To the Graduate Council:

I am submitting herewith a thesis written by Philip J. Carr entitled "Organization of Technology and Lithic Analysis: Prehistoric Occupation of the Hayes Site (40ML139)." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

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ORGANIZATION OF TECHNOLOGY AND LITHIC ANALYSIS: PREHISTORIC HUNTER-GATHERER OCCUPATION OF THE HAYES SITE (40ML139)

A Thesis

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ABSTRACT

The Hayes Site (40ML139) is located in the central Duck River Basin of Middle Tennessee. Excavations at the site revealed Middle Archaic, late Middle Archaic, and Late Archaic components. An examination of the lithic assemblage from the Hayes Site aids in assessing and building models of hunter-gatherer organization for the central Duck River Basin. An organizational perspective on technology, results from published flintknapping experiments, and a lithic resource survey provide the means of constructing and employing an interpretive framework for understanding prehistoric occupation of the Hayes Site. It was found that materials from the Middle Archaic components represent forager residences and the Late Archaic component represents both forager and collector residences. These findings support the model of hunter-gatherer organization formulated by Amick (1984) for the central Duck River Basin.

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Chapter I

Introduction

In a recent review of hunter-gatherer archaeology, Thomas (1986:247-251) found it necessary to "boo" lithic analysts for "chasing rainbows" and not actively participating in middle range theory building. Others have described lithic studies as atheoretical and tangential to current archaeological pursuits (Amick 1984:1; Cross 1983:88; Dunnell 1980:466-467, 1984:496-497). However, the study of lithic materials is essential for a complete understanding of the past. Some progress has been made over the past decade in addressing criticisms leveled at them, and as a consequence, lithic analysts now stand on firmer theoretical ground and can provide new insights into prehistoric lifeways. Specifically, progress has been made in the development of concepts concerning the organization of technology and in the pursuit of flintknapping experimentation.

In this study, published findings from flintknapping experiments and an organization of technology approach are used to analyze the lithic assemblage from the Hayes Site (40ML139) located in Middle Tennessee. The goal of this study is to understand the prehistoric occcupation of the Hayes Site and to assess models of hunter-gatherer organization that have been previously suggested for the central Duck River Basin. In so doing, an approach is developed that draws heavily on the works of others but remains suited to the analysis of the Hayes materials.

The first step in developing this approach was to devise an interpretive framework for prehistoric hunter-gatherer organization and occupation of the Hayes Site. In order to place the interpretive framework into proper context, concepts from the study of the organization of technology and the distribution of raw materials in the area of the Hayes Site were reviewed. To employ the interpretive framework, inferences made from the Hayes lithic assemblage must be reliable. The ability of any archaeologists to make reliable inferences from the archaeological record has been called into question (e.g. Tilley and Shanks 1987a) and is part of the processual-postprocessual debate currently raging in the discipline. This debate is reviewed and it is argued that through middle range research and multiple lines of evidence archaeologists are in a position to make reliable inferences. The type of middle range research that is the key for lithic analysts is experimentation, but not all experiments are equal.

The conduct of a good experiment is reviewed and four basic design features (relation to theory, accuracy, validity, and coverage) are examined. In order for experimentation to aid archaeologists in making reliable inferences, these design features must be more fully utilized in experimentation. Classes of flintknapping experiments are defined and examined in terms of these four design features. Two experiments in the debitage classification group are of greatest importance in this research. These are the experiments conducted by

Magne (1985) and Ahler (1988, 1989) which measure equally well against the four design features.

The focus of this study is the debitage from the Hayes Site. A sample of the debitage was first sorted into raw material categories using written descriptions (Amick 1984, 1985) and a chert type collection. Methodology for classifying debitage into manufacturing stages developed and tested by Magne (1985) through flintknapping experimentation is used to further divide the sample of debitage into early, middle and late stages of manufacture. Findings by Ahler (1988, 1989), also based on experiment, provide multiple lines of evidence to evaluate the classification using Magne's (1985) methods.

Frequencies of local/nonlocal chert types and manufacturing stages from each of the three components at the Hayes Site are compared to the interpretive framework. This study suggests that during both components of the Middle Archaic the Hayes Site was used as a forager residence. During the Late Archaic occupation of the site it was used as both a forager and collector residence. These results provide support for the model of prehistoric hunter-gatherer organization suggested by Amick (1984, 1985). The analysis of a sample of the lithic assemblage from the Hayes Site cannot be used to unquestionably assess the use of the site by prehistoric hunter-gatherers over time, but the groundwork is laid for future research.

Columbia Archaeological Project

The central Duck River Basin of Middle Tennessee has been an area of intensive archaeological investigation since the late 1970s. Much of this work has been conducted as part of the Columbia Archaeological Project. The goal of this project was the generation of data pertinent to understanding the interactions of prehistoric human groups with a changing Holocene environment (Klippel 1977). This goal has been realized for the Archaic period, especially the 8000-4000 B.P. timespan. Models of hunter-gatherer organization and adaptive systems have been constructed based on the collected data (Amick 1984; Hofman 1984). These models are a first step in understanding hunter-gatherer lifeways in the central Duck River Basin and as such require further evaluation and testing.

As part of the Columbia Archaeological Project, Amick (1984) developed a chert type collection for the central Duck River Basin and determined chert type distributions through a lithic resource survey. His survey was thorough and included the examination of gravel bars. This type of survey is necessary for examining current models of hunter-gatherer lifeways employing lithic data.

The huge amounts of data generated by the Columbia Archaeological Project coupled with the models which synthesize much of these data, along with the chert resource survey make the central Duck River Basin an ideal arena for the examination of the organization of prehistoric hunter-gatherer stone tool technology. Amick's (1984) study of the lithic assemblages from seven sites in the central Duck River Basin

was a first step in accomplishing this. He determined, through lithic analysis, that the Middle Archaic was a time of high rates of residential mobility and expediently organized technology while the Late Archaic was more logistically organized with a curated technology. He suggested that these findings were further supported by independent environmental and demographic data; namely, that the Middle Archaic was a time of stress derived from both resource deterioration due to the hypsithermal and population packing in the Inner Nashville Basin.

Other investigations do not support the model presented by Amick (1984). Hofman (1985) through his investigation of human burials suggests that Middle Archaic shell midden sites in the central Duck River Basin were used by logistically organized aggregate groups of hunter-gatherers. This potentially conflicts with Amick's view that the Middle Archaic was a time of high residential mobility. Morey (1988) in his investigation of the faunal remains from the Hayes Site found no evidence to suggest that Middle Archaic populations were under subsistence stress, thus undermining the evidence Amick (1984) cited to support his model. Clearly, more work is needed to sort out the organization of Archaic hunter-gatherers in the central Duck River Basin.

The Hayes Site

Hayes (40ML139) is a large, multicomponent site located at the confluence of Caney Creek and the Duck River in Middle Tennessee (Figure 1.1). The site was tested as part of the Columbia Archaeological Project and consisted of approximately 14,000 m^2. A large portion of the site (9,000 m^2) was a Middle Archaic shel midden (Morey 1988). Middle Archaic, late Middle Archaic and Late Archaic components were identified at the Hayes Site by Turner (n.d.) using projectile point typology, radiocarbon dates, and stratigraphic context.

Excavations at the Hayes Site proceeded in three phases, in which a total of 67 1x1 m units were excavated. The first phase was initial testing of the site consisting of a discontinuous one meter wide trench (referred to as the 920 trench) running from the bank of the Duck River to the midden apex. The 920 trench (25 total units) was excavated using a backhoe and hand excavations.. Hand excavated units covered 1x1 m areas and were excavated in arbitrary 10 cm levels. The excavated matrix was waterscreened using 6.4 mm and 1.6 mm mesh hardware cloth and a 10x10 cm section of each level was removed separately for flotation. The second phase of excavation consisted of a completely hand excavated discontinuous trench (1004 trench) perpendicular to the 920 trench. The 1004 trench (32 total units) began a little south of the midden apex and ran nearly to the bank of Caney Creek. The 1004 trench excavations followed the hand excvation methods outlined above. The third phase of the investigations at the

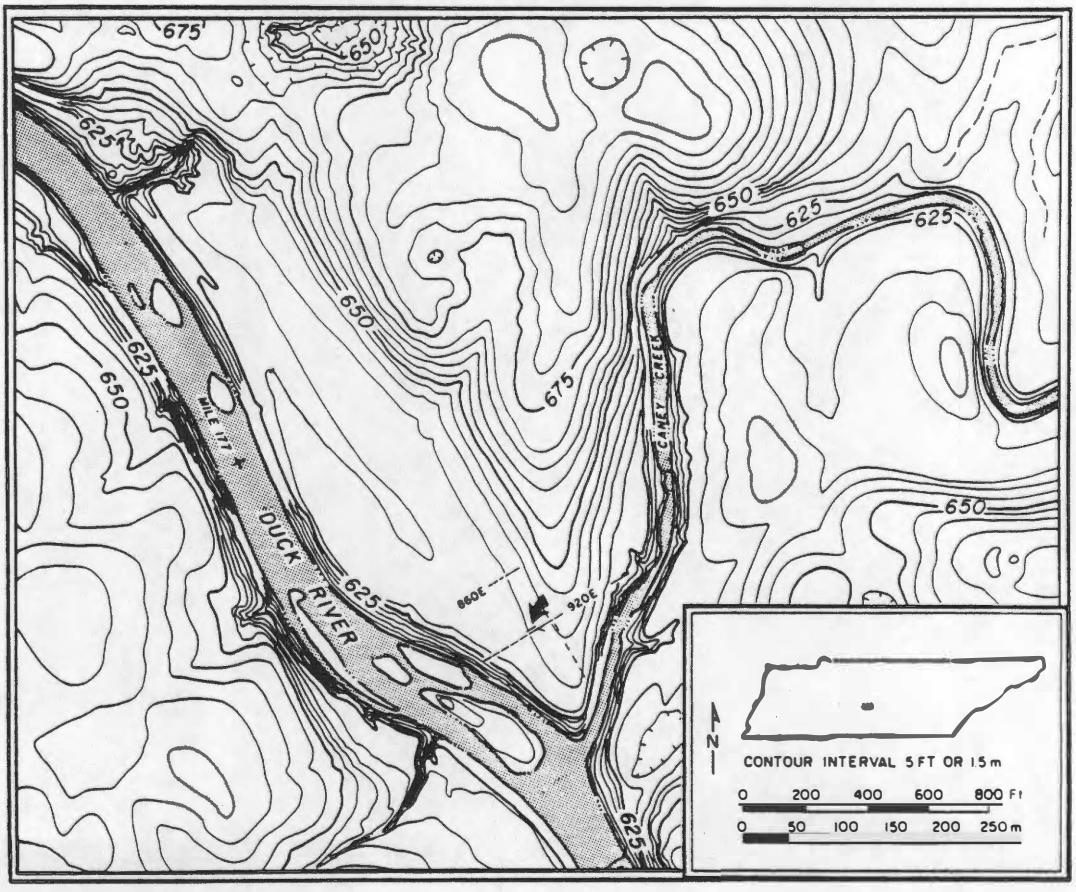

Figure 1.1: Map of the General Vicinity of the Hayes Site Showing the Trench Excavations (after Klippel and Morey 1986)

Hayes Site involved the stratigraphic excavation of a 1x3 m area (referred to as the block). A five meter section of the west wall of the 920 trench was excavated back to the 919 line and a 2x5 m area was gridded off along the five meter stretch. A 1x3 m block was defined which was surrounded by seven unexcavated units. Surrounding units were excavated as noted above for manual methods which isolated the 1x3 m block. Stratigraphic boundaries were mapped and the block was excavated according to natural strata. In this manner, the block unit was excavated with more control and with less mixing of distinct stratigraphic levels.

In suggestions for future work with materials from Hayes, Morey (1988:151) considers the examination of the lithic materials of prime importance especially focusing on attributes which would allow for comparisons to the work by Amick (1984). Analysis of this type is currently being conducted using materials recovered from the stratigraphically excavated block but this represents only a small portion of the total Hayes lithic assemblage. In light of the fact that Amick's analysis was undertaken six years ago, an examination of a sample of lithic material from the trench excavations at the Hayes Site which takes advantage of recent advances in lithic analytical techniques is also important. Although the attributes would differ, the basic goal remains the same: to make sound inferences concerning organizational aspects of prehistoric hunter-gatherer lifeways in the central Duck River Basin. This is the strategy to be followed here.

The analysis of the lithic assembalge from the Hayes Site will not answer all of the questions concerning the organization of hunter-gatherer lifeways during the Archaic period in the central Duck River Basin. Rather, this analysis is one step in the process of increasing our understanding in this area. The approach taken here focuses on utilizing advances in archaeological method and theory, especially those concerned with the organization of technology and lithic analysis. In this way, inferences concerning the interpretation of the lithic assemblage from the Hayes Site are made more reliable.

Chapter II

The Study of Prehistoric Hunter-Gatherers and Implications for the Hayes Site

Significant advances have been made over the past two decades in hunter-gatherer archaeology. Many of these advances were made through the adoption of an organizational approach to investigating hunter-gatherer lifeways. One specific area in which an organizational approach has proved useful is in the examination of hunter-gatherer stone tool technology. A review of the organizational approach as it relates to hunter-gatherer mobility is presented as well as a review of the study of technological organization. Hypotheses and implications based on an organizational approach are developed for stone tool usage at the Hayes Site which provide the framework for the interpretation of the lithic assemblage from the site.

An Organizational Approach to Hunter-Gatherer Mobility

Binford (1977, 1978, 1979, 1980, 1981) is responsible for many of the recent advances in the study of hunter-gatherers. The organizational approach that he advocates has potential for providing insights into the patterning and variability found in the archaeological record of prehistoric hunter-gatherers. One focus of organizational studies has been mobility strategies. Mobility can be defined as the manner in which hunter-gatherers move across a landscape during a seasonal round (Kelly 1988). Understanding

differential mobility has implications for other apsects of hunter-gatherer lifeways. For example, a decrease in hunter-gatherer residential mobility has been linked to increasing complexity (Price and Brown 1985:9). Mobility, as such an important part of hunter-gatherer adaptation, "needs to be accounted for theoretically and documented empirically" (Sassaman et. al. 1988:79). An organizational approach can fulfill both of these needs.

Using an organizational approach Binford (1980) developed the forager-collector model to describe hunter-gatherer mobility. Foragers are said to have a high degree of residential mobility so that consumers are moved to resources. Foragers generally do not store food but range out in search of food on an encounter basis and return each day to their residential base (Binford 1980:5). Collectors, on the other hand, exhibit less residential mobility and move resources to consumers through logistically organized task groups. Collectors "map onto resources" and store food for at least part of the year (Binford 1980:10). Although a dichotomy is drawn between foragers and collectors, Binford (1980:19) rightly makes the point that "logistical and residential variability are not to be viewed as opposing principles... but as organizational alternatives which may be employed in varying mixes in differing settings". The forager-collector model has become a basic tool for archaeologists studying prehistoric hunter-gatherers.

Another aspect of hunter-gatherer organization, related to mobility, is aggregation-dispersion (fusion and fission). The

aggregation-dispersion pattern of hunter-gatherer group composition has been ethnographically documented (e.g. Lee 1979). It has been suggested that prehistoric hunter-gatherers, especially in seasonal environments, were organized to allow for periodic aggregation and dispersion (Conkey 1980; Hofman 1985). During certain times of a seasonal round hunter-gatherer groups are small and dispersed and at other times these groups come together to form a large aggregate. The adaptive advantages of group aggregation include adjustments to ecological conditions and information exchange concerning resources, but the social and ritual components of aggregation must also be considered (Conkey 1980; Hofman 1985). Hofman (1985) has argued that many hunter-gatherer groups likely used both forager and collector strategies, employing a collector strategy when the group comes together to form a large aggregate. The forager-collector model coupled with the aggregation-dispersion pattern illustrates the complexity of hunter-gatherer adaptation and the potential diversity to be encountered in the archaeological record.

Archaeologists investigating the organization of prehistoric hunter-gatherers strive to reconstruct mobility strategies, group composition, and the relation of these variables to the seasonal cycle. Although the forager-collector model is an important and popular method to characterize hunter-gatherers, problems have arisen in operationalizing these concepts for archaeological study (Hofman 1985; Thomas 1983). One of these problems is variable site utilization (Binford 1982). That is, a site used during one season as

a collector residential base could have been used as a collector extractive camp during another season after the residence has been moved. Moreover, the complexity of the problem increases when considering the seasonal mixing of forager-collector mobility strategies. A site used as a forager residential base could be used during another season as a logistical extractive camp by essentially the same group. In addition to variable site utilization from season to season, there is the difficulty distinguishing between an extractive camp used repeatedly by a small task group versus a residential base occupied only occasionally by an aggregate group. It should be evident that differential mobility and group composition can interact to produce a wide range of variability in the archaeological record. Methods must be developed that overcome these problems and sort out the variability.

Organization of Technology

The study of the manner in which technologies are organized, although first developed in the 1970s by Binford (1977, 1978, 1979), is still in its infancy today. Only recently are the concepts which make up this area of research being assessed, applied, and further developed (Amick 1984; Bamforth 1986; Kelly 1988; Koldehoff 1987; Magne 1985; Nelson 1991). Technological organization has been variously described and defined (Binford 1979; Kelly 1988; Koldehoff 1987; Nelson 1991) but differences in these definitions are primarily in terms of emphasis and degree of generality. The definition

formulated by Kelly is sufficiently broad to encompass others and it has a behavioral orientation. Technological organization is

> the spatial and temporal juxtaposition of the manufacture of different tools within a cultural system, their use, reuse, and discard, and their relation not only to tool function and raw-material type, but also to behavioral variables which mediate the spatial and temporal relations among activity, manufacturing, and raw-material loci (Kelly 1988:717).

The goal of studies of technological organization is to determine which technological strategies or combination of strategies were used prehistorically and how these are related to more general behavioral issues including differential mobility and group composition.

Curation and expediency are two strategies described by Binford (1977) that are commonly used in the examination of stone tool technologies. Opportunistic behavior has been added by Nelson (1991) as a third strategy. Prehistoric stone tools and debitage are examined to determine which strategy is represented in a particular archaeological assemblage. Based on this data, other inferences can be made concerning mobility.

Curation has several dimensions (advanced manufacture, caching/storage, reshaping, transport), "but a critical variable differentiating curation from expediency is preparation of raw materials in advance of inadequate conditions (materials, time or facilities) for preparation at the time and place of use" (Nelson 1991:62-63). Curation can solve at least two problems. The first is time stress. Time is invested in manufacture prior to resource

acquisition so as to maximize "capture time" (Torrence 1983). The other problem solved is the lack of raw materials or tools at the location where tools are to be used. Binford (1977:35) has argued for a strong link between curation and logistical mobility "since both are organizational responses to conditions in which improving efficiency would pay off".

Expediency is the counter of curation and the definition of expediency to be followed here is "minimized technological effort under conditions where time and place of use are highly predictable... expediency anticipates the presence of sufficient materials and time" (Nelson 1991:64). This definition of expediency is at odds with Binford's definition. Binford (1977) suggested that an expedient technology is less organized than a curated one. It is clear from Nelson's (1991) discussion that expediency is an organized strategy employed when planning allows for time and raw material availability. Bamforth (1986) considers the linkage made by Binford (1977) between collectors and curation to imply that there is a connection between foragers and expediency.

Opportunistic behavior "is not planned" and is "responsive to immediate, unanticipated conditions" (Nelson 1991:65). Although for both expediency and opportunism, tools are produced at the time and place of use, these two strategies should not be merged. That expedient behavior is planned while opportunism is not has different implications for the manufacture and distribution of stone tools.

Opportunism has not been specifically associated with a particular mobility strategy.

Technological strategies have been linked to mobility strategies because it has been argued that mobility is likely to have a significant impact on the organization of hunter-gatherer stone tool technology (Binford 1977; Kelly 1988). That is, hunter-gatherers employing different mobility strategies would likely organize their technologies differently. Thus by documenting differences in technological strategies inferences can be made concerning mobility strategies. However, Kelly (1988:719) cautions that stone tool manufacture is responsive to "conditions concerning tool needs and raw material availability" and that these conditions can be similar for both collectors and foragers. The result could be the same technological strategy employed by groups using different mobility strategies. Although mobility has an impact on which technological strategies are utilized, there seems to be no direct correlation between technological strategy and mobility strategy (Bamforth 1986; Kelly 1988).

Nelson (1991:59) identified five levels of analysis in organization of technology research. These levels are arranged in a hierarchy based on distance from material implications. In her diagram (Figure 2.1), artifact form is at the bottom with design, technological strategy, and social/economic strategy being succesively higher levels of analysis. Thus, technological strategy can be

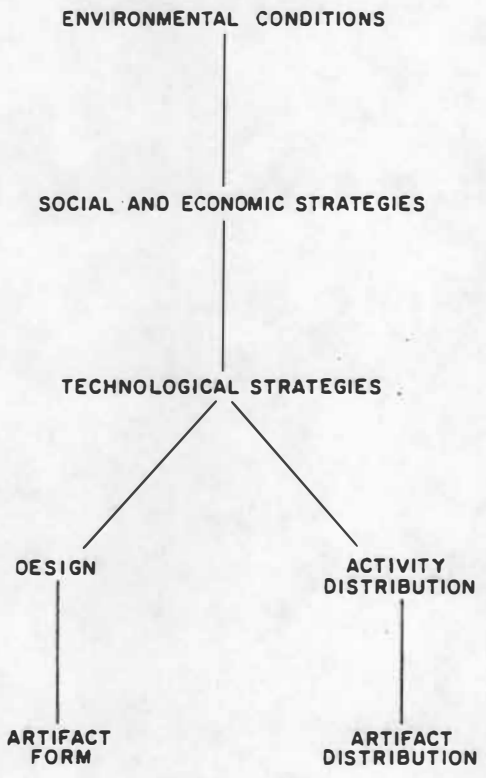

Figure 2.1: Levels of Analysis in Organization of Technology Research (after Nelson 1991)

studied through design which can be examined through artifact form. Design occupies an important level in this hierarchy because of its close proximity to artifact form.

Bleed (1986) discussed two design alternatives, reliability and maintainability, that can be used to optimize the availability of any technical system. Availability is defined as "the amount of time that a system is available to do a job" (Bleed 1986:739). A system designed to be reliable is dependable so that it will work when needed. Characteristics of a reliable system include overdesigned parts, careful fitting of parts, and overall good craftmanship (Bleed 1986). Maintainable systems can be "quickly and easily brought to a functional state" even if broken or not designed for the specific task at hand (Bleed 1986:739). Maintainable systems are characterized as light and portable, extra components ready for use, design for partial function, and repair/maintenance occur at use. Bleed (1986), after examining the costs and benefits, relates these design alternatives to the forager-collector model. Maintainable systems are best used for generalized tasks where there is a continuous need but unpredictable schedules and failure costs are low. Reliable designs wil be used when failure costs are high or when tasks have predictable schedules with available downtime. According to Bleed (1986), foragers would optimally be equipped with maintainable weapons and collectors with reliable weapons.

Nelson (1991) examines the concept of design using Bleed's (1986) work as a basis for the discussion. She identifies versatile and

flexible designs as two ways of attaining maintainability. Flexible tools are designed to be changed in form in order to achieve multifunctional needs. Versatile tools are designed to be maintained in a generalized form to achieve multifunctional needs. Nelson also adds transportability as a design strategy. A toolkit designed to be transportable will "accomodate the constraints of mobility and anticipate future needs" (Nelson 1991:). Transportable systems are characterized as being small, lightweight, and resistant to breakage. The distinction between maintainable and transportable designs is not altogether clear and the latter would appear to be subsumed by the former. It may be more appropriate to focus on reliable and maintainable designs as basic alternatives as suggested by Bleed (1986). Maintainable designs could be further examined by considering characteristics such as versatility, flexibility, and transportability.

Curiously, Nelson (1991) fails to examine the relationship between design alternatives and technological strategies even though they are closely linked in her analytical scheme. Also, Bleed (1986) was able to relate design alternatives directly with economic strategies (forager-collector) without first examining technological strategies (curated, expedient, opportunistic). The relations of the concepts at different levels in Nelson's (1991) diagram are thus unclear.

Upon closer examination of reliable and maintainable designs, it is clear that these are design alternatives for a curated technological strategy and cannot be related to an expedient strategy.

Reliable and maintainable designs are alternatives for optimizing time in terms of system availability. An expedient technology is used when sufficient time is expected to be available. "Where availability does not matter, the system may not be markedly reliable or maintainable" (Bleed 1986:740). It would be expected, by definition, that expedient technology would not be markedly reliable or maintainable. In terms of design, expediency entails minimized technological effort. Besides the recognition that expediency is a planned activity (Nelson 1991) very little examination of this technological strategy has been accomplished.

Expediency has been associated with foragers but convincing arguments of this association do not exist and the relationship is more by default (Bamforth 1986). Accepting the argument by Bleed (1986) that foragers would employ a maintainable design and collectors would use a reliable design then in both mobility strategies tools would be curated. This is not terribly surprising, but the association of foraging with expediency is called into question. Expediency, unlike curation, has not been given a great deal of attention. Parry and Kelly (1987) have examined expedient core technology and found that it is used by both highly mobile and sedentary groups. Expedient technology can be employed by highly mobile hunter-gatherers when raw material is abundant or locally available. Sedentary groups can use such a technology if there is locally available raw material or if it can be stockpiled. Collectors, who are sedentary for part of the year, can be expected to

practice some expedient production of tools at base camps if raw materials are available. The realization that foragers and collectors are both likely to use curated and expediently produced tools underscores the point that mobility and technological strategy are not directly correlated.

Although an organization of technology approach is still in its infancy, advances have been made in recognizing the complexity of the relationships between mobility, technology, design, and tool production. It is no longer possible to assume a direct correlation of foragers to expediency and collectors to curation. It is more realistic to assume that both foragers and collectors will employ expedient and curated tools. This is not to say that an organization of technology approach cannot be used to make inferences concerning mobility. Rather, for an organization of technology approach to be effective, a more sophisticated view of the relations of mobility strategy, technological strategy and raw material distribution is needed. Foragers and collectors both employ curated tools but these tools are designed differently. Based on the implications for these designs, foragers and collectors should be recognizable in the archaeological record. Also, a specific knowledge of raw material distributions will aid in developing other implications for distinguishing forager assemblages from those of collectors. Archaeologists have come to the realization that the archaeological record of hunter-gatherers is diverse and complex. Simple methods and models based on one-to-one correlations cannot be employed to make

realistic statements about prehistoric hunter-gatherers. Methods and models must be sophisticated in order to perform adequately but not become so complex that it is unclear what is being measured.

Foragers and Collectors in the Central Duck River Basin

Models of differential hunter-gatherer mobility have been developed for the Middle and Late Archaic periods in the central Duck River Basin by Amick (1984) and Hofman (1985). Amick (1984) develops hypotheses and associated archaeological implications based on an organization of technology approach to stone tool usage. His findings suggest that Late Archaic hunter-gatherers were more logistically organized than the Middle Archaic. Amick considers the Middle Archaic to have been a time of stress derived from both resource deterioration due to the hypsithermal and population packing in the Inner Nashville Basin which he uses as further support for his model. Hofman (1985) employs an organizational approach to study human burials. He shows that mobility is likely to have had an impact on mortuary practices and that different types of burials will be found at dispersed and aggregated sites. He suggests that Middle Archaic hunter-gatherers used a seasonal mix of foraging and collecting strategies, and that shell midden sites in the central Duck River Basin were used by aggregates employing a collector strategy. Both Amick and Hofman recognize that their models are first steps in understanding hunter-gatherer organization in the central Duck River Basin and further testing is required.

There is some conflict between the models suggested by Amick and Hofman. In Amick's model, the Middle Archaic is nonlogistically organized compared to the Late Archaic but Hofman suggests that Middle Archaic shell midden sites were used by logisticaly organized aggregates. There are two possibilities for resolving the apparent conflict between these models. First, if a seasonal mix of strategies was used during the Middle Archaic with the Late Archaic more logistically organized overall. Second, the Hayes Site could have been occupied by an aggregate group of hunter-gatherers acting as foragers not as collectors.

Morey (1988) offers an alternative to Amick's interpretation of the Middle Archaic as a time of resource stress. He agrees with Amick that hunter-gatherer groups of the Late Archaic were generally more logistically organized than during the Middle Archaic but for different reasons. Morey, utilizing data from his examination of faunal remains from the Hayes Site, proposes that Middle Archaic groups were not under great stress but were "getting along just fine" (Morey 1988:148). Since a shell midden site was not included in the sample of sites that were examined by Amick (1984, 1985), Morey calls for an examination of the Hayes lithic assemblage to determine if it patterns as expected by Amick's model.

The lithic assemblage from the Hayes Site is used here to examine the models of hunter-gatherer mobility postulated by Amick (1984) and Hofman (1985). The Hayes Site, having two Middle Archaic shell midden components and a Late Archaic component, proves a useful test case. A

Middle Archaic shell midden site was not included in Amick's (1984) analysis and it will be informative to determine if the lithic assemblage supports his interpretations.

The similarity in the approach taken here and that used by Amick demands a more extensive review of his model, hypotheses, and test implications. Amick (1984:158) tests the hypothesis that "Late Archaic groups are more logistically organized than Middle Archaic groups in the central Duck River Basin". He states that "Late Archaic groups are characterized by high logistical mobility and curatorially organized technology" and "Middle Archaic groups are characterized as residentially mobile and technologically expedient" (Amick 1984:157-158). Amick first examines these ideas using Middle and Late Archaic assemblages from the Clay Mine Site (40MU347). These hypotheses are further examined using a total of seven sites but the implications are essentially the same. The examination of the Hayes materials will more closely follow the methods used to analyze the Clay Mine Site.

As noted in the discussion of technological organization, an understanding of raw material distribution is critical for relating technological strategies to mobility. Understandably, the first step undertaken by Amick (1984) was a lithic resource survey which included an examination of gravel bars. Without such a survey, this analysis would not be possible. In the resource survey, it was found that the Inner Nashville Basin, where the central Duck River Basin is located, contains only poor quality materials (Ridley and Carters cherts). The

gravel bars in the Inner Basin contain a diversity of materials including high quality Fort Payne and Bigby Cannon cherts but these materials are small and lack angularity making their use for tool manufacture difficult. The situation in terms of raw materials improves moving away from the Inner Basin, where the Hayes Site is located, toward the Outer Nashville Basin and then the Highland Rim. The Outer Basin is still considered a resource-poor zone but there is an increase in the size and angularity of higher quality cherts in gravel bars making these materials more suitable for tool manufacture. The Highland Rim is characterized as a raw material rich zone where high quality Fort Payne chert is abundant and accessible. This raw material distribution must be considered when developing test implications or interpreting raw material usage by mobile hunter-gatherers in the central Duck River Basin.

Amick (1984) devloped test implications concerning the use of local/nonlocal raw materials and technological strategy with consideration to raw material distribution. Two basic implications were developed. First, Middle Archaic assemblages as less logistically organized should have a high frequency of local materials while more logistically organized Late Archaic assemblages would be mainly composed of nonlocal materials. Secondly, Middle Archaic assemblages should have a high percentage of early stage reduction debris while Late Archaic assemblages should have a high percentage of late stage debris.

Problems arise after a close examination of the test implications and hypotheses suggested by Amick (1984). He assumes a one-to-one correlation between mobility strategy and technological strategy. Namely, Middle Archaic foragers used an expedient technology and Late Archaic collectors used a curated technology. It has been shown that this direct correlation is not warranted. Both foragers and collectors employ expedient and curated technologies under certain circumstances. A revision of hypotheses and test implications is needed for an understanding of the Hayes Site lithic assemblage.

Hypotheses and Test Implications for the Hayes Site

The majority of the materials found at the Hayes Site are likely to represent: 1) forager residence; 2) collector residence; or 3) collector camp (definitions based on Binford 1980). The use of the Hayes Site solely as a location (sensu Binford 1980) is considered unlikely because of assemblage size and diversity. But considering variable site utilization, some materials may have resulted from reuse of the site as a location. It should be kept in mind that the Hayes Site is located in the raw material poor zone of the Inner Nashville Basin. Hunter-gatherers, whether foragers or collectors, had to cope with the problems of needing stone tools for certain tasks and not having easy access to high quality materials.

It is hypothesized that residentially mobile foragers would likely have geared up before moving to the Hayes Site, bringing a curated technology designed to be maintainable. Large bifaces, which

could be used as either cores or general tools (Kelly 1988), made from high quality nonlocal chert would likely have been a major part of this technology. Use of local materials for expedient tools is to be expected and replacement of curated tools of nonlocal material (large bifaces and projectile points) would occur using local materials when needed.

It is hypothesized that collectors occupying the Hayes Site as a residence would bring a curated technology designed to be reliable. These groups would have also geared up, possibly more intensively than foragers, because reliable tools need to be made of high quality materials. Bifacial cores and finely crafted reliable tools would have been brought to the Hayes Site. Local materials are expected to be used almost exclusively for expedient tool manufacture. Logistically organized task groups are expected to have access to high quality materials and these materials would be either procured directly or through an embedded strategy (Binford 1979) whenever possible for the manufacture of reliable tools. These high quality materials procured from the Highland Rim, relatively far from the site, would likely be brought back as bifacial cores.

Collectors using the Hayes Site as a logistically organized camp would bring a curated technology designed to be reliable to the site. This group being focused on a specific task would be unlikely to use local materials. Little debris is expected because reliably manufactured tools are manufactured and maintained at times other than use. Broken tools and some repair of tools may occur. The assemblage

should consist almost completely of high quality nonlocal raw materials.

The collector camp should be relatively easy to distinguish from the other two site types but similarities between forager and collector residences makes their identification more difficult. In terms of raw material, foragers are expected to make a greater use of local materials. Foragers would use local materials for expedient manufacture of tools and for manufacture of maintainable tools. Collectors are expected to use local materials expediently at residences only. Manufacture of expedient tools should result in debitage from early manufacturing stages. Manufacture of maintainable tools should result in early and middle stage debitage. Use of large bifaces as cores should result in middle stage debitage. Maintenance and reshaping of maintainable tools would result in middle and late stage debitage. Manufacture of reliable tools from bifacial cores should result in middle and late stage debitage and maintenance of reliable tools should result in late stage debitage. If Hayes represents a forager residence, then local materials should represent mostly early and middle stages of reduction. Nonlocal materials should come mostly from middle stage with some late stage. If Hayes is a collector residence, then local material should be almost exclusively used expediently resulting in only early stage debris. Nonlocal debitage should be mainly late stage with some middle stage. Hypothesized percentages are presented in Table 2.1 to illustrate the

emphasis on local and nonlocal materials and how these materials are expected to be reduced at each site type.

Table 2.1 Interpretive Framework for Determining Hunter-Gatherer Organization and Usage of the Hayes Site

	Local	Nonlocal	Local			Nonlocal		
			E	M	L	E	M	L
Forager Residence	50	50	60	30	10	-	70	30
Collector Residence	30	70	90	10	-	-	50	50
Collector Camp	0	100	-	-	-	-	-	100

E = early stage, M = middle stage, L = late stage

The percentages in Table 2.1 are not considered a set of strict predictions but as a guide for interpretation. Archaeological assemblages cannot be expected to be classified as neatly as shown here. Problems in sorting local from nonlocal raw materials and variable site utilization are just two of the problems that may blur patterning.

The Hayes Site having both Middle Archaic shell midden components and a Late Archaic component is an important test case for understanding hunter-gatherer organization in the central Duck River Basin. Hypotheses and implications developed through an organization of technology approach can be used in the interpretation of the lithic assemblage from the Hayes Site. The ability to reliably infer both raw material type and stage of reduction is critical for the application of the interpretive framework developed here. Middle

range research (especially flintknapping experimentation) and multiple lines of evidence are key elements for insuring that reduction stages are reliably inferred.

Chapter III

Archaeological Debate, Middle Range Research, and Multiple Lines of Evidence: Making Reliable Inferences

Lithic analysts, utilizing concepts of the organization of technology, can construct hypotheses of prehistoric hunter-gatherer lifeways and chipped stone tool use. These hypotheses are only legitimately testable if inferences from a prehistoric lithic assemblage can be shown to be reliable. For example, reliable inferences of raw material type and identification of reduction stages present in a lithic assemblage would be of great importance when investigating hunter-gatherer mobility patterns. The ability to make reliable inferences in any area of archaeology has been strongly questioned by some archaeologists and much debate has ensued. In order for the interpretive framework developed for the Hayes Site to be employed, issues raised by these archaeologists must be addressed. Ignoring or failing to address these issues would leave interpretations open for criticism at a fundamental level which is obviously unwise.

Archaeological Debate

Through critical self-consciousness, the discipline of archaeology has reached another crossroad. To move forward would again involve, what Clarke (1973) has termed, a "loss of innocence". Processual and postprocessual archaeologists have battled over the nature and goals of archaeology for the past decade. Unfortunately,

too often the emphatic proponents of each are more interested in attacking the extremes of opposing views rather than facing challenges and moving forward. This has resulted in logical positivism taking more beatings than a dead horse and the "radical critique" being recently tied to the whipping post. After the dust has settled, the crossroad is in view and choices must be made. "Archaeologists who are unwilling to face the challenge of the new situation may either entrench themselves in traditional positions or retreat within the logically impervious bastions of the freely creative artist" (Clarke 1973:87). Neither choice is appealing. In order to move forward, there must be change. The road that must be followed is the one where legitimate challenges are investigated and reconciled without losing sight of where the discipline has been and where it potentially can go.

Processual or new archaeology emphasizes the scientific method and the importance of understanding cultural processes. The basic tenets of the new archaeology were outlined by Binford (1962, 1964, 1968) and others (Watson et. al. 1971) in the 1960's and early 1970's and this approach continues to be developed as processual archaeology. Postprocessual archaeology is a reaction to and critique of processual archaeology and is part of the critical self-consciousness of the discipline today. Critical self-consciousness, an "explicit scrutiny of the philosophical assumptions which underpin and constrain every aspect of archaeological reasoning, knowledge, and concepts" (Clarke 1973:11-12), is necessary for the advancement of the science of

archaeology but many postprocessualists have become overzealous in their critique and scepticism. Certain postprocessualists have adopted a stance of "dogmatic scepticism" that "impedes the advance of knowledge" (R. Watson 1990:674). Also, postprocessual archaeologists have been too quick to dismiss the whole of processual archaeology. Two points that are crucial to the postprocessualist position are the perceived dependence of processual archaeology on logistical positivism and theory laden observations/data. Closer examination of these points reveals that they can be overcome without losing sight of the goals and nature of processual archaeology.

Wylie (1989) provided some insight into positivism and its effect on new archaeology and subsequent developments. She found it surprising, after new archaeologists had rejected the empiricism of traditional archaeology, that they should turn to positivism because it too is a "species" of empiricism. This produced inconsistencies in the conceptual framework of new archaeology which caused it to be "incapable of fulfilling the planning function required of it" (Wylie 1989:20). Fortunately, the form of positivism that most processual archaeologists invoke today is more general than that of logical positivism or even the positivism described by Wylie (1989). Hodder (1987), a leading figure of postprocessual archaeology, found it difficult to disagree with the statement of positivism advocated by Earle and Preucel (1987:503) where they view "positivism as a research philosophy" which "emphasizes the orderly collection of data within a theoretical framework to acquire knowledge expressed as general

statements". This may be evidence that many processual archaeologists are utilizing one form of positivism, but not positivism in the strict sense of the word, and postprocessual archaeologists are critiquing the logical positivism adopted for the new archaeology. This is a semantic problem easily reconciled by: 1) dropping the term positivism if it does not truly apply or only applies in a general sense; and 2) processual archaeologists redefining their position.

The critique that observations are theory laden deserves close consideration. Hodder (1984) viewed the problem of theory ladenness as the impossibility of bringing data to bear on theory testing. That is, because observations are theory ladened, the testing of theory with observations would be an exercise in circularity. Hodder claimed that "theory and data are not opposed and they are never confronted... rather, data are observed within interpretation and theory" (1984:27). Theory ladenness is a potential problem, but postprocessual archaeologists should not throw out the scientific method with the theory ladened bath water. Contrary to many postprocessualists' beliefs, an acceptance of theory ladenness need not lead to the perspective that "speculation and the subjective are a part of the scientific process" (Hodder 1984:28). Instead of avoiding the problem of theory ladenness it must be confronted with methods which allow for this pitfall to be avoided or minimized.

Binford (1981) has developed middle range theory which is a method that can avoid the problems of theory ladenness and circular reasoning. Middle range theory, a set of interpretive principles that

are separate from general theory, relies on the observation of dynamics in the present to understand the statics of the archaeological record. These dynamics can be inferred from the statics in the archaeological record if uniformitarian assumptions can be made. The ability to make such assumptions relies on an appeal to processes and laws which do not change over time, such as those of physics. Experimental archaeology and ethnoarchaeology are two of the most common ways of conducting middle range research.

Wylie (1990) also took steps in the investigation of the problem of theory ladenness. She suggested that in actual cases "theory ladenness is never monolithic or all pervasive" and that "we need a much more nuanced account of how data and observations are ladened in the process of constituting it as evidence" (Wylie 1990:4). She suggested independent auxiliaries, similar to middle range theory, as a form of background knowledege that can be used in building and evaluating interpretive claims (Wylie 1990:5). Independent auxiliaries, in addition to being based on laws or law-like principles, bring in multiple lines of evidence as a strategy for addressing theory ladenness and strengthening inferences.

Multiple lines of evidence, which can be used to both strengthen inferences and reveal inconsistencies, is an important strategy for addressing archaeological questions and hypotheses. It is accomplished by bringing more than a single line of evidence to bear on a hypothesis. The more diverse the lines of evidence, especially when based on middle range research that appeals to independent

theories, the greater the strength of the inference. Wylie (1989:6) eloquently outlines the principle behind multiple lines of evidence and independent auxiliaries in stating "that it is highly implausible that interpretations of different aspects of the [archaeological] record based on such widely divergent bodies of background knowledge should all point in one direction unless the test hypothesis is (approximately) right in what it claims about conditions or events that actually occurred in the past". Besides strengthening inferences it is possible that multiple lines of evidence will not always agree when brought to bear on a particular question. That is, inconsistencies will be revealed that can be investigated further. These inconsistencies would suggest that either the line of evidence is faulty or the hypotheses need modification and additional investigation. In either case, whether an inference is strengthened or an inconsistency revealed, there is the advancement of archaeological knowledge.

Utilizing multiple lines of evidence is not a new idea in archaeology and has its roots in the multidisciplinary approach advocated with the new archaeology in the 1960's. Binford (1987) suggested a narrow form of using multiple lines of evidence which focused on revealing inconsistencies or "ambiguities" and less on strengthening inferences. He suggested that ambiguity could be revealed by "using alleged knowledge warranted with one set of theory-based arguments as the basis for assessing knowledge that has been warranted or justified in terms of an intellectually independent

argument... we seek to set up an interactive usage of our knowledge" (Binford 1987:230). Gifford-Gonzalez (1989:47) "recasts" Binford's suggestion and called for "a mutual contextualization of several complex relational analogies" specifically for the analysis and interpretation of faunal materials. Although at the scale of interpreting a single artifact class different lines of evidence may be less often based on independent laws and instead utilize the same law or law-like principle, the inference can be approached from different angles. In such cases, multiple lines of evidence should be effective in providing a more reliable inference than a single line.

Theory ladenness is an acknowledged problem. However, through the method of middle range or source side research in conjunction with a strategy of multiple lines of evidence this problem can be confronted and overcome. This position stands in opposition to avoidance of the problem by rejecting science or tampering with the scientific process until it is unrecognizable, both of which are counterproductive for the discipline.

Conclusions

Postprocessual archaeologists took up the important endeavor of critical self-consciousness and have developed new areas of potential study (the individual, gender, power, etc.), but they have been overly eager in adopting stances of absolute scepticism and calling for the abandonment of processual archaeology. Processual archaeology does not have to undergo "radical" change to address postprocessual

critiques. Positivism, as critiqued, does not play a major role in contemporary archaeology and is only used in a general sense. Theory ladenness is a problem which can be addressed through the development of sound methodology and strategies such as middle range research and multiple lines of evidence. All of the issues raised by postprocessualists have not been addressed here but are being examined by others such as Binford (1986, 1989), Earle and Preucel (1987), Schiffer (1988), P.J. Watson (1990), R. Watson (1990), and Wylie (1989, 1990). Change is evident in some areas of contemporary archaeology but the goals of processual archaeology remain as outlined by Binford (1968), reconstruction of culture history and past lifeways, as well as the understanding of cultural process. Basic concepts of processual archaeology are also intact, such as the view that the archaeological record has the potential to yield information concerning past behavior and theories of this behavior should be objective and testable. In other words, archaeology strives to be a science.

To achieve the goals of processual archaeology in a scientific manner and avoid the pitfalls of theory ladenness there must be the continued development of Binford's (1981) middle range theory or what Wylie (1989, 1990) termed source side research. Both scholars encourage the building of an interpretive framework separate from general archaeological theory that can be used to make reliable inferences and legitimately test hypotheses of past behavior. Multiple lines of evidence can be used in conjunction with middle

range or source side research in advancing archaeological knowledge and understanding. The use of middle range theory and multiple lines of evidence are important for making reliable inferences of reduction stages present in the lithic assemblage of the Hayes Site. These inferences can then be used in the interpretive framework for determining type of site occupation (i.e. forager residence).

Chapter IV

Experimental Design and Flintknapping: What Makes a Good Flintknapping Experiment?

Reliable inferences can be made from archaeological evidence through middle range or source side research and these inferences can be strengthened by employing multiple lines of evidence. Two important methods of building middle range theory are experimentation and ethnoarchaeology. Unfortunately, ethnoarchaeology cannot be used to interpret stone tool manufacture and use because of the lack of extant cultures that employ stone tools as a major part of their economy (Kelly 1988). Experimentation is the key for understanding prehistoric lithic technologies.

Replication of chipped stone tools (experimental flintknapping) has a long history in archaeology (Johnson 1978). The earliest focus of experimental archaeology was the process of replicating artifacts to simulate past behavior (Ascher 1961). The goal of experimental archaeology was, and in some instances is today, the reproduction of artifacts ranging from Clovis points to Mississipian clay pots in order to determine the prehistoric method of manufacture. This goal has limited potential, making experimental archaeology an undervalued pursuit. However, with the expanded goal of building an interpretive framework, the importance of experimental archaeology cannot be denied, especially for lithic analysis.

The determination of which stages of manufacture are present in the lithic assemblage from the Hayes Site will be based on the results

of published experiments. However, not every experiment is equal in terms of methods and design. To insure the quality of flintknapping experiments and the analytical techniques based on these experiments, there must be greater consideration of experimental design and methodology.

Experimental Design

The diversity of experimental archaeology has greatly increased in the last twenty years. A few specific examples include construction of a hide boat by underwater archaeologists (Marstrander 1976), the razing of portions of a simulated outbuilding in historical archaeology (Young 1991), and trampling experiments for the benefit of prehistoric archaeology (Stoops 1990). Unfortunately, very little review of experimental design and methodology has accompanied these experimental pursuits. There are several advantages to formally outlining and following an experimental design. These advantages include savings in time and expense as well as providing maximum information gain (John and Quenoille 1977). Also, a poorly conceived or conducted experiment might lead to the acceptance of false conclusions. Although there has been little review of experimental design and methods in the archaeological literature, the point is <u>not</u> that archaeologists engaged in experimentation are performing inadequately. Rather, it would be advantageous when addressing certain problems, if more attention were paid to design features. Archaeologists have a history of borrowing methods and theories from

other disciplines, so it is unclear why there has not been a more extensive use of the rich body of literature that exists in other fields concerning the design and evaluation of experiments.

It is a fortunate time for archaeologists to look to other disciplines for insights into experimentation. Philosophers and historians of science have recently begun an investigation of experiment. These investigations include the assessment of experimental findings, the examination of the relation between theory and experiment, as wel as addressing old philosophical questions in new ways (Hacking 1988). Hacking, in his review article, marvels at the growing concern with experiment, but due to the "intense and continuing" nature of the discourse, he was forced to "present a highly selective retrospective" on the subject (1988:147). Obviously this topic is too large and varied for a comprehensive review here, but archaeologists interested in experimentation should be able to tap into this body of literature with a great deal of success. The issue of "what makes a 'good' experiment" raised by Franklin (1981) will be pursued here due to its relevance to flintknapping and other archaeological experiments aimed at building an interpretive framework.

Elements of a good experiment as outlined by Franklin (1981) have not been fully examined in the archaeological literature. A few important points particular to archaeological experimentation have been raised. For example, Coles (1973) developed eight points that should be considered when conducting archaeological experiments that

he considered "common sense". These points include employing only the materials and level of technology available to the prehistoric culture of interest. A perusal of published archaeological experiments shows that these suggestions are commonly followed. Also, some general features of experimental design have been examined. Ingersoll and Macdonald (1977) suggested that the "more rigorous and useful experiments" are those where a large number of variables are controlled. Stafford and Stafford (1981) emphasized the need for quantification of experimental results and advocated the use of experimental designs which incorporate precision and efficiency. Tringham (1978) and Amick et. al. (1989) called for the development of archaeological experimental designs. Tringham (1978) can be considered a forerunner to the approach adopted here in that she recognized the utility of looking to other disciplines for aid concerning experiment. Amick et. al. (1989) provided a review of concepts of experimental design and they looked outside archaeology to Spector (1981) in that endeavor. An examination of published archaeological experiments shows that there has been less concern with these features of experimental design.

Following is a discussion, relying heavily on Franklin (1981), of basic design features that are part of a good experiment. Because these features have been underutilized in the past, they will be specifically related to flintknapping experiments to illustrate their function and utility. Although Franklin (1981) does not cover all design features that could better experimentation, the points he

developed can serve as a solid foundation upon which archaeologists can build.

Elements of a Good Experiment

A good experiment for Franklin is one that "bears a conceptually important relation to existing theories" (Franklin 1981:372). This is a point not often mentioned by archaeologists but was touched upon by Tringham (1978). Franklin (1981) suggested that theory and experiment can be related in several ways. First, the experiment can be "crucial", where it decides between competing theories. An experiment can also be "corroborative", which means the basic ideas of a particular theory are verified. Also, an experiment can call for a new theory. Finally, the relation between experiment and theory can be one where the goal of the experiment is guided by theory which allows the experimental results to be placed in a theoretical framework.

Unfortunately, not only have archaeologists rarely discussed the general relation of theory and experiment in reporting experimental results, this relation is also often overlooked or assumed. Tringham lamented the fact that experiments were being ignored due to "their lack of a strong theoretical base" (Tringham 1978:171). She pointed out that the relation between experiment and theory should be made clear and hypothesis or theory testing should be a major focus of experiment. Flintknapping experiments can be related to or guided by any number of theories. Some flintknapping experiments are designed

to test theories of fracture mechanics, while others are guided by theories of the organization of technology, and still others are performed to corroborate theories of manufacturing method. Archaeologists can perform better experiments by being more explicit in defining the relation of their experiments to existing theories. This allows for the experiment to be designed in a manner that takes advantage of the relation to theory so that the goals of the experiment are not only attained but also articulated within a broader theoretical framework.

Another element of a good experiment noted by Franklin (1981) is accuracy. Accuracy is simply an assessment of exactness or precision and is related to what Amick et. al. (1989) referred to as reliability. The broadness of this definition allows accuracy to be applied in different ways among experiments or at different levels in a single experiment. One measure of experimental accuracy is at the level of the experimentally reproduced artifact. For example, the accuracy of a fluting experiment can be assessed by visually examining the channel flake scar produced to determine whether it conforms to the definition of a flute. The accuracy could be further measured by quantifying aspects of prehistoric flutes, such as width or depth, to determine if the experimental flute precisely replicates the prehistoric ones. This level can be termed accuracy of the reproduction and as shown can be applied generally or with greater precision. Accuracy of the reproduction can also be applied to flintknapping experiments designed to examine debitage and reduction

stages. The artifact produced in this type of experiment can be examined as in the previous example to determine whether it accurately represents those found in the archaeological record. Those artifacts determined to be inaccurate, along with associated debitage, would have to be excluded from further analysis. Accuracy can also be applied at another level in this same experiment. The debitage from each manufacturing stage can be analyzed to determine the statistical accuracy with which certain methods (e.g. dorsal scar count, mass analysis) can place that debitage in its respective stage of production. This level can be referred to as methodological accuracy. Only two levels of experimental accuracy have been examined here but both provide an important means of assessing an experiment and with greater use of this concept more levels can be developed. Designing an experiment with the explicit goal of incorporating accuracy at as many levels as possible will aid archaeologists in the pursuit of better experimentation and decrease the chance of false conclusions being accepted.

Franklin (1981:370) also indicated an important part of a good experiment is to insure that the phenomenon of interest is being examined and not simply an "experimental artifact". This is a question of validity (John and Quenoille 1977). Any of a number of factors can act to invalidate a lithic experiment. The major factor that might invalidate experimental results is the lack of control of critical variables. Coles (1973, 1979) suggested that only materials and methods available to past cultures should be used in

archaeological experiments. That is, materials and methods are variables that must be controlled. To insure validity, lithic experimenters often employ only the types of raw material available in a particular region when replicating artifacts of that region. Although on occasion these experimenters will use flakers with copper tips for pressure flaking, the effect of this type of tool which was not available prehistorically is unknown and could invalidate the experiment. Other variables can be controlled and the determination of which variables are controlled depends to a large degree on the goal of the experiment.

Amick et. al. (1989:4), following Spector (1981), suggested that "control can range from actual manipulations of cases or variables... to simply structuring the design by case selection". Examples of highly controlled flintknapping experiments can be drawn from those examining the physics of flake removal and include Bonnichsen (1977), Speth (1972) and Young (1989). Others, such as the debitage classification experiments found in Mauldin and Amick (1989), are often conducted with an observational approach to most variables. Variables in these experiments that are generally manipulated include skill of the knapper, the stage/technique of manufacture, and raw material. Many other variables are not considered or only observed. Two examples of such variables are angle of force and handedness. These variables are not chosen to be controlled because they are considered irrelevant to the experimental goal or are thought to be controlled by the manipulation of other variables. For example, angle

of force might be considered controlled in an experiment where level of the knapper is manipulated. The argument is that two knappers of the same skill level would use the same angle of force in a given situation. In this way, some variables are potentially subsumed under other variables. Assumptions concerning the relation between variables are too often based on intuition and this must be avoided. Greater identification and investigation of variables that could invalidate results of flintknapping experiments must be undertaken. Otherwise, experimental results will remain unclear and potentially biased.

An aspect of a "good experiment", not mentioned by Franklin (1981) but worth examining, is coverage. Coverage is the degree to which an experimental conclusion can be extended (John and Quenoille 1977). Coverage and the term "generalizability" used by Amick et. al. (1989) have the same basic connotation. An experiment can be characterized as having wide or limited coverage. Coverage has an inverse relation to accuracy and is dependent on how variables are controlled. One can attain a high degree of accuracy by limiting the variability of experimental units. These homogeneous experiments have low coverage. For example, if a single raw material type is utilized in an experiment, the accuracy of that experiment should be high but results could only be extended to that raw material. Heterogeneous experiments, where experimental units are more varied, have a wider coverage but often lack accuracy. The trick is to maintain wide coverage while increasing accuracy. Wide coverage is often never

realized in archaeological experiments and the results can only legitimately be applied to the experimental population or to a very limited number of cases. Coverage has only rarely been considered in archaeological experiments and it must become part of archaeological experimental designs if an interpretive framework is ever to be constructed.

Conclusions

Experimentation can play an important part in the science of archaeology but archaeologists must give greater consideration to design features. Without proper attention to design, results will be tenuous, time will be wasted, and archaeological interpretations will suffer. Four basic elements of a "good experiment" have been examined. These elements are: relation to theory, accuracy, validity, and coverage. These elements need not be a part of every archaeological experimental design. For example, experiments of an exploratory nature often do not posess all of these characteristics. However, if the results from these experimemts are promising, they must be followed up by experiments of a more rigorous nature. The four elements examined here can be used to evaluate experiments and should be central to experiments aimed at building an interpretive framework. Only the results of "good" flintknapping experiments as judged by the criteria outlined here will be used to make inferences from the Hayes lithic assemblage.

Chapter V

Flintknapping Experiments in Archaeology

It has been argued that experiment is the key for understanding prehistoric chipped stone tool manufacture and use. Experiments with the goal of providing this type of interpretive framework must be well designed and of good quality. The conduct of good experiments is time consuming. Magne (1985) reported six months for carrying out his lithic experiments. Due to the amount of time required to conduct good experiments, no experimentation has been carried out specifically for the analysis of the Hayes Site lithic materials. The analysis of the Hayes lithic assemblage will instead draw on the results of published experiments. The choice of which published experiments to use will be based on applicability and the quality of the experimental design and methodology.

Although flintknapping experimentation has a long and colorful history in archaeology, over the last 30 years an unmatched number of experiments of disparate quality have been conducted with differing goals and utilizing various research orientations. These various types of experiments can be grouped into flintknapping traditions. A flintknapping tradition is a body of flintknapping experiments conducted in order to achieve the same basic goal. Johnson (1978) has provided an excellent, in-depth history of flintknapping experimentation, but her work has been criticized for not examining the roles that lithic experiments can play in addressing general

anthropological/archaeological concerns (Hay 1978) and for not examining the relationships among various experimental approaches (McMannon 1978). An attempt will be made to address these criticisms. Four flintknapping traditions (replicative, fracture mechanics, cognitive, and debitage classification) are defined and reviewed. Each tradition is examined concerning the use of important research design features. Dividing flintknapping experiments into traditions allows for a focus on those experiments applicable to the analysis of the Hayes lithic assemblage and for those of high quality to be readily chosen. The review of each tradition allows for their interrelatedness to be brought forth and how the conduct of each has effected the other. This is important for pointing out problems and suggesting avenues of future research.

Replicative Tradition

The goal of determining the technique by which stone tools were produced characterizes the earliest flintknapping traditon and is referred to here as the replicative tradition. This tradition has its origins in the late 19th century and was reawakened in the 1960s by F. Bordes, D. Crabtree, E. Callahan, and J. Tixier (Johnson 1978). These individuals were interested in determining the technique employed to produce certain stone tools. The goals of this tradition are generally particularistic and difficult to relate to more general archaeological concerns. Even so, prehistoric tool use and technology can be investigated within this tradition. For example, Crabtree

(1970) was able to suggest that the wooden pressure flaker was likely used outside of Australia based on experimental investigations.

Those individuals conducting replicative experiments rarely make reference to archaeological theory so it is sometimes difficult to understand the full implications of their work. These experiments are conducted to test hypotheses of stone tool production. Accuracy is employed in a general manner where experimentally produced artifacts are compared to prehistoric ones to judge the accuracy of the reproduction. Control of variables is of issue when choosing raw materials and flintknapping tools but is not important outside these areas. Coverage is not dealt with in a systematic manner. It is assumed that wherever a particular artifact type is found it was potentially manufactured prehistorically by the method employed in the modern day experiments. Although not always utilizing research design concepts to their fullest, all other flintknapping experimenters owe a debt to the knappers of this tradition for defining and corroborating techniques of stone tool manufacture.

Flintknapping experiments conducted in the replicative tradition usually establish a technique that was possibly used in the past to produce a certain stone tool type. In other words, these techniques have validity. However, the problem that arises is that there is more than one way to produce any particular stone tool. Experiments often just add another technique by which a stone tool could have potentially been produced and do not establish that a specific method was used in the past. A refutation strategy has been suggested as a

method of addressing this problem in archaeological experimentation (Stoops 1990) and has potential for future use in the replicative tradition. Instead of adding another possible method of manufacture, experiments would be aimed at refuting a method as potentially producing a prehistoric stone artifact. Along this same line, accuracy should be integrated into the experimental design more precisely and at as many levels as possible. Accuracy could be more precisely applied through methods of quantification and at levels which incorporate comparisons of prehistoric failures and debitage to experimental ones. As suggested by Amick et. al. (1989), a greater emphasis on working interactively between experimentation and the archaeological record is needed for improved results.

Fracture Mechanics

Another flintknapping experimental tradition is the investigation of fracture mechanics. These studies include the mechanics of percussion flaking (Speth 1972, 1975) and pressure flaking (Faulkner 1972). Furthermore, the investigation of the effect of independent variables such as angle and amount of force on dependent variables such as flake length and width have been undertaken (Cotterel and Kamminga 1987; Dibble and Whitaker 1981). More recently, the use of flake scar morphology has been used as an indicator of the method of flake removal (Young 1989). Theories are often adopted from physics and tested through experimentation but there has been little concern with archaeological theories. These experiments are generally of a

highly controlled nature and devices such as Bonnischen's (1977) "Stainless Steel Indian" are often employed to insure such control. These experiments have been criticized on two accounts. First, they are considered too far from natural conditions or too artificial to be of use (Johnson 1978). That is, these experiments may lack accuracy and validity. Second, the results of such experiments have not been very accessible to archaeologists conducting lithic analyses (Amick et. al. 1989). Also, a discussion of coverage is lacking. The highly controlled nature of these experiments makes their coverage beyond the laboratory questionable.

Theories and schemes of flake formation have been suggested (Cotterel and Kamminga·1987) but there is a need for this information to be related to more general archaeological questions. These experiments could have importance for identifying important variables and redundant variables for lithic analysis. But, too often the experimenters of this tradition stop with the physics of flake formation and do not move to this next step. This tradition will remain unappreciated if attempts are not made to extend experimental results beyond examining the physics of flintknapping to problems of lithic analysis.

Cognitive Tradition

The "cognitive" or "anthropological approach" to flintknapping experimentation is a third tradition. The cognitive tradition is an extension of the replicative tradition. Those in the cognitive

tradition want to go beyond the replication of stone tools and determine what can be learned about prehistoric thinking from understanding technology. The general goal of this tradition is the examination of the relation between cognition, behavior, and material culture (Young and Bonnichsen 1985). A major focus within this goal is the isolation of prehistoric cultural groups (Flenniken 1984, 1985; Young and Bonnichsen 1984, 1985). Flaked stone tools, as manufactured artifacts in which the "craftman's production code is documented in the morphology of the artifact itself", are considered particularly well suited for this task (Young and Bonnichsen 1985:112). For example, Young and Bonnichsen employ a cognitive study to compare two modern day flintknappers in order to document the production of a chipped stone tool so as to understand the "grammatical knowledge" which underlies the production process (1984:37). Also, Flenniken (1984) has described the manner in which children might have learned to manufacture stone tools. Along these same lines, Shelley (1990) has shown through flintknapping experimentation that variability in mistakes, mistake corrections and morphology of chipped stone tools are related to the expertise level of the knapper. It is suggested that the products of learning can be identified in an archaeological assemblage and levels of specialization in prehistoric societies could be determined (Shelley 1990:192). Unfortunately, the cognitive tradition is fraught with problems.

An examination of the cognitive tradition reveals elements important to a good experimental design are employed but not as

rigorously as the goals warrant. The exception to this is that Young and Bonnichsen (1984, 1985) have explicitly identified concepts from cognitive anthropology to be used as the theories to guide their flintknapping experimentation. Accuracy of the reproduction is considered important in the cognitive tradition and Flenniken (1984) suggests that the experimental end product must be compared to prehistoric controls. However, accuracy is employed in a very general manner and no attempts to quantify accuracy or apply it at different levels have been made. Variables considered important to control, as in the replicative tradition, are raw material and flintknapping tools. Other variables seem to be considered controlled by the employment of a skilled flintknapper. To insure valid experiments, two different strategies are employed. Young and Bonnichsen (1984) advocate recording the modern day flintknapping process in as much detail as possible. This is intended to allow for the "grammatical knowledge" to be understood. Flenniken (1984) has outlined a procedure to be followed when conducting cognitive experiments which includes correctly identifing the technique used, controlling variables within this technique, producing a statistically significant sample, and comparison to prehistoric controls. If his procedure is followed, he has argued that "the replicator has reproduced a tangible aspect of prehistoric human behavior and demonstrated the reality of that behavior" (Flenniken 1984:197). Coverage is not discussed by cognitive flintknappers.

The cognitive approach has been reviewed and severely criticized by Thomas (1986). He accuses cognitive flintknappers of being "out of synch with contemporary archaeology" and "ultranormative" in thinking (1986:249). The direction taken by cognitive flintknappers is interesting but tangential to contemporary, mainstream archaeology. Considering the complexity of the goal of this tradition, elements of a good experiment are not employed as rigorously as needed. The criticisms raised here and by Thomas (1986) must be addressed if cognitive flintknappers are to attain their goals and put forth explanations that are more than just-so stories.

Debitage Classification

The final tradition to be defined and reviewed, and which has the greatest bearing on the analysis of the Hayes lithic materials, is the debitage classification tradition. The goal of this tradition is to determine and test methods of classifying debitage as to reduction stage or technique. This tradition is related to the fracture mechanic tradition in that there is an interest in debitage and how that debitage was produced. It differs from the fracture mechanic tradition in that there is a greater interest in general archaeological questions and less with the physics of flake removal. The debitage classification tradition relies heavily on the replicative tradition for manufacturing techniques of various tool types. The debitage classification tradition as defined here is

similar to the "technological approach" defined by Amick et. al. (1989).

A wide variety of experiments can be grouped in the debitage classification tradition. Amick et. al. (1989) divide the technological approach into confirmatory and exploratory strategies which also apply to the debitage classification tradition. Confirmatory experiments are method producing. Often statistical models are used in this strategy to determine with what success reduction stages or techniques can be discriminated (Amick et. al. 1989:7). Exploratory experiments, on the other hand, produce cautionary tales. They often show that certain methods cannot discriminate reduction stages or techniques for a particular experimental data set. The debitage classification tradition could also be divided between analysis techniques such as individual flake versus mass analysis. In the individual flake method, attributes of a single flake are examined (e.g. weight, cortex, dorsal scars). The individual flake is then classified as to reduction stage or technique. In the mass analysis approach, the assemblage or part of an assemblage is the focus of classification. Size grading of the debitage is a key element in the mass analysis technique. The number of flakes in each size grade are counted and sometimes other attributes such as weight and number of cortical flakes are also recorded. Then the assemblage can be characterized based on ratios of flakes in each size grade and using the other attributes. The diversity and large number of experiments within the debitage

classification tradition makes it difficult to review. Instead of trying to encompass all of the experiments that fall under this tradition, there will be a focus on the experiments by Magne (1985) and Ahler (1989) for the discussion of elements of a good experiment.

The experiments by Magne (1985) and Ahler (1989) are both confirmatory strategies and are considered here the best of the debitage classification tradition. Ahler's experiments are of the mass analysis type while Magne's experiments involve study of individual flakes, but the design and methods of these two experiments are similar.

Both of these experiments are guided by theory. An underlying guiding theory is that production of stone tools is a staged process and that these stages can provide information of past behavior. Magne also uses concepts of the organization of technology, based on theories of optimization and least effort, to guide his experiments. Accuracy is applied at two levels. The first, as in the replicative and cognitive traditions, is at the level of the reproduced stone tool. Greater precision in accuracy at this level as suggested for the replicative tradition might be useful. The second level is the accuracy of the method. Statistics are used to determine whether a certain combination of attributes can be used to accurately discriminate reduction stages or techniques. Control of variables is important in the experiments by both Magne and Ahler. Variables controlled in both experiments are raw material and flintknapping tools as in the replicative and cognitive traditions. Other variables

controlled are reduction stage or technique and experience level of the knapper. Another type of control is that debitage large enough for further reduction is removed from further analysis reflecting prehistoric efficiency in use of stone resources (Magne 1985). The validity of these experiments is insured not only through control of variables but by other means as well. There is a set method of gathering experimentally produced flakes for analysis. Multiple knappers of varying skill levels are employed aiding in randomizing the variables not specifically controlled (e.g. angle of force). Also, several tool types are produced (not just bifaces and/or projectile points as in the replicative tradition) and more than a single specimen of each tool type is reproduced. These procedures are employed to more accurately reflect archaeological assemblages and to insure that the experiment is measuring what it is intended to measure. Not only do these procedures aid in insuring the validity of the experiments, they also extend the coverage of the results. The greater the heterogeneity of the experiment, the further the experimental results can be extended. The use of multiple knappers of differing skill levels and the production of multiple tool types multiple times are ways to extend coverage. Another way to extend coverage is to vary raw material types used. This is a strategy that was employed by Magne, where chert, obsidian, and basalt were all used. Unfortunately, Ahler focused on a specific shert types in his experiments. For this reason, Magne's experiments have greater coverage.

One area that may need greater attention in the debitage classification tradition is multiple knappers. The use of multiple knappers is considered a randomizing factor. That is, variables that are not controlled such as angle of force are considered randomized by employing multiple knappers of varying skill levels. However, this may not be the case. In most instances when multiple knappers are employed, the knappers have all been trained by the same individual or individuals. This set of knappers would generally approach flintknapping in the same manner, potentially reducing the actual amount of randomization. This is supported by the observations of Callahan (1975) when he comments that three different styles of flintknapping are evidenced when comparing his students with those of Crabtree and Sollberger. He noted that students in one style when using a billet swing from the elbow, while in another they swing from the shoulder and in the other the swing was entirely from the wrist (Callahan 1975:4). Other differences may also exist and it is unknown at this point how these differences may or may not be reflected in a debitage assemblage. An investigation of multiple knappers who were trained in various styles of flintknapping is needed to better understand the effect it may have on a debitage assemblage and to assess how well multiple knappers of different skill levels but trained within the same tradition act as a randomizer.

Within flintknapping experimentation, elements of a good experiment discussed in Chapter IV are used most often in the debitage classification tradition. Rigorous experiments have been performed

within this tradition and they can greatly aid in the identification of reduction stages or techniques present in an archaeological debitage assemblage. More work is needed in this tradition but there is a body of experiments, especially those conducted by Ahler and Magne, that can be drawn upon for aid in analyzing prehistoric debitage assemblages.

Conclusions

Although there is wide variation in experimental procedures and goals in the various flintknapping traditions, there are also many commonalities. The same basic reduction techniques are used throughout and the traditions are interrelated in other ways. The cognitive tradition is an extension of the replicative tradition and both the fracture mechanic tradition and the debitage classification tradition focus on the examination of individual flakes. Understanding these relations allows a better assessment of the flintknapping traditions and the experimental designs they employ.

Experiment is the key for understanding stone tool manufacture and use. Good experiments have been conducted within the debitage classification tradition that can serve as a guide for the analysis of prehistoric debitage assemblages. These experiments can be used in such a way as to allow multiple lines of evidence to be brought to bear on the questions of reduction stage or technique, further strengthening inferences. The analysis of a prehistoric debitage assemblage would not only aid in understanding prehistoric

hunter-gatherer lifeways but also provide insight into where further experimental work is needed.

Chapter VI

Materials and Methods for the Analysis of the Hayes Site

This chapter describes the methods and materials used in the analysis of the debitage from the Middle and Late Archaic components at the Hayes Site. In lithic analysis, consideration of only formal tool types to the exclusion of debitage can lead to a distorted picture of stone tool manufacture. This is because some stone tools were curated prehistorically so that place of manufacture and discard differ. Three basic reasons for the examination of lithic debitage have been identified (Collins 1975; Magne 1985). First, debitage is present at most prehistoric sites in large quantities so it is well suited to statistical techniques. Also, as a byproduct of the manufacturing process, debitage is usually not curated so it remains at the site of production. Lastly, the manufacture of chipped stone tools is a reductive process so that debitage exhibits evidence of the manufacturing techniques/stages employed at a site. For these reasons, debitage analysis is essential for the utilization of the interpretive framework developed for the Hayes Site where data concerning the reduction and use of chipped stone tools at the site is essential. An analysis of the debitage provides data pertaining to amounts of local/nonlocal raw material and how these raw materials were reduced which can be used to suggest the type of site occupation (e.g. forager residence) for each component.

The analysis of the debitage from the Hayes Site proceeded in several steps. First, a random sampling technique was devised so that an adequate sample of debitage could be obtained. Then, these materials had to be classified as to raw material and reduction stage. Obtaining a sample and assigning debitage to raw material categories is relatively straightforward. The determination of which stages of manufacture are present in an assemblage is a more difficult task.

Various attributes and combinations of attributes have been posited in order to classify debitage as to reduction stage. As pointed out by Mauldin and Amick (1989) some of these attributes are based on experimentation, others on logical arguments, and stil others on intuition. The difficulty is assigning accurate meaning to attributes concerning the manufacture of stone tools. Although archaeologists have defined attributes and given them meaning, until recently very little work has been undertaken to determine the relevancy of attributes and to test the meaning they are assigned. For example, because the manufacture of chipped stone tools is a reductive process it has been assumed that debitage would progressively decrease in size from early to late stages. However, it has been shown that small flakes are produced during all stages of manufacture (Ahler 1989). Therefore, size alone is not an accurate indicator of reduction stage. There is a definite need for middle range research in this area such as flintknapping experimentation for overcoming these difficulties.

A large number of middle range flintknapping experiments are directed specifically at the analysis of debitage (Ahler 1988, 1989; Baumler and Downum 1989; Ingbar et. al. 1989; Magne 1985, 1989; Mauldin and Amick 1989; Odell 1989) with a major focus of determining reduction strategies/stages (early middle, late, etc.). Although more experimentation is needed before more accurate and unambiguous meaning can be assigned to relevant variables, researchers have produced a sizable body of useful experimental data. The use of debitage attributes, tested through flintknapping experimentation, in examining archaeological assemblages has been limited but not without success (e.g. Ahler 1988; Magne 1985, 1989). Experiments by Ahler (1988) and Magne (1985), which were designed to accurately determine reduction stages through debitage analysis, measure up well against criteria of a good experiment.

Attributes from both Ahler's (mass analysis) and Magne's (individual flake analysis) experiments are used to determine the reduction stages present in the lithic assemblage from the Hayes Site. As previously noted, Magne's experiments have greater coverage and for this reason serve as the primary determinant of reduction stages at Hayes. General trends in the mass analysis attributes will be used as other lines of evidence for determining reduction stages. The advantage of using more than a single method or line of evidence is that inferences wil strengthened or ambiguities revealed.

Materials

A random sample of lithic debitage was analyzed from the Hayes Site. This sample was drawn primarily from the 920 trench. The field supervisor indicated that the arbitrary levels from the 920 trench, as opposed to the 1004 trench, were confidently assigned to a temporal period with less chance of mixing of materials from different periods (Bill Turner 1990, personal communication). Due to the variation in the depth of the Late Archaic midden across the site and a need to insure that an adequate sample from this period could be obtained, the seven units excavated to isolate the block were included for that time period. For each of the three time periods (Middle Archaic, late Middle Archaic and Late Archaic), 1x1 m units from the 920 trench were assigned a random number with the addition of the seven units around the block for the Late Archaic. The units were ordered by ranking these random numbers from lowest to highest. The unit with the lowest random number was examined first and so on, until an adequate sample was reached.

For most sampled levels, the debitage larger than a quarter inch had been separated from other archaeological materials. Debitage smaller than 1/4 inch needed for mass analysis had not been separated but could be obtained from the finescreen materils. All finescreen materials in the random sample of unit levels were passed through an eighth inch screen and the lithic debitage was sorted from the other materials. In all cases, debitage was washed to allow for proper classification.

Methods

The analysis of the debitage from the Hayes Site was accomplished in two steps. The first was the assignment of each piece to a raw material type through the use of a type collection. The second was the determination of quantities of early, middle, and late stage debitage represented in the three components based on published findings from flintknapping experiments.

The determination of raw material type was accomplished using a raw material type collection and aided by written descriptions (Amick 1984). Written descriptions provided information on key distinguishing attributes, while the type collection allowed for familiarity with the various raw materials prior to analysis. In sorting the debitage samples into raw material categories, the type collection was continuously used for comparative purposes.

The debitage from the Hayes Site was first sorted into three raw material categories: identifiable, indeterminant, and burned. Identifiable pieces were those that could be assigned to a raw material type with a high degree of confidence. Raw material types included Bigby Cannon, Fort Payne, and Ridley. Indeterminant flakes were tentatively identified to raw material type but the accuracy of these assignments is considered lessened because of the ambiguous occurrence of diagnostic characteristics. Burnt debitage exhibited heat damage which consisted of potlidding, crazing and generally a drastic color difference. Burnt materials were not sorted into raw

material types. Further analysis was carried out to differing degrees on the debitage in each of these categories.

Although debitage was assigned to a specific raw material (e.g. Fort Payne), these types were combined to form local and nonlocal groupings. These groupings were based on the raw material source survey conducted by Amick (1984). Raw materials that are available within 10 km of the Hayes Site, including Ridley and Fort Payne/Bigby Cannon with water-rolled cortex, were considered local. Ridley is available in the Inner Nashville Basin where the site is located and those materials with water-rolled cortex were likely procurred from nearby gravel bars. It is unlikely that many noncortical flakes would be produced from the reduction of raw materials obtained from local gravel bars in the Inner Nashville Basin due to the small size and lack of angularity of raw materials in the gravel bars (Amick 1984). This insures that local materials from the gravel bars were not misassigned to the nonlocal category. Both Fort Payne and Bigby Cannon debitage that did not exhibit water-rolled cortex were assigned to the nonlocal category. The distinction between local and nonlocal debitage is a key for interpreting the Hayes debitage assemblage.

All debitage for each provenience unit was assigned to one of the raw material categories and then a size grade determination was made. The process of determining size grades followed Ahler (1989). However, four nested screens (grade 1 = one inch, grade 2 = 1/2 inch, grade 3 = approximately 1/4 inch, grade 4 = approximately 1/8 inch) were employed instead of five because debitage in the smallest size

grade do not figure into the analysis by Ahler (1989). Debitage in each screen was weighed as a group to the nearest tenth gram using a digital scale and then counted. No further analysis of debitage in the burnt category was conducted. In order to duplicate the mass analysis technique, those flakes assigned to the indeterminant category were additionally sorted as cortical and noncortical and the number of cortical pieces was recorded. Cortical flakes in this case are defined as any piece of debitage that exhibits cortex on the platform or dorsal surface. Identifiable debitage in size grades 1 through 3, in addition to being examined using the mass analysis technique outlined above, were also analyzed individually. Debitage in size grade 4 was not analyzed individually because pieces of this size were not included in the experiments conducted by Magne (1985).

Individual flake analysis included recording ten attributes for each piece of debitage: provenience, raw material, texture, cortex amount, cortex type, size grade, weight, portion, platform type, and dorsal scar count. Variable states for these attributes are defined in Appendix. Platform type and dorsal scar count are the two variables Magne (1985) found through his experiments to be effective in assigning debitage to manufacturing stages and his analytical methods are followed here. Debitage with an intact platform were assigned to a reduction stage based on the number of platform facets (0-1 facets = early stage, 2 facets = middle stage, 3 or more facets = late stage). Debitage without an intact platform but with a distinguishable dorsal surface was assigned a reduction stage based on

the number of dorsal scars (0-1 scars = early stage, 2 scars = middle stage, 3 or more scars = late stage). Debitage without either an intact platform or a distinguishable dorsal surface could not be assigned to a reduction stage by this method. Distinctive characteristics defined by Magne (1985) concerning bipolar and bifacial flakes were also used to distinguish these types of flakes. Portion, texture, and cortex amount were recorded but are not dealt with here.

The primary method of classification is by individual flake analysis using platform type and dorsal scar count. Unfortunately, these variables cannot be recorded on every piece of debitage. Debitage that is defined as shatter using the Sullivan and Rozen (1985) classificatory scheme has neither a platform nor dorsal surface. Also, Magne did not analyze flakes that would pass through a quarter inch screen, so whether the same patterning holds for these small flakes is unknown. Debitage identified as indeterminant for raw material type was also not subjected to individual flake analysis. Indeterminant flakes were assigned to a raw material type but only to satisfy the mass analysis method. The inclusion of this debitage in the individual flake analysis was unwise because a smaller sample of debitage that was confidently assigned to raw material types is preferable to a larger sample having less precision. The result is, that only a fraction of the sample examined could be assigned to a reduction stage by the method developed by Magne (1985).

The placement of debitage into early, middle, and late stages of reduction by individual flake analysis allows for an examination of the relative emphasis placed on each reduction type for local and nonlocal materials for each time period. Loglinear and chi square statistics were used to examine patterning in the data. The significance level for all statistical tests was set at 0.05. Three general trends suggested by Ahler (1991, personal communication) that are based on mass analysis are used to examine this patterning. The first trend is that debitage weight in size grades two and three decreases with later stages of reduction. The second trend is that cortex amount in each size grade will decrease with later stages of reduction. The final trend is that the ratio of debitage in size grade 4 to debitage in size grades 1 through 3 will increase from early to late stages of reduction. The results of inspection and statistical analyses of the mass anlaysis data are used to assess the findings of the individual flake analysis.

Summary

Debitage analysis can provide information concerning differential use and reduction of local and nonlocal cherts over time. Through analyzing and classifying a random sample of debitage from the Hayes Site as to nonlocal/local material type and reduction stage for each time period, the framework developed in Chapter II can be used to interpret the results. A random sampling technique was developed and applied for each component using 1x1 m units in the 920 trench.

Sorting debitage into raw material types was based on written descriptions and a type collection. Raw material types are grouped as local or nonlocal based on the resource survey conducted by Amick (1984). The classification of debitage as to reduction stage represented a more difficult task.

Results from published flintknapping experiments were used to assign debitage to a reduction stage. Use of experiments that focused directly on chert types and tool forms found at the Hayes Site would be preferable, because results could be more confidently extended to the archaeological debitage. However, a sizable data set from good experiments already exists making it unnecessary to conduct these experiments. In order to insure that the results from these other experiments are valid, multiple lines of evidence based on various experimental data sets are brought to bear on the question of reduction stages.

Two methods based on flintknapping experiments are used here. The primary method is the individual flake analysis technique developed by Magne (1985) because it has greater coverage. The experiments conducted in the development of the mass analysis technique (Ahler 1989) measure up wel against criteria of a good experiment but the coverage is not as great. For this reason, general trends seen throughout the mass analysis experiments are employed as a means of bringing other lines of evidence to examine the results from the individual flake analysis.

Chapter VII

Results

This chapter presents the results of the analysis of the debitage from the early Middle Archaic, late Middle Archaic, and Late Archaic components at the Hayes Site. Debitage was examined from two randomly selected units for each of the three components at the Hayes Site resulting in a total of six units examined. A unit was randomly selected for a component and all levels that could be assigned to that component were analyzed. Figure 7.1 lists the units and levels that formed the data set for the analysis. A total of 31,116 pieces of debitage was examined and the counts and weights are presented in Table 7.1. Although the number of levels examined for each time period is comparable, substantially more debitage by count was examined for the Late Archaic component. This situation was unanticipated at the outset of the project but the amount of debitage from the other two components are of a magnitude that the total sample remains adequate for the analysis undertaken here.

For each unit level, debitage was sorted into identifiable, indeterminant, and burnt which dictated the type of analysis the debitage would undergo. Debitage counts and weights by component by category are shown in Table 7.2. Excluding burnt materials (N = 4835; 15.5%), a respectable percentage by both count (81.0%) and weight (95.6%) was considered identifiable. Debitage in all categories was processed through nested screens so the number of pieces of debitage

Component	Unit	Levels
early Middle Archaic (eMA)	996N - 920E	11-15
	1005N - 920E	12-18
late Middle Archaic (lMA)	1011N - 920E	3
	992N - 920E	6-15
Late Archaic (LA)	988N - 917E	4-10
	991N - 917E	3-5

Figure 7.1: Unit Levels Sampled for Each Component at the Hayes Site

Table 7.1: Total Sample of Debitage from the Hayes Site

Component	Count	Weight
Late Archaic	20,183	7,259.4g
late Middle Archaic	7,599	4,824.6g
early Middle Archaic	3,334	6,829.1g
TOTALS	31,116	18,913.1g

Table 7.2: Debitage in General Categories by Component

	Identified		Indeterminate		Burnt		Totals	
	count	weight	count	weight	count	weight	count	weight
LA	12971	5911.3g	3679	385.7g	3533	962.4g	20183	7259.4g
lMA	5547	3966.1g	1021	194.5g	1031	664.0g	7599	4824.6g
eMA	2768	5959.4g	295	153.7g	271	716.0g	3334	6829.1g
TOTALS	21286	15836.8g	4995	733.9g	4835	2342.4g	31116	18913.1g

in each size grade could be recorded. Also, the debitage in each size grade was weighed as an aggregate. Counts and weights of debitage by category, by size grade, and by component are shown in Table 7.3.

Both identifiable and indeterminant materials from each size grade were sorted as to raw material type and then grouped as local or nonlocal. A key element in the interpretive framework is the relative usage of local and nonlocal materials. Local materials are those available within 10 km of the Hayes Site. Due to the importance of this variable, only debitage in the identifiable category, where materials could be confidently sorted into raw material types, was used to examine the differential usage of local and nonlocal materials through time. Table 7.4 shows debitage counts and percentages from the identifiable category (all size grades combined) broken down by component and local/nonlocal. As can be seen in Table 7.4, increasing reliance on nonlocal materials is evident through time from the early Middle Archaic to the Late Archaic. A chi square test (chi square = 988.133, df = 2, $p < 0.0001$) of these values supports the relative differential usage of local and nonlocal raw materials through time. The same basic pattern of an increase of the importance of nonlocal materials from the early Middle Archaic to the Late Archaic was observed by Amick (1984) in his analysis of seven sites in the central Duck River Basin. If the debitage in size grade 4 is not included as was the case in Amick's analyses, this pattern still holds for the Hayes debitage.

Table 7.3: Debitage in General Categories by Size Grade and Component

IDENTIFIABLE

	Size Grade 1		2		3		4	
	count	weight	count	weight	count	weight	count	weight
LA	39	1387.6g	491	2333.4g	3326	1639.0g	9115	511.3g
lMA	31	1269.0g	294	1641.2g	1564	873.1g	3658	182.8g
eMA	57	2781.9g	369	2310.3g	1286	793.3g	1056	73.9g

INDETERMINANT

	Size Grade 1		2		3		4	
	count	weight	count	weight	count	weight	count	weight
LA	-	-	8	42.4g	498	184.4g	3173	158.9g
lMA	-	-	8	47.6g	183	114.2g	830	32.7g
eMA	1	54.8g	7	23.1g	102	64.8g	185	11.0g

BURNT

	Size Grade 1		2		3		4	
	count	weight	count	weight	count	weight	count	weight
LA	4	266.8g	57	191.9g	849	385.2g	2623	118.5g
lMA	3	226.2g	31	169.3g	430	207.8g	567	60.7g
eMA	9	410.3g	30	196.5g	125	98.3g	107	10.9g

TOTALS

	Size Grade 1		2		3		4	
	count	weight	count	weight	count	weight	count	weight
LA	43	1654.4g	556	2567.7g	4673	2208.6g	14911	828.7g
lMA	34	1495.2g	333	1858.1g	2177	1195.1g	5055	276.2g
eMA	67	3247.0g	406	2529.9g	1513	956.4g	1348	95.8g

Table 7.4: Identifiable Debitage by Raw Material Type and Component

	Late Archaic	late Middle Archaic	early Middle Archaic	TOTALS
Local	4641 35.8%	2659 47.9%	1858 67.1%	9158
Nonlocal	8330 64.2%	2888 52.1%	910 32.9%	12128
TOTALS	12971 100%	5547 100%	2768 100%	21286

Those materials in the identifiable category in size grades 1 through 3 were examined by both mass analysis and individual flake techniques. This entire sample of debitage could not be assigned to reduction stage by individual flake analysis because some of this debitage is shatter and does not exhibit the needed attributes. A total of 5485 pieces of debitage could be assigned to a reduction stage by the individual flake analysis. Although the complete sample could not be assigned to reduction stage by this method, the other attributes which are part of the individual flake analysis were recorded. The entire sample was sorted as local and nonlocal chert. No bipolar debitage and very little bifacial debitage (lipped platform with three or more facets as defined by Magne 1985) was found in this sample. The smal amount of bifacial debitage (N=21) was not large enough for separate analysis so this material was added to the late stage category. Counts of debitage by component, by local/nonlocal chert, and by reduction stage are shown in Table 7.5.

The interpretive framework suggests that patterning should be evident as differential reduction of local/nonlocal materials. A loglinear model (Kennedy 1983) was fitted to the data presented in Table 7.5 and it was determined that the interaction of local/nonlocal materials with reduction stage was needed for the data to fit the model. Also, differences exist between the components in terms of reduction of nonlocal and local materials as evident by portions of the interaction of provenience, local/nonlocal and reduction stage being significant to the model. Thus, the loglinear model suggests

Table 7.5: Identifiable Debitage Sorted into Reduction Stages by Individual Flake Analysis

LATE ARCHAIC

	Stages							
	Early		Middle		Late		TOTALS	
Local	888	77.3%	174	15.1%	87	7.6%	1149	100%
Nonlocal	1089	15.1%	504	25.8%	358	18.3%	1951	100%
TOTALS	1977		678		445		3100	

late MIDDLE ARCHAIC

	Stages							
	Early		Middle		Late		TOTALS	
Local	636	77.5%	143	17.4%	42	5.1%	821	100%
Nonlocal	244	49.2%	151	30.4%	101	20.4%	496	100%
TOTALS	880		294		143		1317	

early MIDDLE ARCHAIC

	Stages							
	Early		Middle		Late		TOTALS	
Local	592	74.9%	146	18.5%	52	6.6%	790	100%
Nonlocal	181	65.1%	65	23.4%	32	11.5%	278	100%
TOTALS	773		211		84		1068	

that it is valid to examine patterning between local/nonlocal materials as per reduction stage as suggested in the interpretive framework and differences in this patterning exist in the three components at the Hayes Site.

Two patterns are evident in Table 7.5.

Pattern One: Local materials are reduced in the same manner for all three components with a major focus on early stage reduction.

Pattern Two: Nonlocal materials are used for late stage reduction to a lesser degree in the early Middle Archaic than in the other components.

Pattern One is supported by a chi square test (chi square = 8.2355, df = 4, p = 0.0833), showing that the reduction stages of local materials is not significantly different across the three components. Pattern Two is also supported by a chi square test (chi square = 20.6339, df = 4, p = 0.0004) because a significant difference in the reduction stages of nonlocal materials was found across the three components. Other lines of evidence can be brought to bear regarding the recognition of these patterns.

Other Lines of Evidence

A general trend noted by Ahler (1991, personal communication) in his experimental mass analysis data is the average weight of debitage decreases in size grades 2 and 3 with later stages of reduction. The same patterning should be present in both size grades but only data for size grade 3 is examined here because of larger sample sizes. If support is to be gained for Pattern One as seen in Table 7.5, average

weights of local debitage should be comparable in size grade 3. A log scale was used because the debitage weights exhibited a skewed, non-normal distribution and the log weights are needed for statistical analysis. Only debitage in the identifiable category could be used because individual debitage weights were needed to calculate the log values. Average log weights, standard deviations, and counts for local and nonlocal debitage for each component are shown in Table 7.6. Clearly, the average weights for the local debitage in size grade 3 are comparable, supporting Pattern One (local materials are reduced in the same manner for all three components). If Pattern Two is to be supported, the average log weights for nonlocal debitage in the Late Archaic and late Middle Archaic components should be significantly smaller than the debitage in the early Middle Archaic component. The t-test comparing the Late Archaic to the early Middle Archaic ($t = 4.5360$, $df = 271$, $p < 0.0001$) and the late Middle Archaic to the early Middle Archaic ($t = 3.280$, $df = 271$, $p = 0.0006$) are both significant supporting Pattern Two. Both Patterns One and Two as evident in the individual flake analysis results are supported by examination of mass analysis weights.

A second general trend found by Ahler (1991, personal communication) in his experimental mass analysis data is the number of cortical flakes decreases in all size grades with later stages of reduction. If support is to be gained for Pattern One, the percentage of local cortical debitage should be comparable for all components. The count of cortical local and nonlocal debitage and the percentage

Table 7.6: Log Weights of Identifiable Debitage in Size Grade Three

Component	LOCAL N	LOCAL Mean	LOCAL Std.Dev	NONLOCAL N	NONLOCAL Mean	NONLOCAL Std.Dev.
Late Archaic	1408	-0.877	0.850	1918	-1.208	0.795
late Middle Archaic	1056	-0.840	0.878	508	-1.263	0.816
early Middle Archaic	1014	-0.840	0.875	272	-1.050	0.889

this represents for size grades 1-3 for each component is presented in Table 7.7. Pattern One is not wholly supported by these data. The percentages of local cortical debitage for size grades 1 and 2 are comparable but there is wide divergence between those percentages in size grade 3. Pattern Two is also not wholly supported by the data presented in Table 7.7. If Pattern Two is to be supported, the percentages of nonlocal cortical debitage in the Late Archaic and late Middle Archaic components should be comparable and they should be less than those in the early Middle Archaic component. The percentages of nonlocal cortical debitage in size grades 1 and 2 are comparable for the late Middle Archaic and late Archaic which are both substantially larger than those in the early Middle Archaic component. Pattern Two is supported by the percentages of nonlocal debitage for size grade 3, where late Archaic and late Middle Archaic is comparable and both substantially lower than those for the early Middle Archaic. The examination of mass analysis cortical amounts is inconclusive pertaining to the patterning evident in the individual flake analysis. Ambiguities and congruences are both found when bringing this line of evidence to bear on the question of reduction stages.

The final general trend suggested by Ahler (1991, personal communication) concerning his experimental mass analysis data is the ratio of debitage in size grade 4 to size grades 1-3 should be less than 3 for early stages of reduction and increase for later stages of reduction. Instead of ratios, proportions (size grade 4 debitage divided by size grade 1-4 debitage) are used here so that 95%

Table 7.7: Number and Percent of Cortical Flakes

	LOCAL Size Grade 1		2		3	
Late Archaic	31	96.9%	189	72.1%	493	35.0%
late Middle Archaic	27	100.0%	201	85.2%	578	54.7%
early Middle Archaic	45	100.0%	37	88.5%	662	65.3%

	NONLOCAL Size Grade 1		2		3	
Late Archaic	5	71.4%	21	100.0%	61	3.2%
late Middle Archaic	4	100.0%	21	36.2%	29	5.7%
early Middle Archaic	12	100.0%	17	37.0%	31	11.4%

confidence intervals could be calculated. For these proportions, early stage reduction should be less than 0.75 which would increase for later reduction stages. If support is to be gained for Pattern One, proportions of local debitage in each component should be comparable and less than 0.75. Proportions and confidence intervals are presented in Table 7.8 for local and nonlocal debitage by component. The proportions for local debitage for each component is less than 0.75 but are not very comparable. If support is to be gained for Pattern Two, proportions for the Late Archaic and late Middle Archaic should be comparable and greater than 0.75 while the proportion for the early Middle Archaic component should be less than 0.75. The data support the Pattern Two. Although the proportions for local materials are not comparable, they are all less than 0.75 which is taken as general support of Pattern One. Support is also gained for Pattern Two by the mass analysis proportions.

In summary, the multiple lines of evidence based on the mass analysis technique generally support the patterning in reduction stages evident in the local and nonlocal materials from the individual flake analysis. Clear cut support could not be gained for either Pattern One or Two using mass analysis cortical amounts. In some respects, the cortical amounts patterned as would be expected, but in other areas the opposite is true. One factor that could confuse the interpretation of the cortical amounts is that various cherts with different cortex types (Appendix) are included within the local and nonlocal categories. The only other area where support was not

Table 7.8: Proportions and Confidence Intervals

		Late Archaic	l.M. Archaic	e.M. Archaic
Local	Proportion	0.6942	0.5796	0.3614
	Con. Inter.	0.6832 - 0.70052	0.5493 - 0.5826	0.3418 - 0.3810
Nonlocal	Proportion	0.7678	0.8100	0.5329
	Con. Inter.	0.7595 - 0.7761	0.7963 - 0.8237	0.5028 - 0.5739

obviously gained is in the proportions for local debitage. The proportions for the local debitage for the three components were not as comparable as expected but they did all fall below the value of 0.75 which indicates that the focus for each was early stage reduction. The reliability of the patterning seen in the individual flake analysis has been strengthened by using multiple lines of evidence based on the mass anlaysis technique. The next step is to employ the interpretive framework in order to assign meaning to this patterning.

Employing the Interpretive Framework

Three sets of expectations were developed concerning use of local/nonlocal raw materials for different site types. These expectations specifically concerned: 1) percentage of local and nonlocal debitage at the site; 2) frequency of local debitage in early, middle and late reduction stages; 3) frequency of nonlocal debitage in early, middle and late reduction stages. Through a comparison of these expectations and the actual observed values for the components at Hayes, site types can be assigned and changes over time can be documented.

Although the largest number of levels was examined for the early Middle Archaic component of the Hayes Site (Figure 7.1), the smallest amount of debitage by count (3,334) was examined for this component (Table 7.1). The greatest percentage (67.1%) of local debitage was recorded for this component (Table 7.4). This percentage is higher

than expected for the three site types outlined in Table 2.1, but would best fit with a forager residence. A total of 1068 pieces of debitage was assigned to reduction stages using individual flake analysis (Table 7.5). The percentages recorded for the local debitage in early, middle, and late stages of reduction is also most comparable with the expectations for a forager residence. However, a much higher percentage of nonlocal debitage was classified as early stage reduction. This pattern of a greater amount of nonlocal debitage observed than expected is recurrent for all components and will be examined in greater detail below. Importantly, as expected for a forager residence there is twice as much middle stage debitage as late stage debitage. The early Middle Archaic component at the Hayes Site is best classified as a forager residence based on the evidence presented here. The major ambiguity is the high percentage of nonlocal debitage classified as early reduction stage.

A total of 7,599 pieces of debitage was examined for the late Middle Archaic component of the Hayes Site and the total weight (4824.6 g) of this debitage was the smallest for the components (Table 7.1). The debitage was equally divided between local and nonlocal categories (Table 7.4) which is what is expected for a forager residence. The percentages of early, middle, and late stage local debitage is also consistent with what would be expected for a forager residence. In fact, as previously stated, a chi square test comparing reduction stages of local debitage for the three components showed no significant difference. That is, a significant difference in the use

of local materials for early and late Middle Archaic components could not be found. The observed use of nonlocal materials does not fit well with the expectations for a forager residence. Again, a higher percentage of nonlocal debitage falls within the early stage category making the interpretation of the middle and late stage categories difficult. The relationship of these percentages does not match well with that expected for any of the site types. The observed relationship (1.5 to 1) falls between the relationship expected for a forager residence (approximately 2 to 1) and that for a collector residence (1 to 1). The interpretation of the nonlocal debitage is inconclusive but not drastically inconsistent with what is expected for a forager residence. The best site type interpretation for the late Middle Archaic component of the Hayes Site, like the early Middle Archaic component, is a forager residence.

The debitage from the Late Archaic component at the Hayes Site is the most difficult to interpret. The largest amount of debitage examined by both count (20,183) and weight (7,259.4 g) is from this component (Table 7.1). More than half of this amount by count (73.8%) was from size grade 4 (Table 7.3). The percentages of local and nonlocal debitage presented in Table 7.4 are most comparable with the expectations for a collector residence. However, the use of local chert (Table 7.5), as with the other two components, compares best with the expectations for a forager residence. Also, as with the other two components, there is a higher than expected percentage of nonlocal debitage classified as early stage. Focusing on the middle

to late stage ratio for nonlocal debitage, the observed ratio is close to that expected for a collector residence. The interpretation of the Late Archaic component from the Hayes Site is problematic but the greatest amount of evidence fits with a collector residence site type. Interestingly, the reduction of local debitage does not support this conclusion.

Two areas of ambiguity require further discussion. The first concerns the reduction of local debitage not being significantly different for the three components when other evidence points to a difference in site types. The second is the large amount of nonlocal debitage classified as early reduction when little to none of this material was expected to be from early stages for any of the site types.

The reduction of local materials for the three components follows what is expected for a forager residence. This fits well with the other evidence for the two Middle Archaic components and the conclusion drawn is that they both represent foarger residences. However, for the Late Archaic period the other evidence points toward a collector residence. This ambiguity is difficult to explain. Problems with methods and the framework are potentially to blame. However, based on the results of this analysis, the best explanation is that during the Late Archaic the Hayes Site was used for both a forager residence and a collector residence. During one season or part of the year the site was occupied by an aggregate group of hunter-gatherers organized as collectors and at another time of the

year the Hayes Site was reused by a group organized as foragers. This more intensive use of the site during a given year may also help explain the high density of materials in the Late Archaic component. This is a somewhat complex explanation but is necessary if the present framework and methodology is kept intact. This, of course, needs further testing.

Two potential explanations can be postulated to address the problem of larger than expected percentages of nonlocal debitage classified as early reduction. The first is that Fort Payne and Bigby Cannon materials were procured on a regular basis from the Outer Nashville Basin and that these materials were brought back to the Hayes Site for reduction. That is, the materials from the Outer Nashville Basin gravel bars are close enough to the Hayes Site (12-20 km with resources improving further from the site) that they must be considered local materials. If this is the case, solutions to this problem would be difficult to find because the sorting of local and nonlocal materials might prove impossible. One possible avenue that would need to be pursued is the search for distinguishing charactersitics between Highland Rim Fort Payne and Bigby Cannon cherts from those in the Nashville Basin. The more probable explanantion is that bifacial cores were used throughout the prehistoric occupation of the Hayes Site and the individual flake analysis cannot be used to accurately identify bifacial core reduction as middle stage. Potentially, much of the reduction of bifacial cores for the production of flakes was classified in this analysis as early

stage when it was initially expected to be classified as middle stage. Unfortunately, bifacial cores are not often reproduced and reduced in flintknapping experiments. Greater experimentation that deals with bifacial cores is needed if organization of technology principles are to be used in interpreting lithic assemblages.

Summary

The trends found in the individual flake analysis concerning the usage and reduction of local and nonlocal materials were generally upheld by the multiple lines of evidence established through mass analysis. Having support from the mass analysis, the results of the individual flake analysis were compared to the interpretive framework. Based on this, it can be concluded that hunter-gatherers utilized the Hayes Site as a forager residence during the Middle Archaic period. Although with less reliability, it can also be suggested that the Hayes Site was variably used during the Late Archaic period. At one season of the year the site was used as a collector residence and at another time the site was reused by a smaller group of hunter-gatherers as a forager residence.

The use of the Hayes Site as a forager residence during the Middle Archaic and a collector/forager residence during the Late Archaic supports the model postulated by Amick (1984). In turn, this conflicts with Hofman's (1985) view that Middle Archaic shell midden sites were used as collector residences. At least, the Middle Archaic components of the Hayes Site do not fit this pattern based on this

lithic analysis. It would be interesting to examine the lithics from the Ervin Site, another Middle Archaic shell midden in the central Duck River Basin, because Hofman (1985) concluded that it was used as a collector residence during that time period.

The interpretation of the Hayes Site cannot stand on lithic analysis alone. Indeed, greater lithic analysis using other interpretive frameworks that incorporate expectations concerning frequencies of different tool types of local and nonlocal materials would be an interesting area of research. However, other lines of evidence from other artifact classes need to be brought to bear concerning questions of the organization of hunter-gatherers that used the Hayes Site during the Middle and Late Archaic. The findings presented here should prompt such analyses and provide ideas for further testing and examination.

Chapter VIII

Summary

The goal of this project was the analysis of the lithic assemblage from the Hayes Site to examine hunter-gatherer technological organization and mobility. In order to accomplish this goal, an interpretive framework was developed. This framework was based on concepts from the organization of technology developed by Binford (1977) and others (Bamforth 1986; Kelly 1988; Nelson 1991), models of hunter-gatherer mobility (Binford 1980), and the distribution of raw materials in relation to the Hayes Site (Amick 1984). This interpretive framework consisted of predicting raw material usage and reduction patterns for different hunter-gatherer site types.

If this interpretive framework was to be of use, reliable inferences concerning raw material usage and reduction had to be made from the archaeological assemblage at the Hayes Site. The ability of archaeologists to make such inferences has been strongly questioned by some postprocessualists. Two major arguments used by postprocessual archaeologists (problems concerning positivism and theory ladenness) were laid to rest. It was shown that through building middle range theory and using multiple lines of evidence reliable inferences can be made from archaeological evidence.

Two important methods of building middle range theory are ethnoarchaeology and experimental archaeology. The importance of

experimental archaeology for lithic analysts cannot be understated. Ethnoarchaeological research is not viable because no extant culture uses stone tools as a major portion of their economy. The importance of experimental archaeology to lithic analysis has not always been appreciated. Although there is a long history of flintknapping experiments in archaeology, these experiments have not had a great impact on archaeological interpretations. For flintknapping experiments to have an impact on archaeological interpretations and in making inferences reliable, there must be a reorientation and commitment to high experimental standards. By reorientation, it is meant that flintknapping experiments must be focused less on particularistic goals and more toward the goals of contemporary archaeology. Specifically, the organization of technology provides a guide to the conduct of flintknapping experimentation. Also, high standards in flintknapping experimental methods must be utilized.

Four important elements to the conduct of an experiment were identified from an examination of the literature in the field of philosophy. These elements are: relation to theory; accuracy; validity; and coverage. Other insights into the conduct of experiments could be made from a more indepth examination of this literature. The small extent to which these elements had been used in archaeological experiments was examined. Four flintknapping traditions were defined (replicative, fracture mechanics, cognitive, debitage classification) and it was shown how these four elements had been and could be further used in each of these traditions. Two

flintknapping experiments in the debitage classification tradition (mass analysis and individual flake) were found to measure up well against criteria of a good experiment. These two experiments had the greatest impact on the analysis conducted here.

Debitage analysis was considerd the best method of determining the information needed for using the interpretive framework. Debitage was sorted as to local/nonlocal material and assigned to a reduction stage. Individual flake analysis developed by Magne (1985) was the primary means of assigning debitage to reduction stages, because his technique was considered to have greater coverage than the mass analysis technique developed by Ahler (1988). Multiple lines of evidence based on mass analysis were used to examine the results of the individual flake analysis. In this way, inferences concerning reduction of materials at the Hayes Site would be based on both experimental work and multiple lines of evidence.

The following conclusions were reached based on the implementation of the above approach to the analysis of the lithic assemblage from the Hayes Site:

1) The site was used as a forager residence during the Middle Archaic time period.

2) The site was probably used as a collector residence and a forager residence during the Late Archaic time period.

The patterning evident from the individual flake analysis was confirmed by the multiple lines of evidence derived from the mass analysis data. The interpretation of the Middle Archaic components

was relatively straightforward with the evidence pointing toward a forager residence. However, ambiguity remained in the interpretation of the Late Archaic component. The most parsimonious manner of dealing with this ambiguity was concluding that the site was variably used during that component.

Clearly, this analysis is both an end product and a step; a step toward greater understanding of prehistoric hunter-gatherer lifeways in the central Duck River Basin. Future steps must be taken if inferences are to be strengthened and conclusions further tested. This project has pointed to many avenues of future research. One avenue is the conduct of flintknapping experiments guided by concepts from the organization of technology. Specifically, a greater investigation of the reduction of bifacial cores and the types of debitage produced is important for developing the type of interpretive framework used here. Concerning hunter-gatherer lifeways in the central Duck River Basin, research into the lithic assemblage at the Ervin Site which Hofman (1985) concluded was used as a collector residence during the Middle Archaic could be revealing. Focusing on the Hayes Site, more indepth analysis of faunal and lithic remains is necessary. Also, an investigation of human burials should be completed comparable to that conducted by Hofman (1985) for the site.

Archaeologists are still a long way from reconstructing hunter-gatherer lifeways with the necessary precision. However, the combination of general theoretical concepts such as the organization of technology with middle range theory building such as flintknapping

experimentation can shorten that distance. The central Duck River Basin in Middle Tennessee remains an important arena for utilizing ideas and models concerning hunter-gatherers. As concluded by Morey (1988) in his analysis of faunal remains from the Hayes Site, too few answers have been provided and too many questions have been revealed. More analyses with greater precision are needed if the number of answers are to catch up with the number of questions.

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APPENDIX

Individual Flake Analysis Attributes

Provenience - unit and level designation

Raw Material Type - for chert type descriptions See Amick (1984)
- BC = Bigby Cannon
- B = Brassfield
- C = Carters
- FPB = Ft. Payne light blue
- FPT = Ft. Payne tan
- FPH = Ft. Payne heated
- FPO = Ft. Payne other
- RET = Ridley excellent texture
- ROT = Ridley other texture
- SL = St. Louis

- BT = Burnt - exhibit potlidding or crazing
- Ind = Indeterminate - cannot be confidently assigned to a raw material type

Texture - 1 = excellent - vitreous, homogeneous
- 2 = fine - in between excellent and medium
- 3 = medium - sandy to touch
- 4 = coarse - fossileforous

Cortex Amount - 0 = no cortex
- 1 = 1-50% cortex
- 2 = 50-100% cortex

Cortex Type - 1 = incipient fracture plane - flat smooth surface often with veneer of mineral deposit
- 2 = matrix residual - soft, white to yellow chalk, easily scratched with fingernail or knife
- 3 = water worn - hard, thin, smooth cortex, usually brown to reddish-brown with rounded edges

Size Grade - See Ahler (1989)
- 1 = Grade 1: 1 inch
- 2 = Grade 2: 1/2 inch
- 3 = Grade 3: #3.5 (approximately 1/4 inch)
- 4 = Grade 4: #7 (approximately 1/8 inch)

Weight - to nearest tenth gram, using digital scale

Portion - See Sullivan & Rozen (1985)
- 1 = complete
- 2 = proximal
- 3 = distal
- 4 = shatter

Individual Flake Analysis Attributes (continued)

Platform Type - -1 = cortical
0 = 0 facets
1 = 1 facet
2 = 2 facets
3 = 3 or more facets
4 = lipped.number of facets (ie 4.2)
5 = crushed
6 = completelt cortical

Dorsal Scar Count - number of dorsal scars, See Magne (1985)
0 = 0 scars
1 = 1 scar
2 = 2 scars
3 = 3 or more scars

Mass Analysis Attributes

Provenience - unit and level designation

Raw Material Type - BC = Bigby Cannon
B = Brassfield
C = Carters
FPB = Ft. Payne light blue
FPT = Ft. Payne tan
FPH = Ft. Payne heated
FPO = Ft. Payne other
RET = Ridley excellent texture
ROT = Ridley other texture
SL = St. Louis

BT = Burnt - exhibit potlidding or crazing

Size Grade - See Ahler (1989)
1 = Grade 1: 1 inch
2 = Grade 2: 1/2 inch
3 = Grade 3: #3.5 (approximately 1/4 inch)
4 = Grade 4: #7 (approximately 1/8 inch)

Total Count - total number of flakes in a particular size grade

Total Weight - total weight of flakes in a particular size grade

Count of Cortical - count of flakes in a particular size grade that exhibit cortex

VITA

Philip James Carr was born May 23rd, 1966 in Louisville, Kentucky. He attended St. Helens grade school and was graduated in May 1984 from DeSales High School. He earned a Bachelor of Arts degree in Anthropology at the University of Louisville in May, 1988. He was accepted into the graduate program at the University of Tennessee, Knoxville in August, 1988. He received a Master of Arts degree in Anthropology in December, 1991.