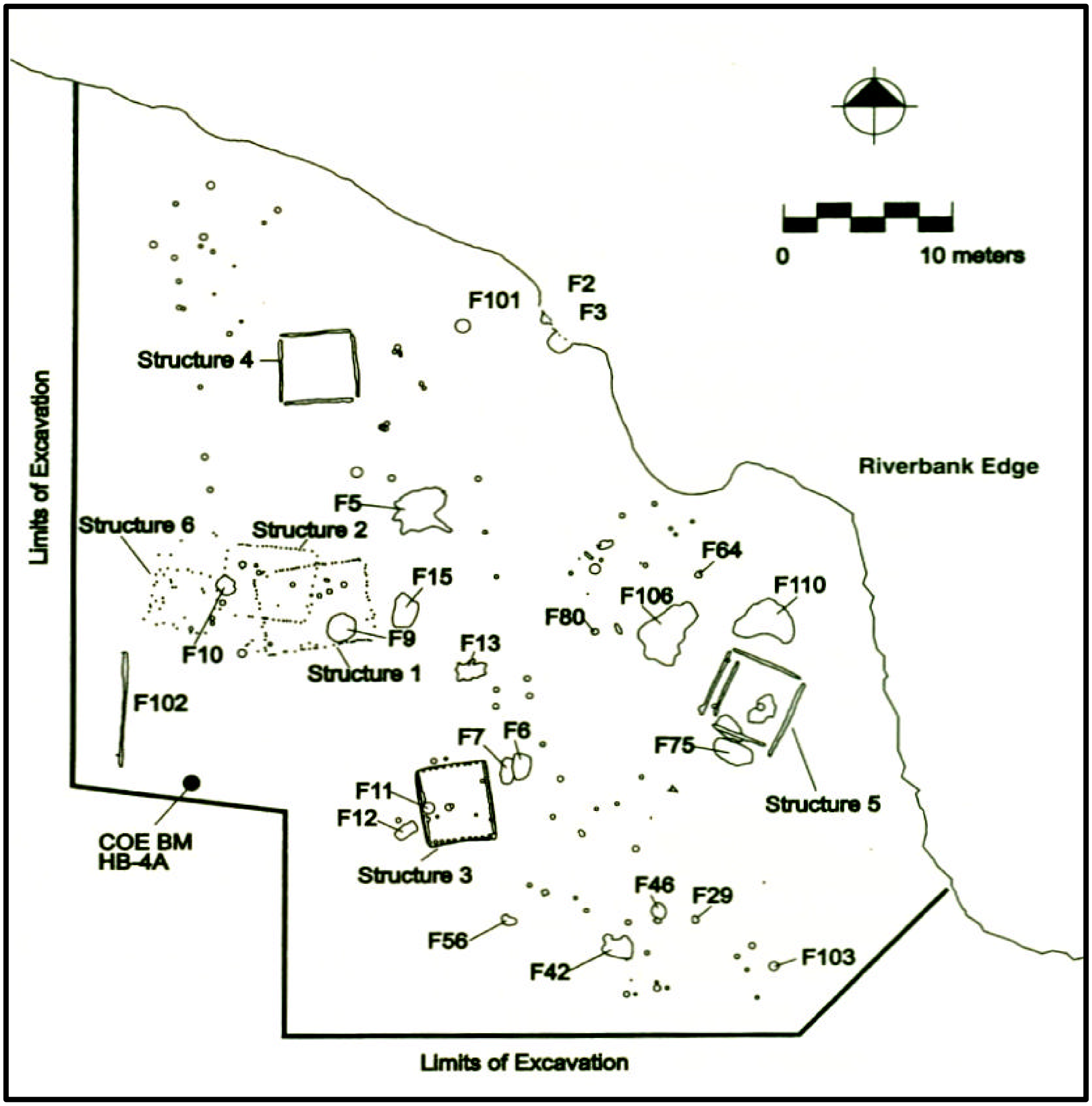


Figure 41. Plan view of the PA tract excavations, Northwest Riverbank area, Moundville site. Six structures were excavated; three single-set structures (Structures 1, 2, & 6), one semi-subterranean structure (Structure 3) and two wall trench structures (Structures 4 & 5) (Scarry 1995: 106). Structure 4 was the model for this experimental project.

Figure 42. The wall trenches of the experimental structure.

the depth of the wall trenches was approximately 25 – 35 cm (10 – 14 in) beneath the plow zone. In determining the depth of the wall poles and wall trenches from the ground surface, 20 – 25 cm (8 – 12 in) was estimated for the plow zone yielding a total of 45 – 60 cm (18 – 24 in). To dig the wall trenches, small and large pick axes were used.

After the trenches were complete, a search was made for trees that were suitable for the project. As stated in Chapter 4, the tree species that could be bent in this manner include hickory, ash, and white oak. Because Moundville is in the flood plain of the Black Warrior River, hickory and ash were not as abundant as was white oak. White oak (*Quercus alba*) was therefore chosen for this project. All of the oak came from the forest surrounding the Moundville site.

The wood was selected based on the diameter, height, and uniformity of each of the saplings. According to archaeological evidence, the poles that were used in wall trench house constructions were approximately 5.0 – 7.5 cm (2 – 3 in) in diameter. The structural engineering data produced evidence suggesting that poles ranging between 5.0 – 6.5 cm (2 – 2.5 in) in diameter were suitable for the amount of weight or "load" needed to bend each pole. These data also indicated that to produce a roof height of 3.2 m (10.5 ft) with an adequate "pitch" or slope, the poles would need to be at least 5.5 m (18 ft) in length. Therefore, to build a structure in the manner proposed, wood that was uniform and straight with few branches was needed. The examination of potential poles for deformities is an important procedure in building any structure. As the poles being used for the project were especially small, this step was extremely important. Small deformities or characteristics such as knots, splits, and checks in a small piece of wood can produce a devastating effect. The larger the member is, the larger the deformities can be before the piece will fail under loading pressure. As a result, all wood selected as wall poles for this project were 5.0 – 6.5 cm (2 – 2.5 in) in diameter, at least 5.5 m (18 ft) long, straight, and in possession of as few deformities as possible.

The wood was harvested and planted in the wall trenches on the same day; doing so with haste results in a more pliable wood, as indicated by the wood technology data explained in Chapter 4. Each pole was collected using a chain saw, and was stripped of branches in the field before being transported back to the construction site. The amount of time required to cut down the trees for house construction using traditional tools has been well documented by several archaeologists (Callahan 1981, 1985; Blanton 1984). Hence, it was not considered necessary for us to calculate the amount of time that was invested to harvest the materials. Once the poles were transported back to the construction site, they were placed into the trench with the shorter and thinner poles being placed closer to the corners and the larger and thicker poles being placed in the middle (Figure 43). The reasoning was that the poles closer to the corners had to bend farther than the ones in the middle. To bend a member farther, the specimen would need to be more flexible, and thinner poles have the extra flexibility required to make such a bend. However, the wood planted on the ends of the trenches did not need to be as long, because the overall arch of the bend was shorter than the bend for the other members. Archaeological evidence that supports this logic has been located in the well-preserved foundations of structures at Hiwassee Island (Lewis and Kneberg 1946: 51-52)

The poles were spaced approximately 20 – 30 cm (8 – 12 in) apart in the wall trenches. A tape measure was not used; instead the length of a person's foot which equaled approximately 25 cm (10 in) was used to gauge the proper distance. Eleven poles were used

Figure 43. The poles after the dirt had been packed back into the wall trench. The larger diameter poles are in the center of the trench.

on the longer sides and ten poles on the shorter sides. Spaces for two doors were left on the northwest and southwest corners. In creating the door, the wall trench was not altered in any way, except that a set of poles on the north and south walls were left out. The spaces left for the doors were roughly 0.6 m (2 ft) wide.

After the dirt was replaced and packed down into the trenches, horizontal supports of white oak approximately 7.5 – 10.0 cm (3 – 4 in) in diameter were added in order to stabilize the vertical poles (Figure 44). These horizontal supports, similar to those mentioned in Du Pratz's account of a Natchez house (Swanton 1911: 59-60), were used as stiffeners to keep the lower walls straight while creating a fulcrum for each pole during bending. Such supports are referred to as tension rings in wood engineering for that reason. One horizontal support per wall was placed 1.2 m (4 ft) above the ground on the interior side of the structure.

Figure 44. The experimental structure after the addition of the horizontal supports.

The poles on the north and south walls were notched at the corners to better receive the horizontal support poles on the east and south walls. After each vertical wall pole was tied to the horizontal supports, the horizontal supports were tightly bound together at the corners. The horizontal supports, then, established the height of the doors.

All bound joints on the vertical poles and horizontal poles were tied with 340 kg (75 lb) test twine approximately 24 mm (0.095 in) in diameter made from sisal. Sisal (*Agave sisalana*) is a form of wild succulent cultivated mainly in the Yucatán and elsewhere in the Caribbean and southern Mexico as well as in Africa, India, the Philippine Islands, and even in parts of Florida (Weindling 1947: 72). This twine was the only inauthentic material used.

After the horizontal supports were secure, the upright poles were bent and tied together. The poles were bent in sets of four, beginning with two poles on the eastern side of the southern wall trench which were bound to the corresponding poles on the east of the northern trench. The process continued with two poles on the south side of the western trench bound to the corresponding right poles on the eastern side, continuing in this manner in a clockwise direction, until reaching the middle poles. The bending process concluded with the poles in the middle of each trench being bent and bound (Figure 45, 46).

Of the forty-two total bends made, only three poles cracked or split. All three breaks occurred at deformities in the trees where branches had been removed. Two of the three poles that broke were still able to be bent and bound to the other side. Only one pole broke completely in half. Because it would have been rather difficult to untie and remove the pole from the trench at this point in the process, the pole opposite the one that split was simply bent over and tied further down, to the top of the broken pole. This pole was not as steady as the others were, but still proved to be adequately stable to remain in the structure.

Figure 45. The beginning of the bending process. The poles were bent in sets of two, starting with the outermost poles of each trench and working in towards the center.

Figure 46. The middle of the bending process. Most of the poles are tied, but the four in the center of the wall in the foreground are still straight.

The necessity of the horizontal supports was demonstrated after the bending was completed (Figure 47). The supports, which had lain straight across the vertical poles before the bending process began, were afterwards found to be extremely bowed towards the inside of the structure (Figure 48). According to the wood bending data from Chapter 4, the average amount of weight placed on the stake representing the horizontal support (Point B) by 5 – 6.5 cm (2.0 – 2.5 in) white oaks is approximately 216.6 kg (47.75 lbs) per pole. As there were ten or eleven poles on each wall, the average amount of stress placed on each of the walls ranged from 2166.00 – 2382.60 kg (475.50 – 525.25 lbs) on each horizontal support, for a combined inward pressure of 9097.2 kg (2001.5 lbs) from all four walls.

Figure 47. The completed wooden framework of the structure.

Figure 48. Photograph demonstrating the inward force on the horizontal supports. Note the piece of cane behind the supports which shows the position of the pole before the bending.

Architecturally, these horizontal supports were one of the most important parts of a flexed pole structure. Their location on the wall was variable, which is to say that they could have been placed anywhere along the walls or in the trenches. However, as they had not been found in the archaeological evidence of the structures excavated at Moundville, the supports were probably placed on the walls and not in the trenches. If they were placed on the walls, they could have been positioned high enough to serve as the top of the door. Removing a section of the horizontal support to increase the door size would defeat the effectiveness of the horizontal supports. Therefore, it seems reasonable to assume that having them bound at the corners makes them part of an effective architectural unit.

Binding the corners of the horizontal supports is what makes the flexed pole house a single architectural component, otherwise, it is four sets of wall poles that are interwoven at their weakest points. Not binding the supports together would cause the wall poles to slant inward, and could produce a shift in the shape of the structure caused by strong winds or a live roof load (people on the roof). Neglecting to tie the horizontal supports, causing inward slanting of the wall poles, can be seen in the full-sized experimental reconstructions of Nash (Figure 22) and Blanton (Figure 34).

The planned height of the roof was approximately 3.35 meters (11 feet), slightly higher than was anticipated in the bending experiments in Chapter 4. However, due to two of the three breaks occurring in the southeast corner of the structure, there was a slight hump in the roof on that side, such that the roof measured roughly 3.65 m (12ft) high. Though trees may have been more numerous at Moundville during the Mississippian period, it is unlikely that similar breakage never happened to builders during this period. Many trees appear sturdy enough for the task at hand, but it is impossible to know until the trees actually are bent.

Following the completion of the wooden framework, river cane (*Arundinaria gigantea*) was tied to the exterior of the frame to add strength to the frame and to support the thatch. The cane was roughly 5 cm (2 in) in diameter at the base and was harvested in lengths of 6 m (20 ft). It was harvested with machetes, approximately 3.2 km (2 miles) north of the construction site. After the leaves had been removed, the cane stringers were tied to the structure starting 1.3 m (4.5 ft) high, and were bound at one-foot intervals until the first crossing wooden roof pole was reached. Five stringers of cane were used on each wall, for a total of 20 stringers (Figure 49).

Figure 49. The complete framework with cane horizontal supports tied on. Note how the cane poles are positioned above the horizontal support and continue until the interwoven framework is reached.

The cane stringers served three purposes. First, and most importantly, the cane served to hold the thatch in place. The cane also added stability to the vertical wooden poles. Poles that had broken or were not as stable as the others were thus better integrated into the framework and were provided with additional security. Finally, the cane stringers formed a ready-made scaffolding system for thatching the house.

Once the framework was complete, it proved to be very strong and supportive. Over 400 hundred pounds (two adult males) could be supported on each of the wooden horizontal supports with no danger of the structure collapsing, and approximately 200 pounds (one adult male) could hang from the center of the interwoven roof framework. It was also possible for an adult male to safely climb to the top on the scaffolding created by the cane stringers.

The final step in the construction was the addition of the grass thatch. The thatch consisted of 1.8 – 2.4 m (6 – 8 ft) tall grasses harvested from the top of Mound A, the central mound in the plaza at Moundville. Most of the thatch consisted of johnsongrass (*Sorghum halepense*), but eastern gamagrass (*Tripsacum dactyloides*) was also used. Other grasses native to Alabama include indiangrass (*Sorghastrum nutans*), and Big and Little Bluestem grasses (*Andropogon gerardi and Andropogon scoparius*) (Hanson 1972); yet, these were difficult to find in abundance. This was also a problem that Blanton (1984) encountered in his experimental reconstruction, which he attempted to remedy by using poplar bark instead of grasses. However, using bark requires a lot of time and a large amount of preparation work (Blanton 1984). Even though johnsongrass was imported from Turkey in 1830 (Hanson 1972), it was chosen as a suitable material in that it is similar enough to native grasses to be used as a substitute. The real problem is that the native grasses are hard to find in abundance nowadays, but presumably they would have been easy to find around cleared fields in the Mississippian stage. Johnsongrass has taken over the niche formerly occupied by native grasses.

In experimenting with the thatch, the leafy branches of the cane used for the horizontal stringers was tried as a thatching material (Figure 50). Initially, it made a suitable thatch, as it was dense, yet light in weight. However, the cane branches were not as long as the grass, and after the first rain, the cane branches shed a substantial proportion of their leaves. The shedding continued steadily over the week it was left in place. This shedding was considered problematic because the house would have needed thatching maintenance frequently throughout the year. Also, a large amount of river cane, far more than what was harvested for the stringers, would be needed to produce enough thatch to complete the house.

Figure 50. Experimentation with the leafy branches of river cane, stripped from the cane stringers, and used as thatch. Note how thick it is, but at the same time how much shorter the cane branches are than grass, visible to the right.

The grass used to thatch the house was cut using machetes, swing blades, and a gas - powered hedge trimmer, was bundled on site, and was then transported to the construction site. To hang the thatch, each bundle was split into two sections with one section slightly larger then the other. Put in place over the stringer, the larger section formed the exterior side while the smaller section was straddled over the stringers and then woven underneath the stringer below, back to the exterior side of the wall (Figure 51). A small opening was left in the center of the roof as a smoke hole, and two openings were left for the doors (Figure 52). The thatched building was observed at intervals over five months after its completion. Several of these observations took place while it was raining. The wall thatch shed water very well. However, I found that the corners were somewhat vulnerable to both rain and wind. This indicates that extra thatching, or another measure, may have been needed for additional protection in the corners.

In the end, approximately 1,800 m^2 (5,900 ft^2) of densely growing grass was needed to thatch the entire structure. It took about three to four bundles of grass, each 2.5 – 4.0 cm (1.0 – 1.5 in) in diameter at the bound end, to thatch between each two vertical poles. Forty to fifty bundles were necessary to complete one row of one wall. Approximately five rows of grass were used to finish a wall, totaling about 250 bundles per wall or about 1,000 bundles for the entire structure. Each bundle weighed approximately 0.9 – 1.1 kg

Figure 51. The grass thatching, illustrating how each bundle was hung over the cane stringers. The tied bundles were added from the bottom stringer up to the smoke hole.

Figure 52. The completed project.

(2.0 – 2.5 lb), yielding an estimated roof load of about 900 – 1,100 kg (2,000 – 2,500 lb). Once completed, the thatched wall was originally about 12.7 – 15.2 cm (5 – 6 in) thick. However, the thickness of the wall decreased to 7.6 – 10.1 cm (3 – 4 in) after five months of exposure to the elements.

The entire building process spanned about one month's time. Work on the structure was only done on the weekends, totaling ten days of actual work over the 30 day period. Many of the days were cut short due to rain or excessive heat. If all the hours were totaled, it would amount to six 8-hour days. In terms of labor, the structure necessitated approximately 250 person - hours of work with an average of 4 – 5 people helping at any given time.

After the completed house had stood exposed to the elements for a little over five months, the building was destroyed by fire (Figure 53), both to make observations on the burning of this type of structure, as well as to prevent hazards to park visitors. After two days of a steady drying, in which a central hearth was maintained during the daylight hours, the building was set ablaze on a dry day in January. To light the fire, a small piece of smoldering wood was placed in the center of the eastern wall on its interior. The house caught fire immediately and the whole structure was afire to the point where anyone inside could not have escaped unscathed more than about 30 seconds after placing the coal on the thatch. The short span of time it took for the structure to be completely engulfed, less than two minutes, emphasizes that cane mats must have been used to line the interior of any safely habitable grass thatched structure that routinely used a hearth. Tightly-woven mats, as documented in the ethnohistorical data would serve as an effective retardant against sparks from the hearth without adding significant weight to the already heavy roof load. The

Figure 53. The experimental house after being set on fire from the inside, approximately 45 seconds after lighting the fire.

exterior probably would have been mat - covered as well, as suggested by the ethnohistoric accounts from the lower Mississippian Valley.

After flames had engulfed the structure, the burning grass thatch began sliding down the walls and accumulated on the ground around the exterior side of the wall poles, where it continued to smolder and burn. The bindings of the horizontal supports came apart next. All four horizontal supports dropped to the ground in place, above their respective wall trenches on the interior sides of the walls. The accumulation of the smoldering grass thatch and the horizontal support poles caused a small fire that burned through the basal ends of the wall poles just above the ground, causing the wall poles to fall systematically inward onto the floor of the structure (Figure 54).

Figure 54. The burnt remains of the house, lying as they fell. Note how most poles were burnt through at the base, but otherwise remain intact.

The entire burning process took less than five minutes. Of the forty-two total poles, fourteen remained standing after the fire. A majority of the poles that did fall remained unbroken but burned beyond any reuse. Notably, only one pole of the flexed poles fell outwards as the binding burned. This indicates that by this time there was no more tension in the wall poles. They had dried and stabilized in conformity to the shape of the structure.

There were several aspects of the building process that were realized only by constructing a full scale replica. Most importantly, it was determined that the design of the flexed pole structure is possible and completely consistent with what is found in the archaeological record. In retrospect, things that should have been done differently include using horizontal supports that were larger in diameter, completely dried out, and placed a little higher on the walls. There was a suggestion while building the structures that perhaps two sets of horizontals were needed, especially if the house was constructed without subterranean horizontal wedge supports in the trenches. Without any horizontal supports, the design of the building would not have been as structurally sound as it was. Not only did the supports keep the wall poles steady by connecting them to a single, rigid frame, but it also prevented the walls from moving in either direction front to back. Simply having horizontal supports on the walls unbound at the corners, as seen in the Nash reconstructions, is not enough. If a strong wind or stress from a live load, such as people on the roof, were to occur, a structure with unbound horizontal supports most likely would have been deformed.

Daubed walls would not have been a good addition to the exterior of this structure. Due to the rounded nature of the roof, there was no eave present to protect the clay daub from the rain. This was a problem Blanton (1984) experienced in his reconstruction of a domestic flexed pole house with daubed walls. If clay daub were used, it would have needed to be repaired continually. It is important to mention that daub has not been reported from wall trench domestic houses at Moundville. It is however, reported consistently for Late Mississippian set post architecture among the surrounding sites. Instead, for flexed pole houses, bark or cane mats lining the grass thatch would have been a good choice for the interior and exterior, as documented for the historic Natchez. The addition of cane mats or bark as interior lining would have protected against fire, and would have made making the building more resistant to rain and wind. Another aspect I might consider if I were to redo this experiment is adding rafters, like the ethnohistorically documented Natchez house possessed (Swanton 1911: 59-60). This would provide storage space above, and convenient places to hang things.

In conclusion, building an experimental flexed pole structure demonstrated that this form is both structurally efficient and consistent with excavated wall trench floor plans. The construction of the frame was not very labor intensive. The trees were small and were not difficult to harvest or transport. The most time-consuming aspect of the construction was harvesting, bundling, and applying the thatch. The building, once erected, was extremely sturdy and resistant to wind and rain. With a little more experience in selecting and bending poles, it would be possible to build a very symmetrical frame at the target height of 3.2 m (10.5 ft) for this diameter floor, or even lower.

Chapter 6
Typology, Chronology, and Technological Changes of Mississippian Structures

In previous chapters of this study, ethnographic analogies from Africa and the Yucatán demonstrated that there are two basic types of wooden-frame houses, those with a single wall-roof component and those with separate wall and roof components. Additional evidence in the form of ethnohistorical accounts from the Southeast United States indicated the presence of the same two distinct house types. Wood technology, structural engineering, and experimental archaeology have been used to show that open-corner, narrow wall trench house patterns found archaeologically are consistent with structurally sound, flexed pole, above-ground architecture. In other words, this is a goodness of fit argument for the relevance of an ethnographic analogy. However, it remains to be seen that the two house types existed at Moundville and surrounding areas in west-central Alabama, and that small, closely set pole structures have characteristics that are statistically distinct from the large individually set post structures. The diagnostic components and chronology of each house form also need to be presented and that is the purpose of this chapter.

Seventy-five Mississippian structures from six sites in west-central Alabama compose the sample for this comparative study. Following a brief discussion of the context of these sites and their structures, methods for the measurement of variables from the excavated floor plans and the results of statistical comparisons are presented. It is hypothesized that this sample of structures will show bimodal distributions, in terms of both post size and post spacing, representing the two distinct construction methods. The alternative would be that rather than showing two distinct types, the data will merely show a continuous distribution from small pole to larger, within basically a single form. Concluding the discussion of the results, a typology and chronology of house types from the six Mississippian sites is presented, focusing on both archaeological characteristics and inferred above-ground architecture. Assuming that there is an architectural shift, reasons for this transition will also be provided.

Research Sample

Moundville. Moundville is a Mississippian mound site on the banks of the Black Warrior River in west-central Alabama. The civic-ceremonial center, including at least twenty-nine earthen mounds situated around a central plaza, was initially excavated by Thomas Maxwell and Nathaniel Lupton during the mid-nineteenth century (Peebles 1981). The largest excavations at Moundville occurred in the 1930s and early 1940s by Walter B. Jones and the Alabama Museum of Natural History, in which the Museum used Civilian Conservation Corps (CCC) federal relief labor for a number of archaeologically related projects. One of these projects of the CCC was to construct a road that encircled the site. The excavations undertaken to complete this project are referred to as the Roadway excavations.

McKenzie (1964) described the characteristics of 22 of these Roadway structures, 21 of which were constructed with wall trenches and one with individually placed poles. Nineteen of these structures were used in the sample of this study, as the other three exceeded the 37^2 m (400 ft^2) limit for domestic structures used in this study. Also included in this study were seventeen structures of domestic size that McKenzie did not use in his study, that were taken directly from unpublished field drawings of the Alabama Museum of Natural History Roadway excavations. These additional structures from the Roadway excavations consisted of individually set, wall trench, and individually set and wall trench combination forms. Both wall trench and individually set construction techniques were also found on the Northwest Riverbank of Moundville during excavations in 1992 (Scarry 1995). Twelve structures were located at the Northwest Riverbank, four of which had been rebuilt, for a total of 16 cases included in the sample for this study. These 16 structures from the Northwest Riverbank, along with the 32 structures from the Roadway excavations, equate to 52 total Moundville structures for the sample.

<u>Lubbub Creek site</u>. The Lubbub Creek site is a Mississippian mound site in the Central Tombigbee River Valley of western Alabama, approximately 53 km (33 miles) from Moundville (Blitz 1993). The site was excavated by Christopher S. Peebles (1979) in 1978 and 1979. The site possessed several varieties of domestic structures, including small closely-set pole structures constructed either using a wall trench or individually set posts, as well as several large widely-spaced post architectural forms with four internal roof supports. The small pole structures of the Lubbub Creek site appear to be characteristic of the Summerville I phase (equivalent to Moundville I phase), while the large widely spaced post structures occurred later in the Summerville II/III, and IV phases (equivalent to Moundville II through Moundville IV). Many of the Lubbub Creek structures were too large for inclusion in the sample, however four structures were included dating to Summerville I, three from Summerville II and III, and five from Summerville IV, along with one undated structure, for a total of 13 houses that met the study's criteria.

<u>Bessemer</u>. The Bessemer site lies approximately 48 km (30 miles) north of Moundville in west-central Alabama. The site was first recorded in 1890 by Cyrus Thomas, the man indirectly responsible for ending the mound-builder race theory while at the same time compiling a great deal of information concerning sites over the Eastern United States. The Bessemer site was extensively excavated in the late 1930s by DeJarnette and Wimberly (1941). The Bessemer site includes three mounds: a ceremonial mound, a domiciliary mound, and a burial mound. Four structures, including three wall trench structures and a single set pole structure, were found under and around the ceremonial mound. However, Structure 1 contained an elevated seat of clay, and was therefore eliminated from this study as the building was possibility public or ceremonial in nature. Seven structures were found on top of the domiciliary mound and were thus excluded from this study as well. There were also 17 structures found under and around the domiciliary mound. However, only two of these structures were added to the sample, as three were circular and the other 12 exceeded the size threshold for a domestic house and were therefore excluded from the study. Altogether, five structures from the Bessemer site met the criteria laid out for this study.

<u>Pride Place</u>. The Pride Place site is located in Tuscaloosa on the banks of the Black Warrior River. It was first partially excavated by David L. DeJarnette and geologist Walter B. Jones in January of 1933. Johnson (1999, 2001) conducted the data recovery for a cultural resource management project there in 1998. Two individually set post structures were located, which utilized both large and small post wall members. Based on the ceramic analysis, Johnson inferred that the site was a Moundville III phase farmstead. In his original presentation, Johnson (1999) stated that both of these structures were constructed in a flexed

pole form that possessed central roof supports. However, in his later presentation, Johnson (2001) stated that it was unclear as to whether these houses were flexed or rigid.

Big Sandy Farms. The Big Sandy Farms site was located and excavated in 1990 during a pipeline survey project. This Mississippian site lies 3 km (1.8 miles) north of Moundville, in the area near where Big Sandy Creek flows into the Black Warrior River. Ensor (1993) discussed four structures, one complete semi-subterranean structure, and three other partial structures that were located at the site. Only the semi-subterranean structure, Structure 1, and Structure 2 are included in the sample, as the other two are not convincingly identified as structures.

Powers site. The Powers site is located 5 km (3.1 miles) southwest of Moundville within the vicinity of Elliott's Creek. The site was recorded by Walter B. Jones in the early 1930s. Excavations were conducted by Richard Krause and University of Alabama field schools in 1981, 1988, 1991 (Welch 1998). During his excavations, Krause uncovered three individually set post structures. Two of these structures were included in the sample (Structure 1 and Structure 2). The remaining structure (Structure 3) was excluded based on its large size. All three houses Krause excavated date to approximately 1400 A.D., the estimated beginning of the Moundville III phase. Redwine (2002) has proposed that all three houses consisted of rigid post architecture, even though Structure 1 possessed four internal roof supports and large quantities of daub, while Structure 2 only possessed one roof support and very little daub.

Methods

Seventy-five complete or partial structures from six sites in the west-central Alabama region met the criteria of the study. The focus of the remaining pages of this chapter is to first statistically compare characteristics of the structures located at these six sites, followed by an explanation for the transitions in house form. The data are presented in Table 2.

In order to record variables such as post hole diameter, post spacing, floor area, and the presence or absence of wall trenches and roof supports, plan view representations of all the houses in the sample were collected. The dichotomous variables such as the presence or absence of wall trenches or roof supports were recorded simply by examining these plans. If there was any indication of a wall trench in any part of the structure, with the exception of entry wall trenches, the structure was recorded as possessing wall trenches.

The presence of roof supports is a little different. Not only did interior post holes have to be present to be considered roof supports, but they also needed to be positioned in a particular location within the structure. There are typically several scattered post holes throughout the floor area of any given structure. However, only cases where (a) one large roof support in the middle of the structure, (b) two large central post holes parallel to the long axis of the house, or (c) four large post holes forming a square in the center of the structure, were considered as possessing roof supports.

Floor area and post hole size, if not specifically provided in the text that accompanied the drawings, were measured using the associated scale, manually gauged as accurately as possible with a ruler and calculator. This method does introduce a small degree of error, however if there were indeed two very distinct architectural groups as hypothesized, the degree of error should be negligible.

It should be noted that the terms post hole and post mold are sometimes used interchangeably. However, for accurate analysis the two need to be distinguished. The difference is that post holes are the actual hole that was dug in the ground in order to plant

Table 2. Structural Data

Structure Number	Site	Floor Area (m^2)	Shape	Mean Post Diameter (cm)	Mean Post Spacing (cm)	Chronological Assignment	Method of Insertion	Inferred Architectural Form
PA Structure 1	Moundville	32.5	Rectangular	11	17.9	M I/ M II	Individual	Type II
PA Structure 2	Moundville	22.5	Rectangular	12	18.3	M I/ M II	Individual	Type II
PA Structure 3	Moundville	18.0	Rectangular	18	31.3	Early M I	Composite	Type Ia
PA Structure 4	Moundville	17.0	Rectangular			Late M I /II	Wall Trench	Type III
PA Structure 5a	Moundville	14.0	Rectangular			Late M I /II	Wall Trench	Type III
PA Structure 5b	Moundville	22.5	Rectangular			M I/ M II	Individual	Type II
PA Structure 6	Moundville	14.0	Rectangular	11	25.5	M I/ M II	Individual	Type II
ECB Structure 1	Moundville			13	18.5	Undated	Individual	Type II
ECB Structure 2	Moundville			20	37.5	Undated	Individual	Type II
ECB Structure 3	Moundville					Undated	Wall Trench	Type III
ECB Structure 4	Moundville	13.0	Square			Undated	Wall Trench	Type III
ECB Structure 5a	Moundville	10.5	Rectangular		13.3	Undated	Wall Trench	Type III
ECB Structure 5b	Moundville	13.7	Rectangular	9	12.5	Undated	Wall Trench	Type III
ECB Structure 6a	Moundville					Undated	Wall Trench	Type III
ECB Structure 6b	Moundville	20.3	Square			Undated	Wall Trench	Type III
ECB Structure 6c	Moundville	20.0	Rectangular	12		Undated	Wall Trench	Type III
House 1	Moundville	20.2	Rectangular	10	11.6	Undated	Wall Trench	Type III
House 2	Moundville	27.1	Rectangular	10		Undated	Wall Trench	Type III
House 3	Moundville	8.2	Rectangular	11	19.3	Undated	Individual	Type II
House 4	Moundville	9.2	Rectangular	10	14.1	Undated	Wall Trench	Type III
House 5	Moundville	24.5	Rectangular	9		Undated	Wall Trench	Type III
House 5a	Moundville	13.2	Rectangular	9	13.1	Undated	Wall Trench	Type III
House 6	Moundville	12.2	Rectangular	12	14.2	Undated	Wall Trench	Type III
House 7	Moundville	10.9	Square	9	13.9	Undated	Wall Trench	Type III
House 8	Moundville	35.4	Rectangular	16	25.6	Undated	Composite	Type I
House 11	Moundville	35.9	Rectangular			Undated	Wall Trench	Type III
House 12	Moundville	11.1	Square			Undated	Wall Trench	Type III
House 13	Moundville	6.6	Rectangular			Undated	Wall Trench	Type III
House 14	Moundville	13.6	Rectangular	10	15.4	Undated	Wall Trench	Type III
House 15	Moundville	8.8	Rectangular	30	45.0	Undated	Individual	Type IV

House 18	Moundville	25.6	Rectangular	15	23.3	Undated	Wall Trench	Type III
House 19	Moundville	20.3	Rectangular	10	17.5	Undated	Wall Trench	Type III
House 20	Moundville	11.4	Square	9	17.0	Undated	Wall Trench	Type III
House 21	Moundville	16.1	Rectangular	10	16.5	Undated	Individual	Type II
House 22	Moundville	15.8	Square	11	15.3	Undated	Wall Trench	Type III
House 23a	Moundville	13.3	Square	15	28.3	Undated	Composite	Type I
House 23b	Moundville	23.2	Rectangular	17	28.0	Undated	Composite	Type I
House 23c	Moundville	25.9	Rectangular	8	15.3	Undated	Wall Trench	Type III
House 24	Moundville	13.9	Rectangular	14	27.5	Undated	Composite	Type I
House 25	Moundville	12.2	Rectangular	12	23.3	Undated	Wall Trench	Type III
House 26	Moundville	16.0	Square	10	18.9	Undated	Wall Trench	Type III
House 27	Moundville			16	21.4	Undated	Wall Trench	Type III
House 28	Moundville	14.4	Rectangular			Undated	Composite	Type I
House 29	Moundville	23.9		12	22.5	Undated	Wall Trench	Type III
House 30	Moundville	19.8	Square	11	21.0	Undated	Wall Trench	Type III
House 31	Moundville	18.1		10	16.0	Undated	Wall Trench	Type III
House 32	Moundville	28.3	Rectangular	13	25.5	Undated	Wall Trench	Type III
House 33	Moundville	37.18	Rectangular	11	18.8	Undated	Composite	Type I
House 34	Moundville	27.3				Undated	Wall Trench	Type III
House 35	Moundville	26.5	Rectangular			Undated	Wall Trench	Type III
House 36	Moundville	23.4	Rectangular	10	14.5	Undated	Wall Trench	Type III
House 37	Moundville	18.4	Rectangular	11	19.3	Undated	Wall Trench	Type III
Structure 1	Big Sandy Farms	18.7	Rectangular	16	29.2	Early M I	Composite	Type Ia
Structure 2	Big Sandy Farms	6.9		11	20.0	M I/ M II	Individual	Type II
Structure 1	Powers	22.5	Rectangular	22	79.3	M III	Individual	Type IV
Structure 2	Powers	36.0	Square	17	33.0	M II	Individual	Type II
Structure 2	Bessemer	18.2	Square			Undated	Individual	Type II
Structure 3	Bessemer	20.9	Square			Undated	Wall Trench	Type III
Structure 4	Bessemer	18.2				Undated	Wall Trench	Type III
Structure 12	Bessemer	29.3			16.9	Undated	Wall Trench	Type III
Structure 1	Pride Place					Undated	Individual	Type IV
Structure 2	Pride Place					Undated	Individual	Type IV
Structure 2	Lubbub Creek	27.6	Square	11	18.3	Late M I /II	Wall Trench	Type III

Structure 3	Lubbub Creek	32.4	Rectangular	13	30.0	M I/ M II	Individual	Type II
Structure 4	Lubbub Creek	12.9	Square	14	22.6	M I/ M II	Individual	Type II
USN 2542	Lubbub Creek	30.0	Rectangular	26	75.1	M III/IV	Individual	Type IV
USN 8168	Lubbub Creek	36.6	Rectangular	25	87.5	M III	Individual	Type IV
USN 1552	Lubbub Creek			27	87.5	M III	Individual	Type IV
USN 2317	Lubbub Creek	33.0	Rectangular	25	62.5	M III	Individual	Type IV
Structure 5b	Lubbub Creek	36.0	Rectangular	26	81.3	M III/IV	Individual	Type IV
Structure 5c	Lubbub Creek	37.0	Rectangular	24	60.4	M III/IV	Individual	Type IV
USN 4776	Lubbub Creek			29	87.5	M III/IV	Individual	Type IV
USN 6422	Lubbub Creek			25	75.0	M III/IV	Individual	Type IV
USN 7470	Lubbub Creek			26		M III/IV	Individual	Type IV
USN 3880	Lubbub Creek	31.9	Rectangular	25	72.5	M III/IV	Individual	Type IV

	Individually Set	Wall Trench	Composite	Total
n	27	40	8	75
Average Diameter	19.969	10.76	15.29	54
Average Spacing	48.75	17.14	26.9443	53
Average Floor Area	29.59	19.61	21.836	64

Table 3. A chart describing the mean post diameter, post spacing, and floor area by structure category. The total column represents the number of cases used in the measurement of that particular variable.

the post. Post molds, on the other hand, are the stains within the post holes, only occasionally present, that provide data on the actual size of the post. In measuring post diameters, post holes, not post molds were recorded for this study. The reason is that post molds are not as clearly identifiable as post holes and as a result, post holes are more frequently recorded than post molds. The measurement reflects the maximum diameter of the wall member. However, comparisons of post hole to post mold size reveal that post molds are typically 25 to 50 percent smaller than post holes, so the values given for this variable are no doubt slightly larger than the size of wall posts used (Polhemus 1985: 18)

Mean post spacing was a slightly more difficult variable to record. This measurement was absent from many of the published works from which structures were taken, or in some cases was over-generalized. Therefore, in almost every case, post spacing was manually re-measured. In order to limit post hole/post mold size discrepancies, spacing was measured from center to center of post stains. The scale provided with the illustration was used to measure a span of posts judged as average for the structure. This distance was divided by the number of spaces within the selected span. For example, if five post holes, from the center of the first to the center of the last, were found in a span of one meter, this distance would be divided by four, as there are four spaces between five posts when measured in this manner.

Results

The result of the comparison of structures from the six Mississippian sites indicates that the majority of the structures were, as hypothesized, bimodal in both post diameter and post spacing. By graphing the frequency of post hole diameters (Figure 55), it is clearly shown that this sample of structures is bimodal, confirming two distinct sizes of construction materials, a small pole and a larger post size. The first mode (11 cm) represents the small pole structures, both individually set and set in wall trenches. However, the individually set method is itself bimodal, showing a small as well as a larger mode. The high end of the small diameter distribution in between the two modes (16 cm) reflects the large individually set poles of composite construction houses (shown in light blue), that were constructed in a wall trench flexed pole fashion along the long axis and a rigid post method on the shorter sides. The second mode (25 cm) represents the large post structures, which were never constructed using wall trenches. Also, note that all of the wall trench structures appear in the first mode.

The average post diameter of houses constructed in wall trenches ranged from 8.0 to 16.0 cm ($x = 10.76$, $s = 1.87$, $n = 25$) while the large individually set poles and posts ranged from 11.0 to 30.00 cm ($x = 19.696$, $s = 7.02$, $n = 21$). It should be noted that the diameter for individually set wall posts is very conservative, as the smaller and larger diameter, individually set poles were grouped together even though they are believed to represent different architectural forms. Therefore, if statistical tests still indicate that the means between the wall trench and individually set poles are different, while the smaller individually set poles clustered around the smaller mode, then one can assume that the diameter between the wall trench poles and the rigid set posts is quite different.

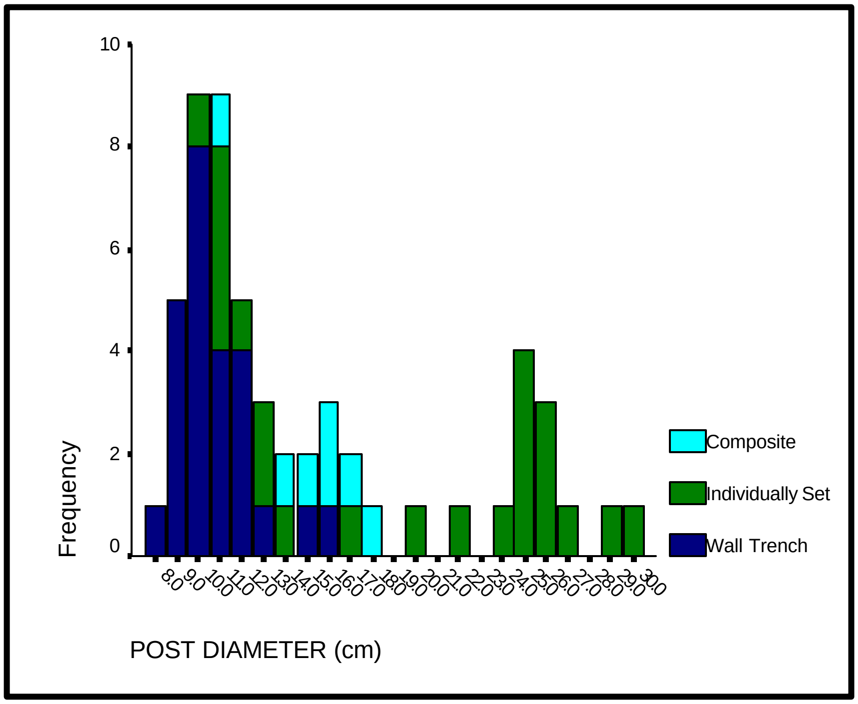


Figure 55. Histogram showing the frequency of post diameters according to whether the wall posts were in a wall trench, individually set, or in a house combining both. Note that the distribution is bimodal and that the two modes sort by insertion technique.

Levene's test for equality of variances indicated that the variances of the two means were not equal (F = 81.481, p = .001) when assuming the required 90 percent confidence level for the test. Therefore, equal variances were not assumed in calculating a two-tailed t-test of the difference in post diameter of the two architectural forms. The results indicated that the post diameter of individually set forms was significantly greater than the post diameter of wall trench houses (t = -5.906, df = 24.88, p = .001). The confidence interval generated also supported the rejecting of the null hypothesis, in that the mean of the post diameter in wall trench houses was 5.82 to 12.05 cm smaller than the mean of the individually set structures. The composite structures (x = 15.286, s = 2.29, p = 7) were not included in this test as they utilize both small and large diameter wall posts.

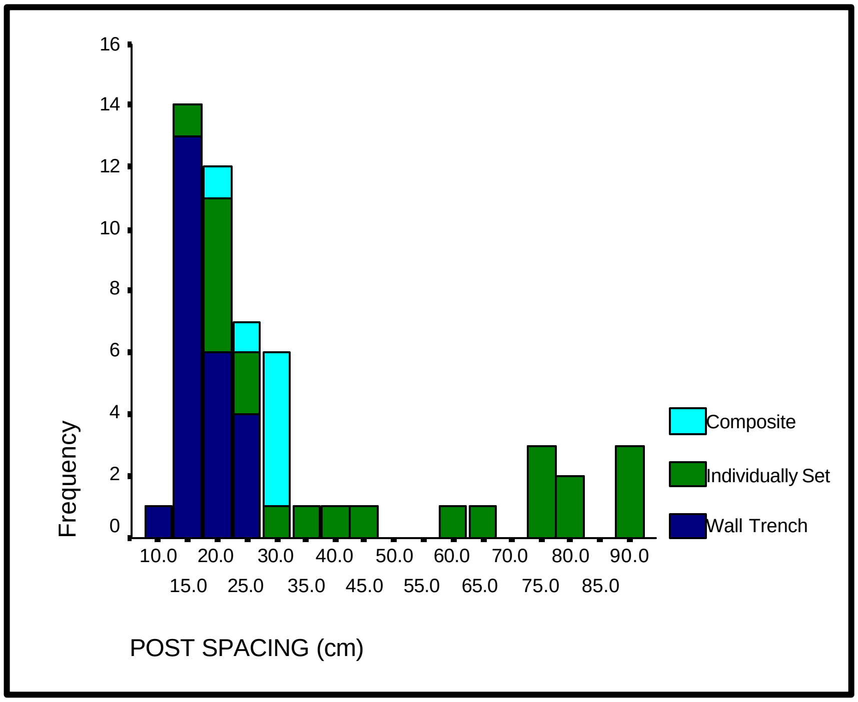


Figure 56. Histogram showing the frequency of wall post spacing, sorted by method of insertion. Note that the distribution is again bimodal, as in Figure 55.

Post spacing, when similarly graphed (Figure 56), is also bimodal. The histogram confirms the presence of two spacing modes, closely spaced and widely spaced. When these data are broken down into groups based on the presence or absence of a wall trench, the histogram shows that the wall spacing of all wall trench houses is concentrated in the area of the graph that represents closely spaced wall poles (x = 17.14 cm, s = 3.98, n =24). There are no widely spaced wall trench postholes. The post spacing of individually set pole houses, on the other hand, is bimodal, representing both a small pole individually set method and a large post individually set technique (x = 48.75 cm, s = 27.83, n = 22). The spacing of the larger individually set posts of the composite construction houses, which combine individually set and wall trench poles, distribute in between the closely spaced poles and the widely spaced posts (x = 26.94. s = 4.00, n = 7). The spacing of the smaller poles in such composite houses is similar to the spacing of the small individually set and wall trench forms.

In calculating a t-test between the mean post spacing of wall trench houses and individually set pole and post houses, Levene's test for equality of variances indicated that the variances of the two means were not equal ($F = 124.459$, $p = .001$) when assuming the required 90 percent confidence level for the test. Therefore, equal variances were not assumed in calculating a two tailed t-test between the difference in post spacing of the two architectural forms. The results indicated that the post spacing of individually set structures is significantly greater than that of wall trench houses ($t = -5.279$, $df = 21.78$, $p = .001$). The confidence interval generated also supported the rejecting of the null hypothesis, in that the average post spacing in wall trench houses was 19.19 to 44.04 cm smaller than the average post spacing of the individually set structures even with the more narrow set poles included with the widely set individual posts.

The correlation between post diameter (as a polychotomous ordinal variable) and post spacing was calculated, which indicates an enormously high positive relationship ($r = .921$ $p = .001$) (Figure 57). In other words, as post size increases, so does the spacing of the posts. The scatterplot also shows that there are two distinct building techniques, (a) small pole, closely set, usually in a wall trench, and (b) large post, widely spaced, and never in a wall trench.

For the purpose of having quantifiable information to build the chronology, the presence or absence of wall trenches was used in examining the frequency of forms from each of the phases in the Moundville – Summerville phase sequence (Figure 58). This graph shows that individually set pole houses are the primary form in the Early Moundville I phase.

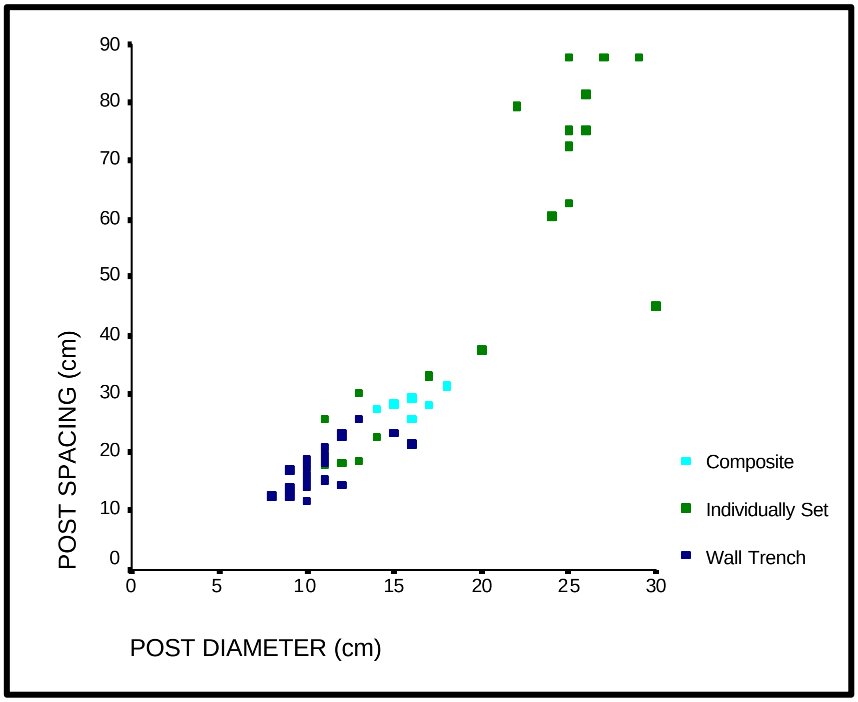


Figure 57. Scatterplot showing the correlation between post diameter (x axis) and post spacing (y axis). The data are grouped by post insertion technique.

These Early Moundville I phase houses tend to possess small individually set poles, while the houses of the Late Moundville I phase are almost exclusively constructed in a wall trench. However, the importance of the wall trench as an architectural characteristic declines in the Moundville II phase, and completely disappears by the Moundville III phase. Houses late in the Moundville and Summerville sequences are entirely constructed of individually set posts. More information concerning these data can be provided by a proposed chronology of these house forms.

Typology and Chronology

There are five types of floor plans represented in the Mississippian archaeological record in west central Alabama: (1) a composite construction form, which combines small

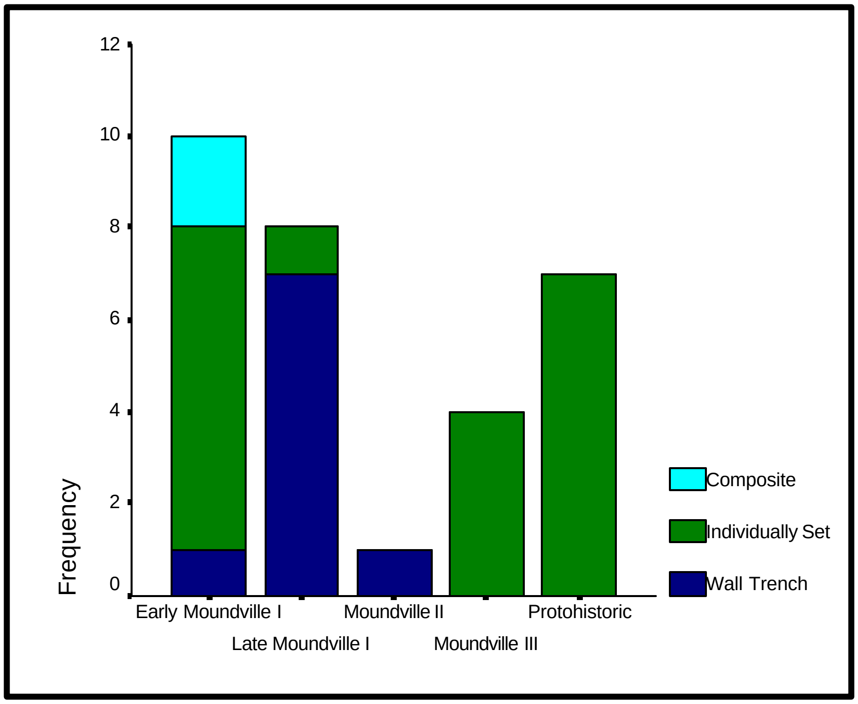


Figure 58. Bar graph showing the frequency of post insertion techniques by phase in the Moundville/Summerville sequence.

pole wall trench and individually set posts; (2) a small pole individually set form; (3) a small pole wall trench form; (4) a large post individually set form; and (5) an amorphous post daubed form. This last form was omitted from the statistical analysis, as little is known or can be identified regarding its above-ground architecture, and patterns of posts are difficult to distinguish in the archaeological record of these structures.

Type I. *A Composite Construction Form*. Eight examples of this form are in the sample, seven of which occur at Moundville and one at the Big Sandy Farms site. This form employs both individually set post and wall trench techniques. Two of the eight were constructed in a semi-subterranean basin, Structures 3 from the Northwest Riverbank at Moundville and Structure 1 from the Big Sandy Farms. These semi-subterranean houses are classified as Type Ia in Table 2. The composite construction form in general is characterized by small, closely spaced poles placed in wall trenches on two opposing walls, together with slightly larger wall poles spaced a little farther apart on the remaining two walls. In seven of the eight cases the structures were rectangular, with the larger individually set poles positioned on the short sides of the building and the small wall trench poles placed on the long sides of the structure. In the other example, the layout is square, created with two equal opposing sides of wall trenches and individually set poles. There are no indications of internal roof supports in any of these examples.

This form, based on the two sizes of wall member diameters and spacing, probably consisted of two bent pole sides and two rigid sides, resembling the historic architecture of the Algonkin tribes of the Atlantic coast (Figure 32). The structure type may or may not have had longitudinally running ridge poles that were used to connect the two bent sides, which could have been propped up on the large posts of the shorter sides. I doubt that this house form was originally created with individually set poles and later repaired in the wall trench method, as suggested by Jenkins (1982: 109) and Scarry (1998: 91), because the post sizes of the individually set posts of these composite houses are slightly larger and spaced further apart than those structures that are constructed completely with small individually set pole (Type III). Radiocarbon dates place this form at the beginning of the Moundville chronology, contemporary with the earliest wall trench and small individually set pole forms.

Based on the calibrated average date of radiocarbon dates from Structure 3 (AD 1030 – 1146 at 1s) of the Northwest Riverbank excavations at Moundville, and the ceramic analysis of Structure 1 from the Big Sandy Farms site, this composite construction form was constructed within the Early Moundville I phase. There is also a perfect example of a rebuilding episode that can provide chronological evidence. House 23 of the Roadway excavation was a composite construction structure utilizing both individually set posts and wall trenches, which was rebuilt twice, once in the same composite form, and the second time completely in the wall trench fashion. There are no dateable cases of this form in any other phase, indicating that perhaps this architectural form was no longer being utilized after Early Moundville I.

Type II. *Small Individually Set Pole Form*. This small individually set pole form, represented by twelve structures, was constructed with small poles that were positioned closely together. Examples of this architectural form occur at the Lubbub Creek site, the Big Sandy Farms site, the Bessemer site, and Moundville. The majority of these structures were rectangular in plan.

Based on the metric evidence, there does not seem to be a continuum in size or spacing between the small individually set pole form and larger individually set post form. Therefore, it is likely that these small pole structures were constructed in the same fashion as those using a wall trench. Both the small pole individually set form and the wall trench form, were most likely constructed with a continuous wall roof frame. Long poles would have been needed to complete the task, ones that could be bent over and bound to the opposing side. There is no indication of central roof supports, and interestingly, no indication of significant amounts of clay daub in these structures, suggesting that the walls were not covered in clay daub. Instead, daub may have been used sparingly as a plaster to cover gaps and holes.

In the Northwest Riverbank excavations, Scarry (1998: 91) determined that the small individually set pole structures (Type II) and the composite construction structure (Type Ia) were older than the wall trench structures (Type III). The composite construction form, Structure 3 of the PA tract, produced an average calibrated date of AD 1030-1146 at 1s , while the other small individually set pole structures (Structures 1, 2, and 6) produced a calibrated date of AD 1044-1151 at 1s . Of the wall-trench structures, Structure 4 of ECB excavations has a calibrated date of AD 1214 -1393 at 1s while Structure 5 at the PA tract excavations, has a calibrated date of AD 1221-1256 at 1s (Scarry 1998: 69). This evidence indicates that the small individually set pole form was contemporaneous or slightly more recent than the composite construction form, but appears to predate the wall trench method.

Figure 59 shows that the small individually set pole method was a dominant form during the Early Moundville I phase, but declined considerably in the Late Moundville I phase, and disappeared or became very uncommon by Moundville II, being replaced by the wall trench form. There is some evidence to suggest that the small individually set pole form continued in use sparingly throughout the Moundville II phase along with the more prominent wall trench form, as indicated by a small individually set pole structure (Structure 2) at the Powers site. Radiocarbon dating of this structure, which has been misidentified as a rigid post structure (Redwine 2002: 3), has produced a calibrated date with an intercept of AD 1360 ± 50 a two sigma range (Redwine 2002: 10). This structure was in possession of one centralized roof support and lacked large quantities of daub. However, it has been shown in the ethnographic evidence that flexed pole houses were occasionally constructed with one centralized roof support, as in the larger Zulu houses of South Africa.

Type III. *Wall Trench Form*. Forty-six examples of this form are in the sample. These occur at Lubbub Creek, Bessemer, and Moundville. All cases of this form were constructed with small, closely spaced poles, and with the exception of Structure 5b of the

Northwest Riverbank excavations, there were no indications of internal roof supports. Structure 5b has one support post sunk in the center of the floor (Scarry 1995: 154). Regardless, this single roof support is insufficient evidence that the structure had a separate roof component.

Notably, none of these wall trench structures possessed substantial amounts of clay daub. This evidence is contrary to the general belief that early Mississippian houses in west-central Alabama were usually created with daubed walls. Using clay daub would require a large amount of labor with very little benefit, as there were no eaves in this architectural form to protect the daub from rain runoff.

Like the architecture of the small individually set pole form, the wall trench form probably was constructed using a basket-like method consisting of a single wall roof component. None of these structures possessed horizontal trench wedges, so it is presumed that the vertical wall poles were stabilized through the use of a horizontal support placed above ground, as in the experimental construction. The wall trenches were constructed in number of ways. The majority were constructed with open corners, but a few possessed closed corners forming a continuous wall trench. It is usually assumed that the doors of this architectural form were typically positioned in the corners of the structure. This assumption comes from the fact that the corners are usually open, a misunderstanding of what the open corners are all about. However, it is not doubted that the door could have been placed anywhere along the wall, as with a few cases at Lubbub Creek in which the entryway is marked with wall trenches that lead to the center of a wall, not a corner.

As stated previously, Scarry (1998: 69) determined that the composite forms (Type I) and the small individually set pole forms (Type II) were slightly older than the wall trench form (Type III). Wall trench Structures 4 and 5 date to the Late Moundville I to Moundville II phase. Based on the chronological results, I believe that a majority of the Roadway structures, which are not independently dated, represent forms associated with Late Moundville I through Moundville II.

Type IV. *Large Individually Set Post Form*. This building technique, represented by thirteen structures, appears to be prevalent only during the later phases at the Lubbub Creek site and among the Moundville farmsteads. There is also one case of a large individually set post structure at Moundville, House 15 (McKenzie 1964: 239), which also indicates that this form was probably beginning to rise in popularity around the same time the chiefdom was being reorganized and individuals previously living at Moundville spread out up and down the Black Warrior River Valley (Knight and Steponaitis 1998). The large individually set post form is the predominant architecture among the excavated Moundville farmsteads, with all of the excavated examples occurring late in the Moundville sequence.

This architectural form is characterized by large, widely spaced individually set wall posts. There is a clear indication of internal roof supports in many of these houses, such as Structure 1 at the Powers site (Welch 1998: 146) and structures USN 6422, 7470, 3880 and 8168 at Lubbub Creek (Blitz 1979), whereas there are no clearly distinguishable internal supports in either of the Pride Place houses (Johnson 1999, 2001). These houses were also commonly constructed with large quantities of clay daub.

Based on the ethnohistoric and ethnographic data, these houses were constructed with a hipped or gabled roof. Several large, widely spaced wall posts were planted in the ground in order to support a wall plate. The wall plate supported the basal ends of the rafters. The upper portions of the rafters were supported by a roof plate or ridge pole, which was propped up by the internal roof supports. According to the chronological data, this form of large widely spaced post structure was not adopted in west-central Alabama until around 1400 A.D., the end of the Moundville II phase. From that point on, the large widely spaced post form was the predominant architectural form lasting into the Protohistoric era.

Type V. *Amorphous Post Daubed Form*. This form of structure is characterized by large, widely scattered, individually set posts, that indicate no clearly identifiable post hole patterns, but are marked by large quantities of daub. Based on the large individually set and widely spaced posts, this form was probably constructed in a rigid architectural fashion. There were no examples of this form in the sample, but they have been found at the Moody Slough site and the Furman site in west-central Alabama, and based on ceramic analysis, date to the Protohistoric period corresponding to Moundville IV, the Alabama River phase and Summerville IV (Curren 1984: 84).

Discussion

According to the most recent ceramic chronology (Knight et al. 1999), Type I, the composite construction form, which combines both small pole wall trench and larger individually set posts, and Type II, the small individually set pole structures, existed during the Early Moundville I subphase (AD 1120 – 1190). Both Type I and Type II houses were constructed in a flexed pole manner. However, whereas Type I had two flexed sides, Type II had four flexed sides.

Type I architecture was a short-lived form in this region, only existing in the Early Moundville I subphase. Type II, individually set small pole structures, such as Structures 1, 2, 6 at the PA Tract excavations on the Northwest Riverbank at Moundville (Scarry 1995), that characterized the Early Moundville I subphase, may have persisted as late as the end of

Moundville II, as indicated at the Powers site. This practice of using small individually set wall poles was partially contemporaneous with Type III, wall trench houses, or perhaps the wall trench method may have overtaken the small individually set practice, only for this method to return briefly at a later date, before the final transition to Type IV architecture, the large individually set rigid post form.

Type III, the subsequent wall trench form, existed during the early and late Moundville I (AD 1120 – 1260) and Moundville II (1260 – 1400) phases. However, according to the data this form occurred much more frequently in the latter half of the Moundville I subphase than in the earlier portion of the subphase. This form, like Type II, was constructed in a flexed pole fashion with four flexed sides and no internal roof supports. This method was overwhelmingly popular during this period but was quickly replaced by Type IV architecture by AD 1400, characterized by large individually set posts, typically with four internal roof supports.

During the Moundville III and Moundville IV phases, Type IV, large individually set rigid post structures were completely dominant. An example of this construction technique was located at the Powers site, in the form of a large post single set structure with four central roof supports (Redwine 2002). The transition from various methods of small pole construction to that of large posts with central roof supports also has been observed in East Tennessee (Webb 1938; Lewis and Kneberg 1946; Polhemus 1985), and Central and West Tennessee (Nash 1968). Large post houses in western North Carolina have been dated as early as AD 1200 (Dickens 1976), and along the Upper Savannah River as early as AD 1400 (Anderson and Schuldenrien 1985). Generally, this rigid post building technique was common during the late Mississippi/early Protohistoric period, and in some areas persisted

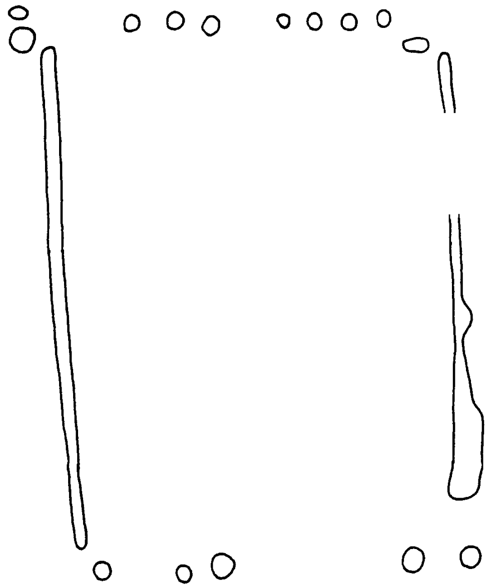
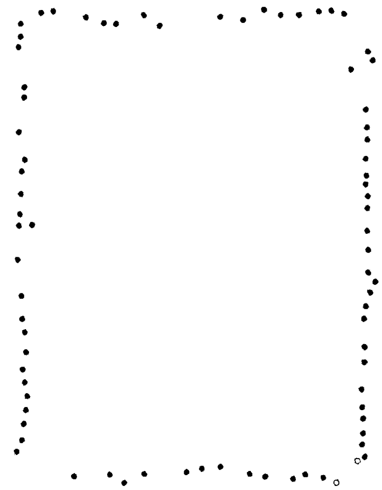
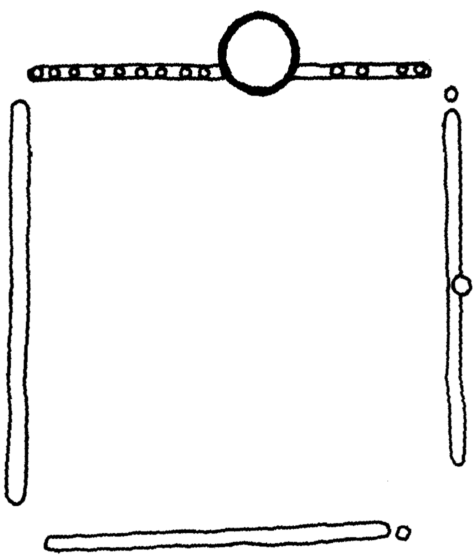
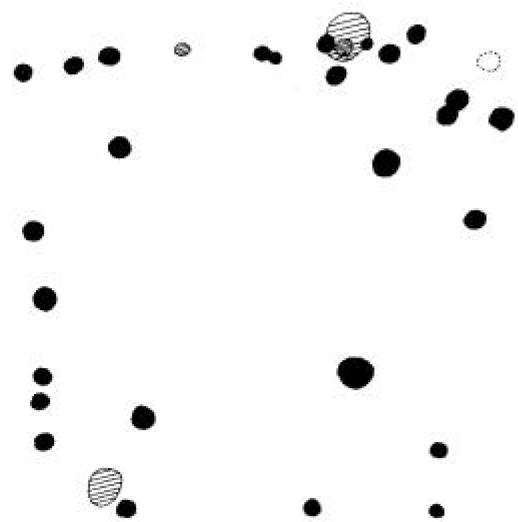
 **Type I – Composite Construction Form**	 **Type II – Small Individually Set Pole Form**
 **Type III – Wall Trench From**	 **Type IV – Large Individually Set Post Form**

Table 4. Diagram showing the four of the five house types in west-central Alabama.

Proposed Chronology of Basic Domestic Architecture

	Time Period	Floor Plans
AD 1120-1190	Early Moundville I	Type I, Type II, and Type III
AD 1190-1260	Late Moundville I	Type II and Type III
AD 1260-1400	Moundville II	
AD 1400-1520	Moundville III	Type IV
AD 1520 – 1650+	Moundville IV (Protohistoric)	Type IV and Type V

Table 5. Table illustrating the construction method of the various types of houses at Moundville and surrounding areas in west-central Alabama. The red line represents the transition from flexed pole to rigid post architecture.

into the historic period (Hally 2002). In the Moundville area, Type IV, the large individually set post form with four internal roof supports, was succeeded by another form of large post construction method during the Protohistoric period, Type V. This presently enigmatic building technique demonstrates no clear wall post patterns, marked only by heavy daub concentrations, and randomly distributed postholes (Curren 1984: 84).

Technological Change in Architecture

It has been established that there is a high probability that there were two forms of domestic architecture in west-central Alabama during the Mississippian stage. Through the establishment of a chronology, it is possible to determine that there appears to be a sudden, dramatic change in the architecture during the latter half of the Mississippian stage. It should be stated that the motivation for these technological changes from flexed pole to rigid post houses is not a primary concern of this study, but certainly the topic needs to be examined.

It also should be noted that the transition from flexed pole to rigid post architecture did not occur everywhere simultaneously, but it seems to occur rather abruptly in each local area. Terminal Woodland tribes such as the Iroquois of New York (Fenton 1978) or the Powhatan of the Virginia coastal plains (Callahan 1981, 1985), used flexed pole architecture in the creation of longhouses until European contact. However, in the Southeast, evidence demonstrates that Mississippian cultures made use of a rigid post form as early as the thirteenth century in Western North Carolina and Eastern Tennessee (Dickens 1976; Nash 1968; Polhemus 1985), while Du Pratz witnessed a flexed pole house construction in the lower Mississippi Valley during the eighteenth century (Swanton 1942). In west-central Alabama, this transition began around the beginning of the fifteenth century, according to the chronology that has been established in this study. The question therefore remains as to what caused this architectural transition, and why it was widespread in the southeastern United States.

In order to determine if in fact it was social circumstances that led to these changes in architecture, the floor areas of each house were recorded and compared to the corresponding type of architecture. According to Trigger (1968), the arrangement of a domestic structure reflects the social organization of the family unit. A large change in domestic floor area, whether positive or negative, would indicate an alteration in social conditions. For instance, if the floor size of a domestic house doubles, then one might assume that the structure is housing twice as many members. The average floor area of houses believed to be flexed pole structures ranged from 6.9 m^2 to 37.18 m^2 ($x = 19.61$, $s = 7.85$, $n = 56$) while the dwellings believed to be rigid post houses ranged from 8.84 m^2 to 37.00 m^2 ($x = 29.59$, $s = 9.79$, $n = 8$). Although the two sets were not equal ($n_1=56$, $n_2=8$), Levene's test for equality of variances indicated that the variances of the two means were equal ($F = .104$, $p = .749$) when assuming the required 90 percent confidence level for the test. As a result, a two-tailed t-test can be calculated to test the null hypothesis ($x_1 = x_2$) that the difference in the mean floor area of the two architectural types is not statistically significant. The results of the test indicated otherwise, in that there is sufficient evidence to reject the null hypothesis ($t = -3.262$, $df = 62$, $p = .002$). The confidence interval generated also supported the rejecting of the null hypothesis, in that the mean of flexed pole houses was 3.9 to 16.1 m^2 smaller than the mean of the proposed rigid post houses (Figure 59). In other words, there is statistical evidence to assume that the average flexed pole house was smaller than the average rigid post house, and therefore seems there was an increase in floor area corresponding with the change in architecture.

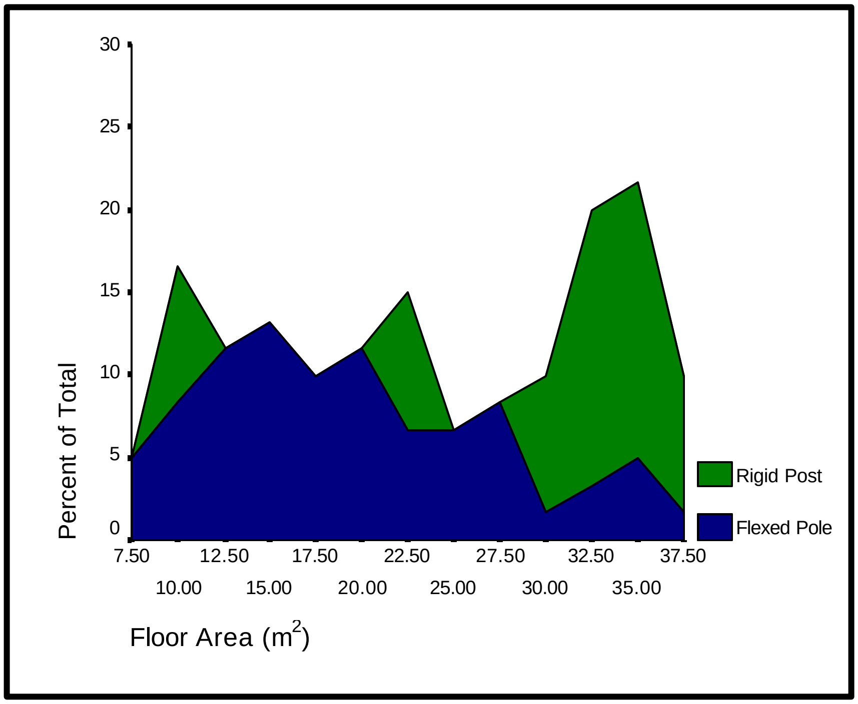


Figure 59. Chart illustrating floor area by architectural type.

According to Gunn (1994), the period AD 1250 – 1920 marked the Little Ice Age following a period of gradual warming. This climatic change may have influenced the architecture of the Mississippian stage. As temperatures began to cool, rigid post architecture may have arisen to protect the clay daub that was used with the production of eaves, as clay would make a better insulating material than grass or bark. Hally (2002: 91) also claims that the interior roofs of the rigid post houses in Georgia were also daubed, which would have produced a very heavily insulated building overall. If the climate did influence architecture, it is odd that it did not have any affect on the Terminal Woodland tribes of the Atlantic Coast and the Northeast, some of which lived in more extreme cold conditions without rigid post architecture or the use of daub throughout the Little Ice Age. Climate thus may have been a strong influencing factor, but is probably not the main cause of the architectural transition. However, it is difficult to ignore the fact that the Little Ice Age begins at the same time as the earliest rigid post structures in the Southeast.

Polhemus (1985) suggested one possibility for this transition might have been due to changes in resource variability. The earlier flexed pole method, with its single wall roof component, required that much of the construction material meet rather rigorous specifications. The wood would have to be flexible, yet strong, uniform, decay resistant, and most all, readily available. Based on the wood technology data, Polhemus stated that the wood that met the flexibility, strength, and uniformity requirements was usually not the most decay resistant (Polhemus 1985: 99). Consequently, smaller diameter wood is more susceptible to breakage, due to smaller deformities in the wood, as compared to larger deformities in large wood. In other words, having large deformities in large diameter wood is more structurally sound than small deformities in smaller diameter wood. This makes the process of choosing suitable woods more selective in flexed pole construction than in rigid post construction. With the large diameter rigid post houses, several different types of wood could easily be used for different tasks in the construction process. For instance, wood science technology has indicated that pine is a poor material to create a flexed pole house, but due to the exceptionally high crushing strength, pine would have made an ideal wood type for center roof supports in a rigid post house (Department of Agriculture 1987). Rigid post architecture allows for the use of different woods in different parts of the structure. For instance, woods that are more decay resistant could be placed in the ground, while the more flexible types could be used as roof framework (Polhemus 1985: 100).

Another possibility for the transition in architecture may have been based on a decrease in the availability of suitable materials. Small trees suitable for flexed pole construction (slender, long, and free of deformities) needed to meet strict qualifications. The longest, most bendable trees would be those located in a heavily canopied forest, the trees of which would have grown long and thin in order to compete for sunlight. Clearing land for agricultural, domestic, and ceremonial purposes decreases the canopy, which produces the most suitable flexed pole members. These long and slender trees would have quickly been exploited, leaving only larger trees. Climate may have influenced this process slightly. Colder temperatures would slow the reproduction and growth of the hardwood trees, which seem to be the most viable option for flexed pole houses. Larger trees obviously cannot be bent, therefore, rigid post architecture may have arisen in order to provide shelter to those who had increasing limited access to suitable small poles.

The only evidence for material availability that can be provided is that of personal experience. In the wood bending experiments, three locations were used to retrieve suitable specimens for testing. Thirty-two poles of both oak and hickory were collected in this experiment. In building the experimental structure, roughly fifty poles of white oak were cut (only 46 were used). After these eighty trees had been harvested, the areas being used to collect these trees began to exhibit rather few specimens that met the specifications. Granted, the areas being utilized were not incredibly large, nor did we wander very far from the road. However, most of the white oaks and hickories that could still be located in the subject areas were either too large, too small, or twisted. This depletion occurred after the construction of what would have been approximately two completed flexed pole frameworks. It has been estimated that Moundville would have been occupied by approximately 1,050 – 1,680 people during the Moundville I phase based on the average density of houses from the Northwest Riverbank excavations (Steponaitis 1998: 42). Based on this estimation of the number of residences and assuming that were roughly 5 – 8 people per residence (Swanton 1911: 43), there should be approximately 131 – 336 houses. If the building techniques utilized in the experimental structure were accurate, then it would take an average of fifty poles to create a flexed pole dwelling. Therefore, roughly 6,500 – 16,800 wooden poles would have been needed to house the Moundville inhabitants at any given time during Moundville I. The average house life has been estimated at 10 years for the wooden framework (Warrick 1988), therefore it would taken estimated 91,875 – 235,200 thin, flexible, wooden poles to house the Moundville inhabitants for the entire length of the Moundville I phase, assuming there were no large changes in population.

Upon examining all the possibilities for the architectural shift, it is difficult to state that one explanation is more accurate than another. It appears that there were probably several reasons for this shift. First, evidence suggests that there was a change in floor area with the transition in architecture. This many be due to a change in the social unit of the family or perhaps due to change a change in cultural preferences. With the appearance of rigid post architecture is seen an increased segregation of work or personal space. This division was created by using rows of posts in the interior of the house to create individual rooms. These partitions were commonly built using rows of posts that extended from each corner to the corresponding roof support (Polhemus 1985: 95). This can be seen in several of the rigid post structures in this study, including Structure 1 from the Powers site and Structures USN 8168, USN 3880, and USN 2317 from the Lubbub Creek site.

Secondly, climate also may have influenced the transition of house forms. Rigid post architecture appears at the very beginning of the Little Ice Age. With eaves to protect daub, rigid post houses may have been better suited for colder temperatures. However, the majority of rigid post structures in Eastern Tennessee and Western North Carolina (Dallas, Pisgah, and Mouse Creek phases) do not have wall daub. Daub is restricted to the interior partitions and, more consistently to the underside of the roof component from the main roof supports to the center of the structure. There is no daub on outer portions or roof interior (Polhemus 1987). Thirdly, these houses also could have been constructed with several different wood types with a larger array of qualities, and placed in positions that would have increased the life of the structure. The wood selected for the construction of these dwellings did not have to meet as stringent criteria, therefore expanding the range of wood that could be used, which may have been necessary due to the exhaustion of the particular type of saplings needed for flexed pole construction.

Chapter 7
Conclusions

This study had several objectives. The primary objective was directed at providing evidence in support of hypotheses that small, closely spaced wall poles represented a different architectural form than that of large, widely spaced individually set posts in Mississippian houses of west-central Alabama, and that the most common house type at Moundville, the wall trench form, was of a flexed pole form. In order to support such hypotheses, several subsidiary concerns were formulated and examined prior to the testing of the primary hypothesss. The results of these secondary concerns not only reinforced the primary objective but produced results that were capable of independent interpretation. These concerns included ethnographic studies of African and Mesoamerican domestic structures, a history of the architectural conceptions of Mississippian architecture in the Southeast, wood technology, structural engineering, experimental archaeology studies of Native American architecture, and a typology and chronology of Mississippian houses in west-central Alabama, with an attempted explanation of the transition between two major architectural forms.

These secondary concerns relate to the primary hypotheses in that the ethnohistoric accounts of the Southeast United States, as well as ethnographic accounts of Africa and Mesoamerica indicate two distinct domestic houses forms, continuous wall-roof framed houses and those structures that possess separate wall and roof components. The results of these studies also indicate that flexed pole houses had wall poles that were typically closely spaced and of small diameter. On the other hand, the separate wall and roof component structures utilized larger, wider spaced wall posts that were not spaced or aligned with the same degree of accuracy as in flexed pole architecture, probably because they were not weight bearing. The ethnographic analogies drawn from these areas also demonstrate that a variety of materials, techniques, and floor plans were used in the creation of both architectural forms. Concerning the flexed pole form, a variety of roof supports were found to be utilized, including arrangements of one or two central roof supports in some of the larger domestic houses, providing evidence that one central roof support does not necessarily indicate a rigid post structure, but instead may indicate a flexed pole structure. Structural forms were not found in ethnographic evidence that possessed a hipped or gabled roof supported by one central roof support. Additionally ethnographic information also demonstrated a lack of clay daub on houses created in the flexed pole fashion.

Wood science technology, structural engineering, and experimental archaeology confirmed that the small, closely spaced pole form was the most architecturally suitable type for the archaeological floor plan of small closely spaced pole structures. Wood science technology indicated that various wood types could be used to construct this form, but that the woods with the most workability include oaks and hickories. Structural engineering was used to demonstrate the structural integrity of this flexed pole form as opposed to a small, closely spaced separate wall and roof component method, while experimental archaeology was utilized to demonstrate that the flexed pole form is as practical as it is plausible.

Statistical evidence concerning post diameter and post spacing in a sample of archaeological structures confirmed that these two architectural forms were present at Moundville and in surrounding areas. Based on this evidence, the hypothesis is supported, in that there is a bimodal distribution in this sample in both wall post diameter and wall post spacing, indicating a small and a large log form, with a closely spaced and widely spaced wall post method. Correlation analysis was used to show that small poles are almost exclusively closely spaced and that larger posts were always widely spaced. In other words, the larger the posts were in diameter, the more widely the posts were spaced.

Assuming that there are multiple forms of above ground architecture, as the evidence has shown, it was predicted that the forms would be chronologically distinctive, at least relatively. Therefore, they were sorted into a typology and a chronology. The typology was created using the analogies of ethnographic and ethnohistoric information and the information generated through structural engineering and experimental archaeology. Radiocarbon dates, along with ceramic dating, made it possible to formulate a chronology of west-central Alabama houses during the Mississippian stage. It appears that a composite form (Type I) and a small individually set pole form (Type II) generally predate wall trench structures (Type III) as the dominant form of architecture. It also appears that small pole architecture in general (Types I, II, III) precede forms that utilize rigid post architecture (Type IV, V), which are introduced at about AD 1400.

Climate, social, and environment models were examined in order to propose a reasonable cause for the change from flexed pole to rigid post architecture. Climate and environmental conditions may have been indirectly linked to the change in housing, as the Little Ice Age (AD 1250 – 1920) began around the time that rigid post houses begins to appear. However, there also appears to be evidence that there was a change in social structure or personal space that may have contributed to the transition or perhaps may have simply resulted from the change. Material variability and availability also may have been a contributing factor to this transition.

With the mutually supportive outcome of all subsidiary concerns, it is possible to conclude that the small pole form is indeed a separate type of architecture from rigid post architecture. Flexed pole structures, which are defined by small, closely spaced wall poles, were the ordinary structures in west-central Alabama during the early half of the Mississippian stage, but the form gave way in Late Mississippian times to rigid post structures, an archaeologically distinguishable type of dwelling. Characteristics of these rigid post dwellings include large, individually set, widely spaced posts, and normally the use of four strategically placed interior roof supports. These are two separate architectural concepts that appear to be chronologically distinct with no transitional architectural form in this area.

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