Chapter 7

Left in the Dust

Contextual Information in Model-Focused Archaeology

CHRISTOPHER CARR

1. INTRODUCTION

Many of the chapters in this volume explore models for identifying and interpreting archaeological intrasite spatial patterns. The purpose of this chapter is not to discuss models, *per se*. Rather, it is to stress the complementary roles of models and contextual data in the scientific process. In the excitement of building, testing, and applying models, there can be a tendency to focus too quickly and unduely on a narrow range of data specified by some model, to the exclusion of a broader arena of relevant contextual information. I will discuss some general problems with this model-focused approach and some advantages of using contextual data.

While exploring this broader topic, four additional points will be made. First is that contextual data become more essential to the process of identifying a phenomenon as its characteristics become more ambiguous—a condition often true of archaeological observations. Second, the attitude and techniques of exploratory data analysis (Tukey 1977), which allow the integration of contextual data, are often critical to accurately identifying and interpreting intrasite spatial patterns. Third is the importance of using multiple, alternative models to identify and interpret patterns. This is one of the basic tenets of exploratory data analysis. Fourth, the process of analysis, which culminates in identification and interpretation, is broader than the process of applying a model deductively to data in

---

CHRISTOPHER CARR • Department of Anthropology, Arizona State University, Tempe, Arizona 85287.

order to identify or interpret a phenomenon. The two processes should not be confused.

Each of these subjects will be illustrated with the problem of identifying spatial patterns at the site of Pincevent habitation no. 1 (Leroi-Gourhan and Brézillon 1966). Pincevent is an Upper Paleolithic reindeer hunting camp in northern France.

Focus will be on the logical process of "identification" rather than "interpretation" (Figure 1), as defined by Binford (1977). Identification is the process of inferring "facts" from primary observations or the patterns found among them. It is accomplished with "middle-range theory" (Binford 1977:6), which relates observations or patterns to their formation processes, and these to some identity.

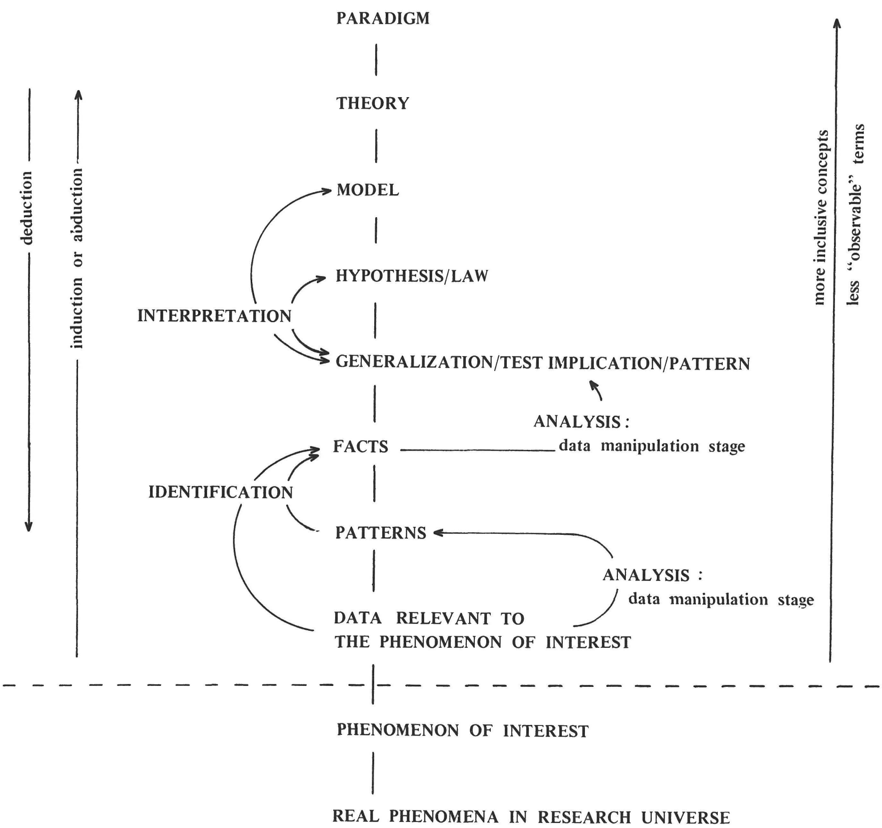

Figure 1. Identification, interpretation, and analytic manipulation in relation to levels of scientific thought and information.

For example, spatial patterns of artifacts around a prehistoric hearth, suggesting their having been tossed and dropped, might be used to identify the hearth as a men's outside hearth rather than an interior one. In contrast, interpretation is the process of explaining a pattern among inferred facts or data by subsuming it under some theoretical framework: explanation in the usual sense (Hemple 1966; Salmon and Salmon 1979). For example, regional spatial distributions of male and female activities—inferred facts—might be found to associate with the seasons of activity—more inferred facts. This pattern might be interpreted using social and economic theory regarding the division of labor. Whereas the process of identification often leads to reconstruction of the states or values taken by variables, which are conditions in the past, the process of interpretation often involves relating variables to each other.

The term *context* has been given many meanings in archaeology (cf. Taylor 1948; Schiffer 1972; Butzer 1982; Hodder 1982). In this chapter, contextual data are defined as those that are relevant to identifying some archaeological observation or pattern, or to interpreting some facts, excluding the data that are used by the one model to make the identification/interpretation. Thus contextual data are not definable in absolute terms, such as environmental contextual data or historical contextual data. Rather, they are defined relative to the phenomenon of interest and the current model being applied to understand it. Data used by a current model can serve as contextual data relative to another model. Contextual data can also be case-specific circumstances that are unlikely to have identifying or interpreting power in general and that consequently are unlikely to be included in models for identifying observations/patterns or interpreting facts.

2. THE IMPORTANCE OF CONTEXTUAL DATA

When making identifications, archaeologists have traditionally used implicit, commonsense models (e.g., Taylor 1948). These contrast with explicit models of formation processes, which are becoming more common in the field today, especially in the United States (e.g., Binford 1978, 1980; Schiffer 1976; Keeley 1977; Yellen 1977).

Explicit models are preferable to the extent that their application permits scrutiny of the logic of identification. However, in moving from intuitive to explicit identifications, there has also been a tendency in American archaeology to narrow the range of exploited data from the diversity of relevant information that is stored in the researcher's mind to many fewer data that are directly specified by middle-range theory. Contextual information, which is often case-specific and cannot be accommodated in theory, is left behind.

This practice of focusing solely on model-specified data rather than on these in conjunction with contextual data is unwise in any scientific endeavor. It can have several negative consequences, as follows.

First, by not letting all of the data speak for themselves, contextual evidence that happens to be strongly supporting or refuting in a specific case may be bypassed for much weaker evidence that is stipulated by the model.

Second, overlooking diverse contextual data and focusing on a limited, model-specified range of information does not encourage the *accurate* identification of observations/patterns. This is especially true when the characteristics of the observations have moderate ambiguity, that is, when the characteristics are not strongly determined by or reflective of unique processes and thus are not good indicators of the observations' identities. The behavioral sciences and sciences of the past, including archaeology, are typified by such data. Here, single characteristics often are unreliable indicators of single processes or else simultaneously reflect multiple processes.

In archaeology, ambiguity results from the degrading, transforming, or pattern-changing effects of cultural and natural formation processes (e.g., Schiffer 1983; Wood and Johnson 1978); from the polythetic nature of behavior and many of the formal properties of material culture (e.g., Carr 1984; Clarke 1968; Goodenough 1965; Williams *et al.* 1973); from the overlapping and indeterminant relations rather than one-to-one mapping between material form, function, behavior, and ideas (e.g., Sackett 1982); and from our lack of knowledge of the full repertoire of past behaviors and technologies.

For ambiguous data, by definition, the probability of determining the correct identity of each kind of relevant observation is unacceptably low when they are considered individually, outside of the context of each other. It is advantageous, instead, to consider multiple kinds of relevant observations *simultaneously*, each as a *context* to the other, and to look for *mutually reinforcing* identifying patterns among them. That is, one asks, "Of all the identifications possibly assignable to each kind of relevant observation on the basis of its characteristics, which identities are shared in common or are logically related to each other?" It is these identities that will have greater prior probabilities of being correct. Thus looking for mutually reinforcing identifying patterns increases the chance of correctly identifying each kind of observation and each observation, on the average.

This approach to using contextual data is analogous to taking a multivariate as opposed to a univariate view of the world. It is similar to using R-mode factor analysis to derive the primary underlying dimensions that commonly structure the characteristics of a set of observations, as opposed to considering each kind of observation by itself for its individual meaning. In semantics, it is analogous to assigning meanings to words in a sentence. Several words may each have multiple meanings, but in the context of each other, their case-specific meanings are constrained to a more limited set and become known with greater certainty.

A detailed example of the strategy of simultaneous identification, where observations have ambiguous meanings and each is used as a context for the other to determine its probable identity, is provided by Carr (1982:218–308).

Here, some kinds of tools and debris in a Middle Woodland base camp in Illinois could not be assigned functions with any certainty on an individual basis. The morphological and raw material characteristics of each such class of items had multiple possible uses. However, based on the spatial associations of the classes and the possible functions that associated classes shared, the probable functional identity of each was constrained to a much more limited set.

Third, and related to the second consequence, overlooking contextual data and focusing on model-specified data during identification does not encourage the building of a *coherent* system of facts from a holistic system of observations. In a model-focused identification strategy, each kind of observation is identified individually with only a small portion of all the data that are available and relevant—those specified by the model. Different kinds of observations are identified sequentially with different models. Attempts may then be made to integrate the identifications—the facts—into a larger picture. However, there is no guarantee that they will fit together, for they have not been inferred in consort as a system.

This is especially true when observations are ambiguous. In this case, the chance of correctly identifying each kind of observation individually is not good. Consequently, the inferred facts have a low probability of coordinating in an integrated system of knowledge. When observations are ambiguous, simultaneous consideration of multiple kinds of observations for their shared or related meanings is a more appropriate procedure. It is more likely to produce correct identifications and logically consistent facts.

Deriving an internally inconsistent set of facts from a system of observations is less likely to be a problem when the ambiguity of individual observations is negligible. In this case, even if different kinds of observations are identified by themselves, each has a high probability of being identified correctly. Inferred facts thus have a good chance of coordinating. Consequently, model-focused identification of individual observations becomes a justifiable procedure. This circumstance often does not pertain, however, to the identification of archaeological observations, which are commonly ambiguous, as described before.

Fourth, by not considering contextual data and instead restricting analysis to the data that pertain to a single model, one reduces the diversity of data that are used in making the reconstruction. This may reduce the plausibility of the argument (Hemple 1966:34).

3. EXPLORATORY DATA ANALYSIS

Consistent with recognizing the importance of contextual data in making archaeological identifications is the philosophy of exploratory data analysis. Exploratory data analysis (EDA) in a strict sense is a set of robust quantitative and visual techniques for recognizing patterns in data (Tukey and Wilk 1970; Tukey 1977). Underlying the application of these techniques, however, is a more general philosophy of how data should be investigated (Tukey 1980). EDA stresses the importance of inductive versus deductive logic. It centers on the question, "What *unanticipated* structures or relationships occur within the data, regardless of expectation?," as opposed to assessing whether a particular structure, stipulated by a model, occurs within them (Tukey and Wilk 1970:371; Hartwig and Dearing 1979:9–10). Thus the philosophy of EDA encourages the use of diverse contextual data, rather than a limited set of model-specified data, in the process of identification.

Although consistent with a context-sensitive approach to identification, EDA is broader. EDA has as its goal the search for patterns regardless of the phenomena to which they pertain. EDA aims at understanding the totality of a data structure in order to generate new ideas, problem areas, and hypotheses (Tukey 1979:122, 1980:23–24). In contrast, the process of identification focuses on understanding a particular phenomenon of interest.

Thus, a context-sensitive approach to identification strictly concords not with EDA but CEDA: constrained exploratory data analysis (Carr 1985a:31–34). CEDA, like EDA, has as its goal the understanding of a data set's total structure. However, this is done in order to isolate those aspects of it that are relevant to one explicitly specified phenomenon of interest, as defined deductively by the larger theoretical framework, paradigm, or problem domain of the researcher. CEDA is an inductive middle step that encourages the researcher to examine a wide range of data from many angles, but within a larger deductive framework that focuses on a single phenomenon. In contrast, EDA is truly an exploratory, unbounded process for initiating inductive analysis. Context-sensitive identification, in evoking a wide range of data but focusing ultimately on a single phenomenon, is consistent with CEDA.

4. USING MULTIPLE, ALTERNATIVE MODELS

One of the basic tenets of EDA and CEDA is that it is preferable to use multiple, alternative models rather than a single model to evaluate data. This holds true for a context-sensitive approach to identification, as well. There are three reasons.

First, usually it is only with multiple models that diverse and contextual data can be accommodated in the identifying process and that mutually reinforcing patterns can be explored. A single model usually pertains to only a narrow range of formation processes and data.

Second, using multiple models as baselines for envisioning data can lead to the discovery of unsuspected data patterns and suggest unexpected identities. The search for hidden data patterns is a primary rationale behind exploratory data analysis and is always a worthwhile endeavor (Tukey and Wilk 1970).

Third, when only one model is used, it becomes difficult to assess the significance of any points of discordance between the data and the model and to evaluate whether the model-specified identification is applicable. Is a 60%, 70%, 80%, or 90% fit between an identifying model and data sufficient for accepting that identity (Hemple 1966:33–34)? Moreover, one is not necessarily guided by the discordances toward any more appropriate model and identity, although this may sometimes be true.

In contrast, when multiple, alternative models are played off against one another, the significance of discordances for different models can be assessed on a relative scale—relative to each other—and the model with the best fit and with the identity that is most probable becomes clear. If the fit of all the models is at best moderate, directionality in their ranking or mutually reinforcing patterns among the residuals from different models may suggest the applicability of other potential models and identities (see later discussion on "abduction"). Rank directionality in the fit of models is especially useful when the casual processes described by the models differ in degree, whereas mutually reinforcing patterns among residuals are useful when the processes differ in kind.

5. MODELING AND ANALYSIS

The final general point of this chapter is that applying a model to a set of data and confirming deductively that the data fit it, in order to identify an observation or pattern, or to interpret a fact, should not be confounded with the process of analysis. Analysis is a broader activity, which if successful, leads to identification or interpretation and includes these as its end products (Figure 1). Analysis includes several kinds of activities: definition, measurement, manipulation, and inference. These respectively pertain to selecting a set of relevant observations and variables; selecting the variables' scale(s) and collecting data with those rules, searching for patterns in data or modeling data, and identification or interpretation. Analysis should not be reduced to the status of determining deductively whether data fit a model.

Analysis requires the use of diverse contextual data as well as explicit models and model-specified data. It also requires data exploration, including inductive and abductive logic (Hanson 1972) as well as model confirmation through deduction (Carr 1985a). These requirements follow directly from the above remarks on EDA. As Tukey (1980) has commented, "We need both exploratory and confirmatory," and by implication, context as well as model.

6. ILLUSTRATION

6.1. Two Views of Pincevent Habitation No. 1

To illustrate these points, let us turn to the site of Pincevent habitation no. 1 (Leroi-Gourhan and Brézillon 1966), a reindeer hunting camp in northern France. Habitation no. 1 dates to the late Magdalenian with radiocarbon assays ranging from 10,760 ± 60 B.P. (Grn-4383) to 12,300 ± 400 B.P. (Gif-358). It occurs in a late glacial tundra setting. The site is one of a series of similar small artifact scatters that are found at various stratigraphic levels within the area. The occupation is comprised of concentrations of lithic artifacts and reindeer bones around three aligned hearths (Figure 2).

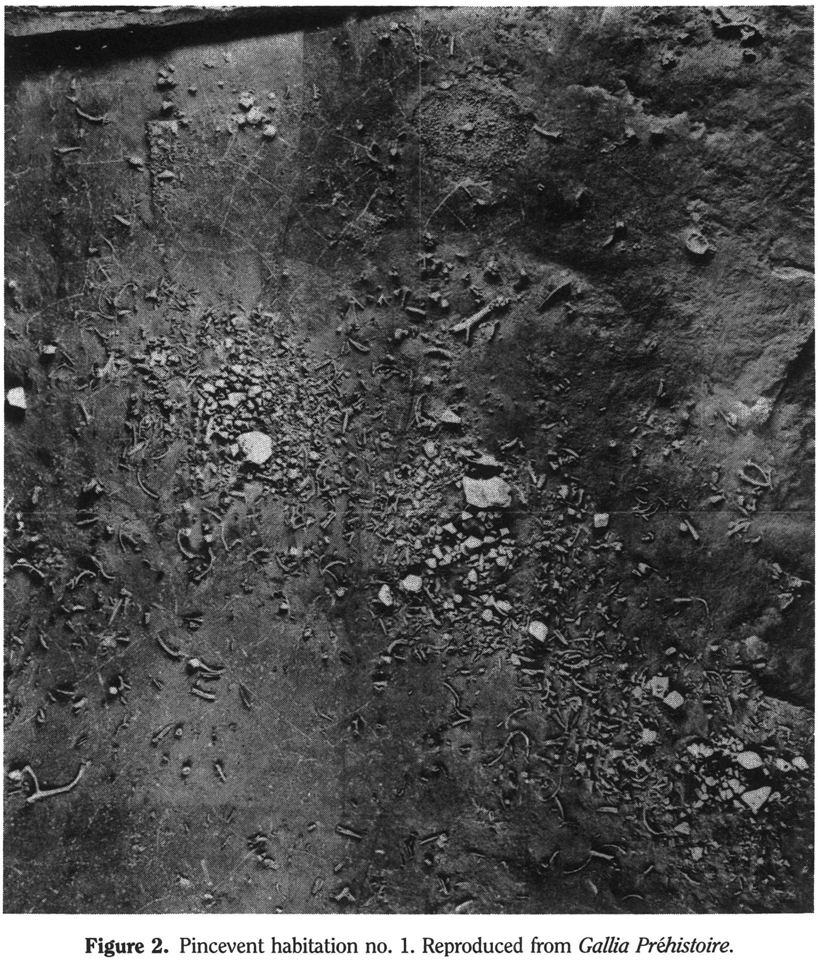

Figure 2. Pincevent habitation no. 1. Reproduced from *Gallia Préhistoire.*

The excavators of the site, Leroi-Gourhan and Brézillon, have suggested that each hearth occurred within a hut of skin and poles (Figure 3a) and that the three huts overlapped to form a single larger tent with a common central gallery and multiple entrances (Figure 3b). Skin tents are common among mobile hunters of the Arctic and Subarctic and would not be unexpected at Pincevent. On the other hand, Binford (1983:156–160) has identified Hearths 2 and 3 as men's outdoor hearths, with a tent possibly having existed over Hearth 1. Hearths 2 and 3 are thought to have been made and used sequentially in response to a change in wind direction during a single occupation. Thus Binford disagrees with Leroi-Gourhan and Brézillon at the basic level of identification, concerned with developing facts.

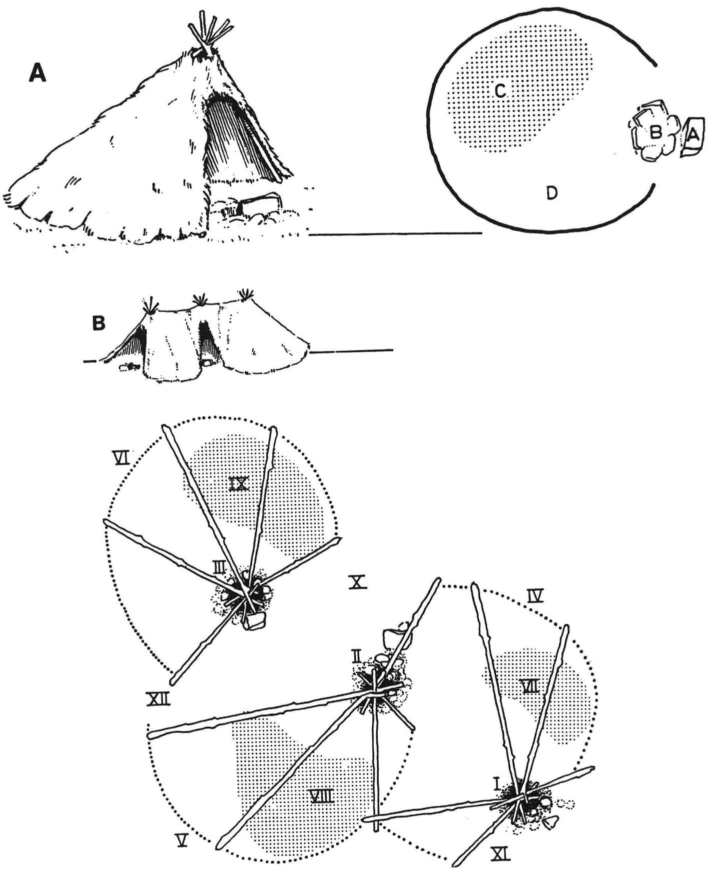

Figure 3. Leroi-Gourhan and Brézillon's (1966) reconstruction of (a) hut modules at Pincevent habitation no. 1 and (b) their integration into a common tent structure. Reproduced from *Gallia Préhistoire*.

The difference between the behavioral meanings assigned to the hearths and artifact scatters by these researchers is significant. It directly affects higher level identifications and facts. For example, estimates of site population, based on hut floor area, are affected by the meaning assigned to the hearths. When combined with seasonality and faunal kill information, their meaning also influences estimates of the duration of site occupation (Carr 1985b:385–391) and assessments of whether the site was a logistic camp or residential camp. Whereas Leroi-Gourhan and Brézillon conclude the site to be a residential base camp, Binford apparently identifies it as a logistic camp (Binford 1978:357).

The approaches used by Leroi-Gourhan and Brézillon and Binford to understand habitation no. 1 are very different. Leroi-Gourhan and Brézillon used a broad variety of contextual data and multiple models—some implicit, some explicit. The flow of their logic is generally inductive and abductive. Each of these characteristics reflects an attitude similar to CEDA. In contrast, Binford used one explicit model and a narrow range of data pertinent to it. The flow of his logic is deductive. Each of these traits define an approach similar to confirmatory statistics. Both approaches have deficiencies, and, as shall be seen, a synthesis of their strengths is preferable.

6.2. A Model-Focused Approach

First let us look at Binford's reconstruction. The model that Binford used describes the expectable distribution of debris around a men's outside hearth (Figure 4). Such hearths are said to be identifiable by two concentric arcs of debris concentration: an inner drop zone and an outer toss zone (Binford 1978:345, 355; 1983:149–156). A drop zone is composed primarily of small waste items that result from activities performed by a group of men who are seated in a circle around a fire. The items drop around each man or fall between his legs as he works (Binford 1978:349). Because the items are small, they are not bothersome to further work and are left in place. Examples of items include small impact chips created during stone-tool knapping or small fragments of bone created during marrow cracking. In contrast, a toss zone is composed of larger debris that would disrupt further work or make it impossible to sit down later if the debris were allowed to accumulate in the immediate work area. The debris are tossed behind the men or across the fire in front of them. Examples of larger debris are the intact articulator ends of long bones, the shafts of which have been crushed for marrow. The model also stipulates the spacing and dimensions of toss and drop zones (see later discussion). These parameters are based on the characteristics of men's outside hearths at a Nunamuit Eskimo hunting stand, the Mask site (Binford 1978).

Binford overlayed a scaled version of the Nunamiut model of drop and toss zones over the distribution of stone chipping debris at Pincevent habitation no. 1

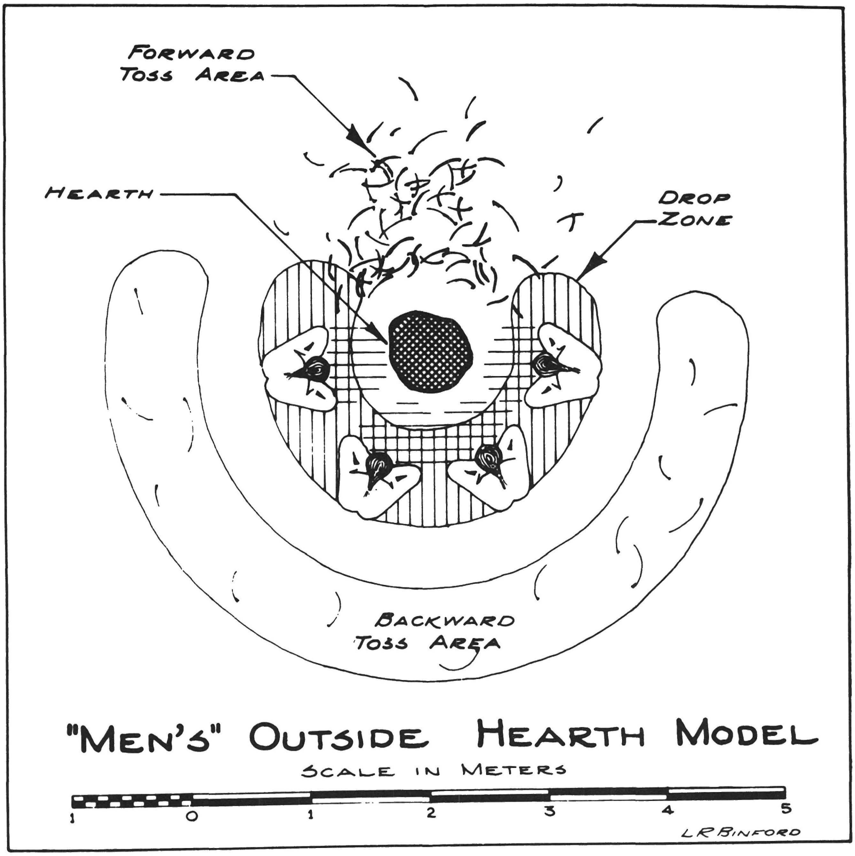

Figure 4. Binford's (1978) model of a men's outside hearth. Reproduced with permission from Lewis R. Binford.

(Figure 5). He (Binford 1983:158) concluded that the distribution at Pincevent "fits exactly" with the drop zone in the Nunamuit model. The fit does appear reasonable. The Nunamiut drop zones illustrated by Binford range from 0 to 1.2 m away from a hearth. At Pincevent, most of the chipping debris that ring the hearths lie 0 to .75 m away. (This is a correction of data previously reported by Carr [1985b:388].) However, there are also arcs of chipping debris at greater distances from the hearths that require identification (see later discussion).

The same model was overlayed by Binford on the total bone distribution at Pincevent, taking that distribution to represent tossed elements (Figure 6). There is no obvious resemblance between the two distributions. In part, this reflects a

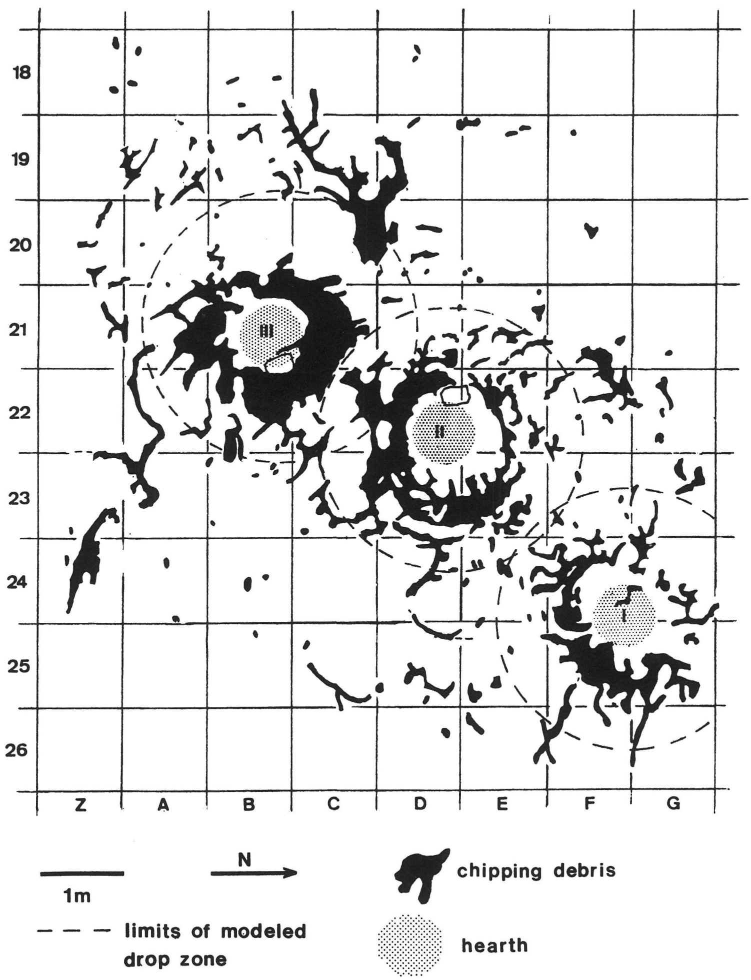

Figure 5. Distribution of stone chipping debris at Pincevent habitation no. 1 relative to Binford's (1978) model of a drop zone around a men's outside hearth.

poor choice of data. The total bone distribution is composed not only of large bones that could have been tossed but also small bones such as splinters, phalanges, and metapodials, which are less likely to have been tossed.

However, even considering and correcting for this problem by examining the individual distributions of specific kinds of faunal elements that could have been tossed, rather than a composite distribution of all bones, the fit of the model to the data is ambiguous. Table 1 shows the number of potentially tossed elements

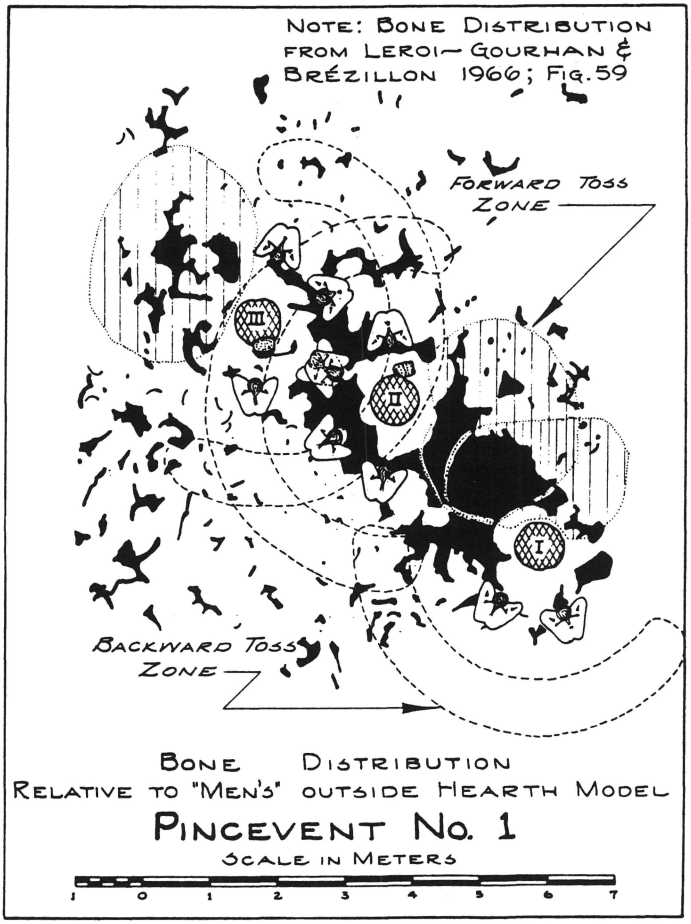

Figure 6. Distribution of all bone debris at Pincevent habitation no. 1 relative to Binford's (1978) model of toss zones around a men's outside hearth. Reproduced with permission from Lewis R. Binford.

(tibia, humeri, femurs, and ribs) that fall within sectors of the modeled drop zones and backward toss zones that do and do not overlap with each other. The data are based on Figures 7 through 10 and are a correction of data presented in Carr (1985b). Several things are clear. First, the data are ambiguous: one-third of the items occur within areas of overlap of the two kinds of zones and cannot be used to support or refute the identification. Depending on how one classifies areas as drop zones or backward toss zones, it is possible to support or refute the fit of the

Table 1. Distribution of Potentially Tossed Items among Modeled Drop and Toss Zones at Pincevent Habitation No. 1

Faunal element	Number of items in just drop zones[a]	Number of items in just toss zones[b]	Number of items in areas of overlap of drop and toss zones or between them	Number of items beyond both zones	Total
Tibia	7	7	10	8	32
Humeri	4	6	8	4	22
Femurs	9	8	14	2	33
Ribs	50	29	42	8	129
Total	70	50	74	22	216

[a]A drop zone is defined as 0–1.2 m from a hearth's edge, based on Binford's data from the Mask site.
[b]A toss zone is defined as 1.5–2.5 m from a hearth's edge, based on Binford's data from the Mask site.

model to the data. Second, considering only areas where drop zones and backward toss zones do not overlap, potentially tossed items fall more frequently within the modeled drop zones than the backward toss zones. This unpredicted pattern might be taken to suggest that the model fits poorly to the data on faunal distribution. However, it may also relate again to the ambiguity of the data. Forward toss zones can occur within potential drop zones. Depending on how one classifies areas as drop zones or forward toss zones, the data can be made to strongly support or refute the fit of the model to them. Thus the faunal distributional data cannot be used to support the identification of toss zones and the hearths as men's outside hearths.

The distribution of ribs (Figure 10) is especially interesting. Ribs are numerous, and some of them form rings around the hearths. As potentially tossed items, one might consider the rings to represent backward toss zones. However, given the dimensions of the human body and the spatial geometry of men seated around a hearth, these rings are too close to the hearths to be backward toss zones. Some elements are as close as .1 m away. In contrast, the Nunamuit backward toss zones reported by Binford (1978) range from 1.5 to 2.5 m away.

Other model-specified aspects of the distributional data are not congruent with the model of a men's outside hearth. First, large faunal elements or lithic debris occur immediately next to the hearths around most of their perimeters (Figure 2). They would have created an intolerably rough floor and lead one to question whether the areas were, indeed, occupied by seated men. Would you want to sit on the debris shown in Figure 11?

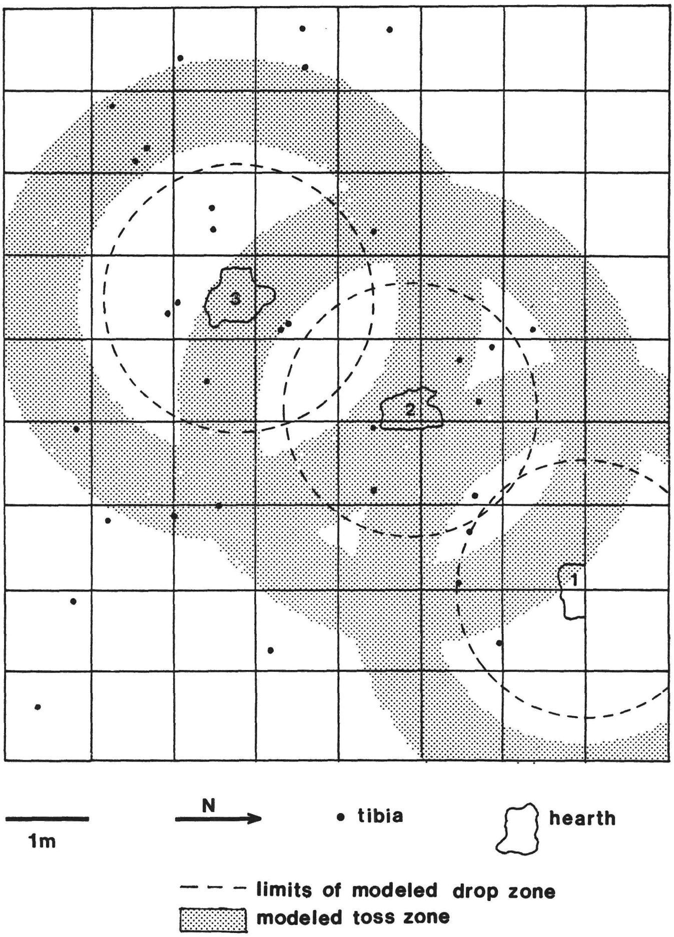

Figure 7. Distribution of reindeer tibia at Pincevent habitation no. 1 relative to Binford's (1978) model of drop and toss zones around a men's outside hearth.

Second, the nature of the borders of potential backward toss zones at Pincevent does not concord with the model. Backward toss zones, by the nature of their formation, should occur as gradients of debris density rather than sharply delimited arcs. Instead, the potentially tossed debris at Pincevent define a number of crisp borders between rings of high and low artifact density. These are seen in Figure 12, a map of most artifacts and debris of bones and stones at Pincevent. Lines 6a, 6c, and 4b correspond to strong breaks in artifact density, which if not

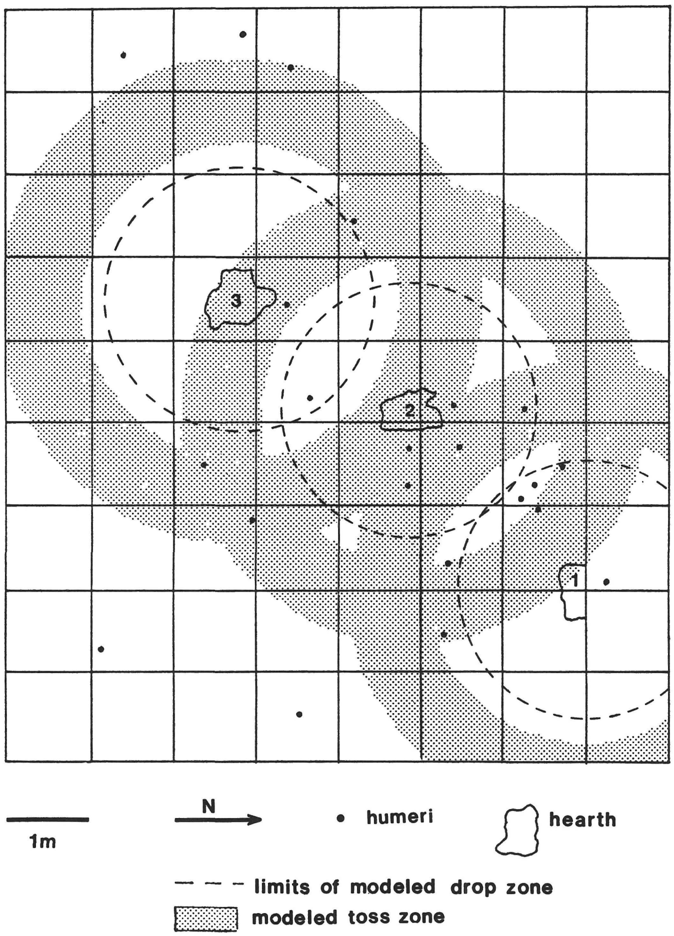

Figure 8. Distribution of reindeer humeri at Pincevent habitation no. 1 relative to Binford's (1978) model of drop and toss zones around a men's outside hearth.

crisp, might define the outer limits of backward toss zones. Lines 5a, 5b, 4a, and 4c correspond to strong density breaks, which if not crisp, might define the inner limits of backward toss zones. Thus, tossing, as described in Binford's model, does not account well for the Pincevent distributions. We shall see later that several kinds of contextual evidence suggest that these density breaks are locations where debris was moved against some now-decomposed or removed structure, such as a hut wall.

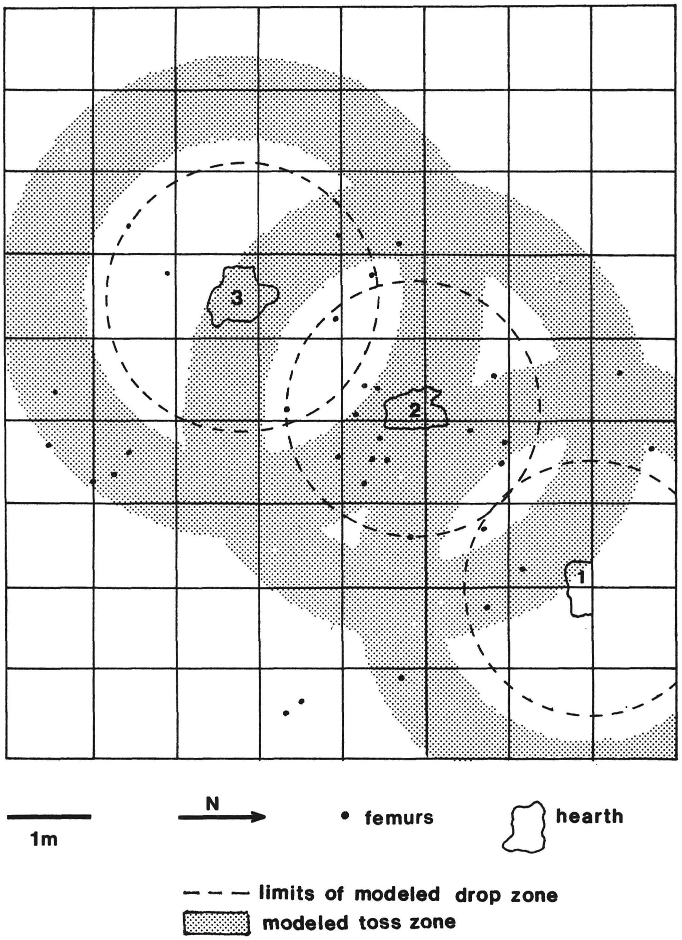

Figure 9. Distribution of reindeer femurs at Pincevent habitation no. 1 relative to Binford's (1978) model of drop and toss zones around a men's outside hearth.

In sum, Binford's analysis of habitation no. 1 is good in that it involves an explicit model for identifying archaeological phenomena. Its explicitness allows one to evaluate the logic of identification. However, the analysis has several drawbacks. (1) Only one model relevant to one set of formation processes was used, rather than multiple, alternative models relevant to multiple kinds of formation processes. This was done despite the fact that Binford (1983:156–158) had built two alternative models, one for outside hearths and one for inside hearths.

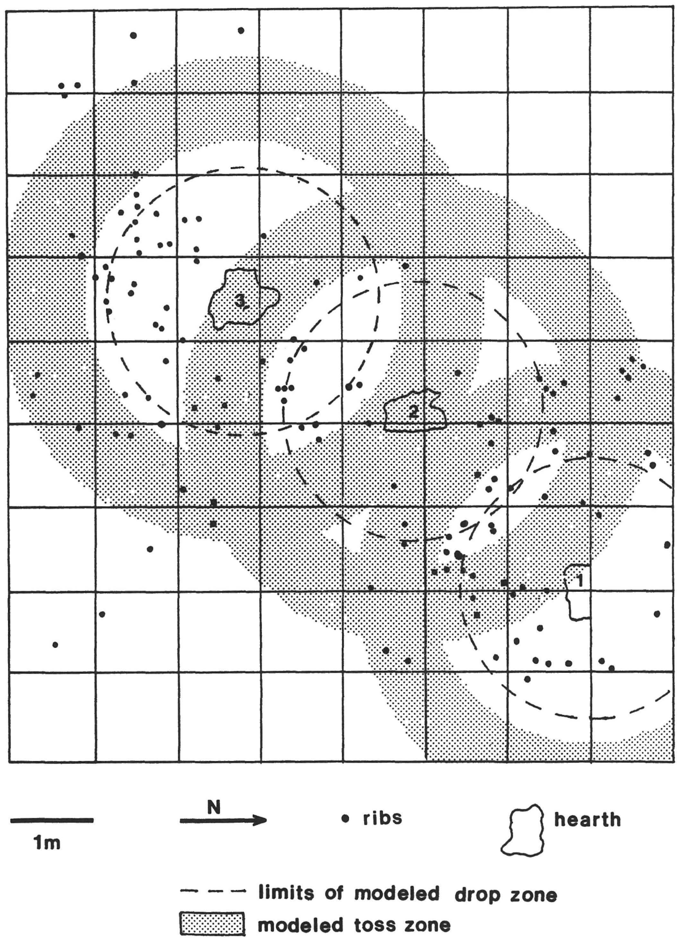

Figure 10. Distribution of reindeer ribs at Pincevent habitation no. 1 relative to Binford's (1978) model of drop and toss zones around a men's outside hearth.

As a consequence, it is difficult to assess the significance of the points of discordance between the data and his model. Had multiple models of different formation processes been used, the stronger of them would have been apparent (see later discussion). Moreover, applying the single model and noting its discordances from the data does not necessarily guide one toward any particular, more appropriate model and identification. (2) The data were handled in a deductive, confirmatory manner, apparently without the benefit of or serious con-

Figure 11. Lithic and bone debris around Hearths 3 (foreground) and 2 (background) at Pincevent habitation no. 1. Reproduced from *Gallia Préhistoire.*

sideration of prior, inductive exploration. Had the attitude of CEDA been seriously adopted, the data would have been envisioned in multiple ways, minimally by positioning arcs of toss and drop zones in various ways (i.e., varying the parameters of the men's outside hearth model). This would have revealed the ambiguity of the data shown in Table 1 and its sources already discussed. It would have suggested the need to examine other, contextual data to identify the nature of the hearths. (3) A rich amount of contextual data was overlooked (see later discussion). Considered jointly, these could have helped resolve the data ambiguities and the identity of the hearths.

In fairness to Binford, it must be said that he may have envisioned Pincevent's formation more holistically in private. However, this is not reflected in the published rendition of his procedure for identification (Binford 1983). Also, his analysis is presented in a book that is intended to be more thought provoking than substantive and in a chapter that is aimed at introducing the reader to identifying models, rather than in a research publication where a fuller treatment might have been given. At the same time, one must question the image of science and analysis that is presented and the manner in which the data are handled, for each of the reasons just given.

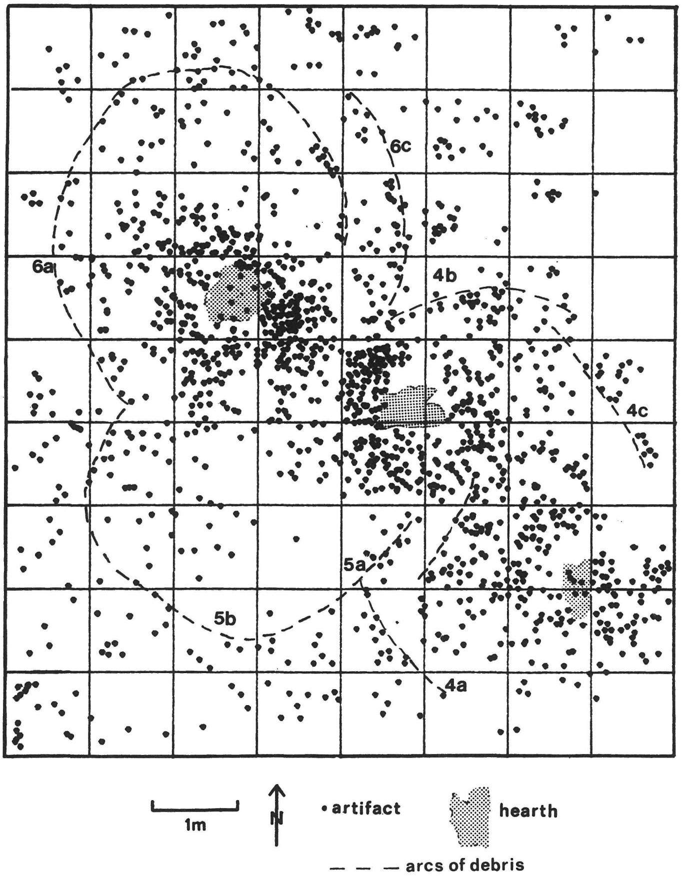

Figure 12. Crisp-bordered arcs of artifacts and debris within the distribution of most artifacts and debris at Pincevent habitation no. 1.

6.3. A Context-Sensitive Approach

Now let us look at Leroi-Gourhan and Brézillon's (1966) approach to understanding habitation no. 1. In a more traditional style of identifying observations/patterning, they use implicit models that are assumed to be understood by the profession at large. Some site-specific lines of reasoning are unstated, as well. These are the primary drawbacks of the study. To the good, multiple, diverse kinds of data are presented, each providing a context for the other. Mutually reinforcing patterns among the data were sought in an inductive, exploratory manner in order to define a coherent system of facts and to develop an integrated picture of the site's formation and use. Multiple alternative formation processes were explicitly considered and tested when identifying some aspects of the site. However, reconstructions alternative to the occurrence of three contemporaneous huts were not explicitly proposed or evaluated.

A number of converging lines support Leroi-Gourhan and Brézillon's conclusion that three huts were built at habitation no. 1, that the hearths were interior ones, and that they were used simultaneously rather than sequentially. Most of these are site-specific and constitute contextual data that would be bypassed by applications of general models for hearth identification. Some of the data are presented by Leroi-Gourhan and Brézillon in explicit support of their reconstruction. Others are simply documented as part of their general description of the site and have been used by me (Carr 1985b and here) to further support their argument.

First, as mentioned, there are arcs of artifacts and debris that have sharp borders in places and that do not correspond well with the expectable nature of toss zones. The arcs are distinguishable in the composite distribution of most artifacts and debris (Figure 12) and in the individual distributions of more frequent artifact classes, such as chipping debris (Figure 13). They were identified by Leroi-Gourhan and Brézillon (1966:332–336, 361) as places where rubbish, which was generated by activities in more central parts of the structure, was swept to its sides, forming a sharply bounded distribution. The empty spaces between the arcs and the hearths were identified as generalized work and sleeping areas that were kept clean and that were the sources of materials moved to the sides of the huts. Both the crispness of the arcs and the complementary arc-void structure support this interpretation.

Similar depositional processes and patterns, involving the build-up of secondary refuse along the walls of structures and the cleaning of central activity areas, have been recorded for the tents of gold rush prospectors in the southwest Yukon (Stevenson 1987), longhouses at Ozette, Washington (Samuels 1983), houses of Guarijo Mexicans (Dodd 1984), and multiroom dwellings at Nawthis Village (Stevenson 1985). These studies add credibility to Leroi-Gourhan and Brézillon's interpretation that huts surrounded the Pincevent hearths.

Stevenson (personal communication) has documented that refuse build-up along the walls of dwellings can result not only from sweeping but simply from persons forgetting where items were placed and from their loss in poorly lighted zones away from central light sources. A Pangnirtungmuit informant at the historic site of Kekerten, Cumberland Sound, Baffin Island, told Stevenson this, and he substantiated it through the excavation of a number of double-walled skin houses. Placing, forgetting, and losing thus may be processes that were responsible for the development of the arcs at Pincevent. Their role, however, would have been at most only partial. The spatial patterns of artifact joins and red ocher soil

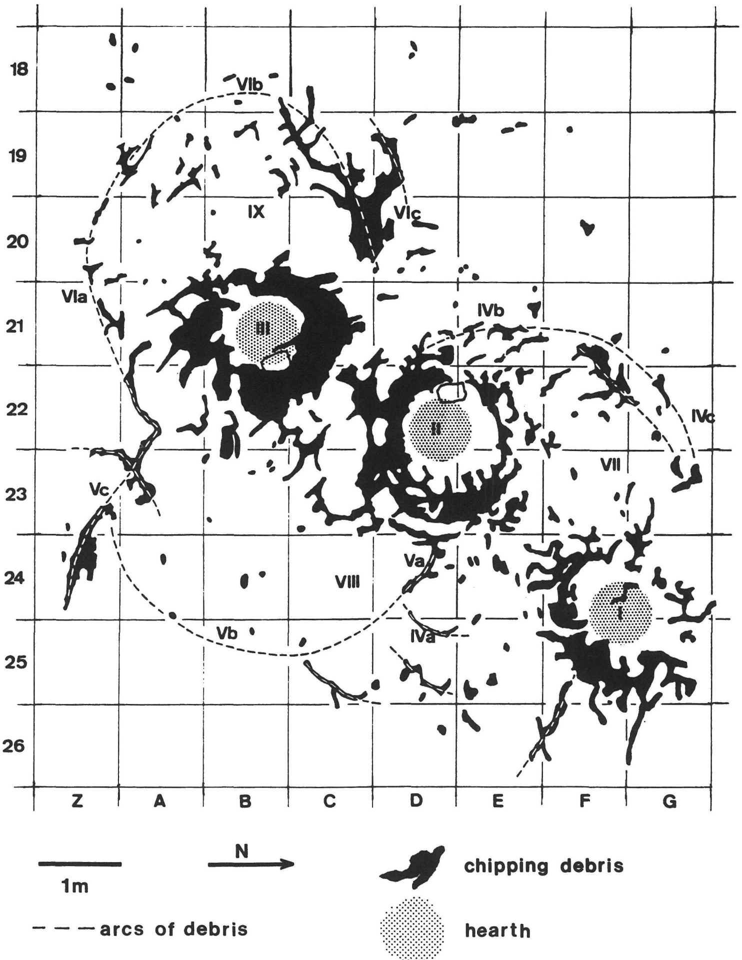

Figure 13. Distribution of chipping debris relative to distribution of arcs of artifacts and debris at Pincevent habitation no. 1. Adapted from Leroi-Gourhan and Brézillon (1966:Figure 56).

stains described later indicate the mechanical effects of sweeping and redeposition and that these processes also formed the arcs of refuse. In either case, the reconstruction of huts around the Pincevent hearths is supported.

At Pincevent, the area delimited by the arcs corresponds well with the limits of red ocher soil stains (Figure 14). A thin sprinkling of ocher underlaid the artifacts within the bounds of the hypothesized structure and helped to define it (Leroi-Gourhan and Brézillon 1966:330–332). The rationale for spreading red

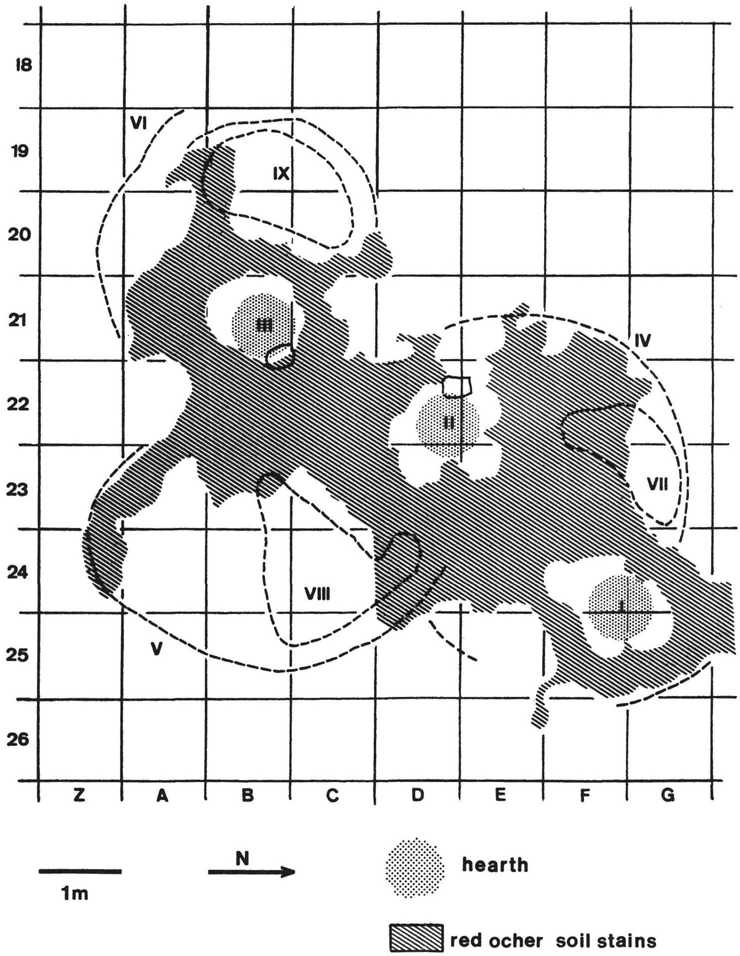

Figure 14. Distribution of red ocher soil stains relative to the distribution of arcs of artifacts and debris at Pincevent habitation no. 1. Adapted from Leroi-Gourhan and Brézillon (1966:Figure 55).

ocher over this portion of the occupation floor prior to its use is unclear. However, one is struck by the correspondence between the edges of the distribution of ocher and the arcs of debris. Also, the supposedly swept areas, indicated by low densities of debris, fall for the most part within areas lacking ocher. This is expectable if sweeping did occur. Finally, if the huts did not exist, one must wonder why the ocher was spread over only the portion of the occupation floor around the hearths rather than all work areas.

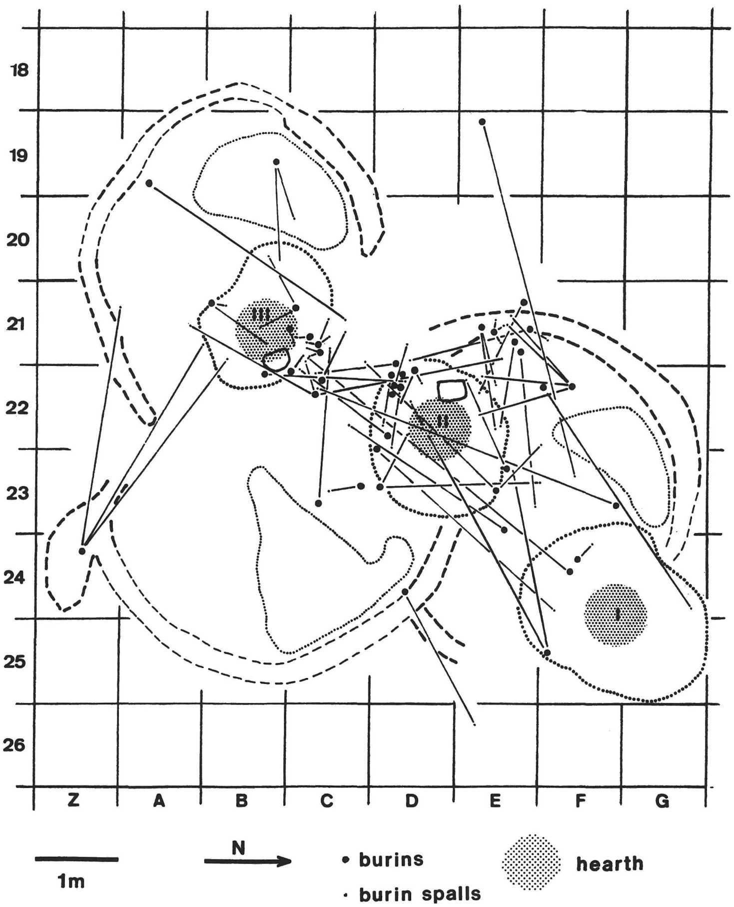

Figure 15. Distribution of joins of refitted burins and burin spalls at Pincevent habitation no. 1. Adapted from Leroi-Gourhan and Brézillon (1966:Figure 65).

Second, refitting studies of burins and burin spalls, cores and core debitage, broken scrapers, and snapped blades indicate an extensive network of conjoined pieces among the hearths and their surroundings (Leroi-Gourhan and Brézillon 1966:337, 341–345, 349–350, 364). Figures 15 and 16 provide examples. Importantly, for each of the artifact classes, some of the refitted pieces fall within the arcs of debris, which have been defined in other ways and are linked to pieces in work areas around the hearths. One possible meaning of this pattern is that some debris generated around the hearths was swept to the sides of the presumed huts during floor cleaning. This assessment of the refitting patterns is consistent with

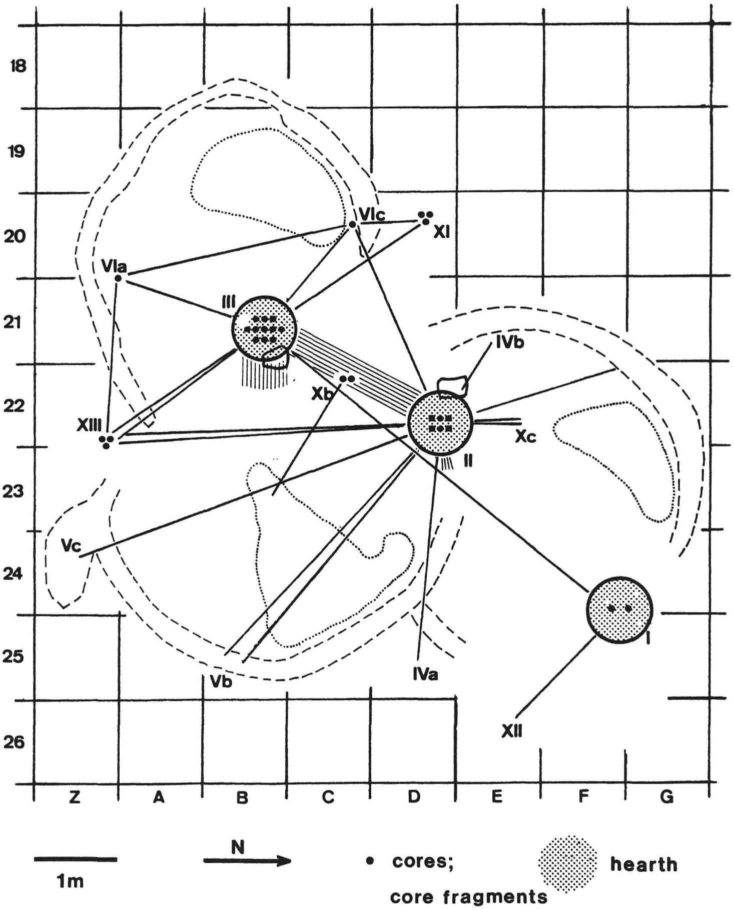

Figure 16. Distribution of joins among refitted core fragments at Pincevent habitation no. 1. Adapted from Leroi-Gourhan and Brézillon (1966:Figure 63).

the identification of the arcs, themselves, and their crisp borders. Both phenomena can be seen as the products of the same cleaning process.

Another interesting pattern is that different refitted tool and debris classes link the central work areas to different portions of the debris. Refitted burins and burin spalls fall within arc segments 6b, 5c, 5a, and 4b. Cores and core debitage fall within arc segments 6c, 6a, 5c, 5b, 4b, and perhaps 4a. Snapped blade refits fall within only segments 6c and 4c. This pattern might be taken to indicate separate episodes of different kinds of activities in work areas around the hearths, followed by sweeping in different directions. The pattern does not strengthen or weaken Leroi-Gourhan and Brézillon's identification of the hearths.

Finally, the patterns of refits can be used to suggest the contemporary use of all three hearths and the proposed hut modules. Some of the joins link items around a hearth of one proposed hut to items against the walls of another proposed hut. This pattern would have been generated if work around one hut's hearth had been followed by the sweeping of the resulting debris against the walls of another hut, which would have had been standing at the same time. The pattern is found for core and core debitage refits and burin and burin spall refits. For both, the refits relate Huts 2 and 3 and Huts 2 and 1.

Taken alone, this pattern is ambiguous. The joins that link the work and depositional areas within the different huts could be the product of mining, recycling, and redeposition of lithic material (Ascher 1968) rather than hearth and hut contemporaneity. Cahen and Keeley (1980) have provided a convincing example of this kind of situation for the Belgian Epipaleolithic site of Meer II. Considered with other contextual data discussed in this section, however, the pattern can be evoked as one of a number of mutually reinforcing patterns that identify three contemporaneous hut cells.

Third, the orientation of items within the arcs of debris also suggests that the arcs represent debris swept up against the walls of some structure. The composite artifact and debris map from Pincevent (Leroi-Gourhan and Brézillon 1966:fold-out) shows that the long axes of many larger bone and lithic items (greater than *ca.* 5 cm long) parallel the directions of curvature of the arcs that they form. This pattern in orientation is what one would expect mechanically for debris swept up against a barrier. It has also been found ethnographically to characterize the distribution of larger items along the walls of the Pangnirtungmuit skin houses mentioned before (Stevenson, personal communication). Again, the pattern does not allow one to determine whether placing and loss or sweeping are responsible for it, but does suggest the existence of the huts.

Fourth, along one arc of debris, 4b, there is a hummock of soil several centimeters thick, with large flint nodules on top. Other large nodules are spaced with some regularity along the arc. These could represent a position at which a tent pole was anchored and places where a tent skirt was weighted down (Leroi-Gourhan and Brézillon 1966:327, 362). The features occur on the prevailing, upwind (west) side of the proposed structure, where they would have been needed most. A similar criterion has been used by Campbell (1977:73–75) to identify hearths as interior ones at the LUP site of Hengistbury Head. The Lack of more frequent pole and skirt anchors of rocks or dirt at habitation no. 1 may relate to the use of the site during cold seasons (see later discussion), when the ground was frozen and snow was available for these purposes (Gordon 1988).

Fifth, information on the local weather conditions and the seasons of occupation of habitation no. 1 also are pertinent to assessing whether huts existed there. Two episodes of occupation were reconstructed by the original faunal analysts, Guillien and Perpere (1966:377): a longer period represented by winter kills and a shorter period in late spring. The methodological and sample limitations of their analyses have been discussed elsewhere (Carr 1985b:389). More recent and methodologically sensitive analyses by Gordon (1988), using the cementum of reindeer teeth, generally support the reconstructed seasons of occupation but do not reflect whether the period was discontinuous or continuous. Of seven examined teeth, three indicated late winter kills and four indicated spring kills. Other debris scatters at Pincevent (M-89, E-74, G-65, V-105), which are similar in arrangement to habitation no. 1, were found by Gordon to have early winter, late winter, and/or spring kills, in various combinations.

Winter occupation of habitation no. 1 would have been rigorous. The site was used during the Bølling or Allerød period, at the end of the second cold maximum of the Würm glacial. Winters in northern France at that time are thought to have been colder and drier than at present (Butzer 1971:274–286; see also Planchais 1976). The vicinity of Pincevent is relatively flat and can be windy, as its name, "pinching or biting wind," indicates.

In these conditions, one would expect most work to occur indoors when possible—especially tasks involving finer finger manipulations. In contrast, refuse deposition would not be expected to be spatially constrained in this way. Looking at the distribution of tools, alone, at habitation no. 1, one does find that nearly all of them occur within the limits of the proposed huts rather than outside. Also, bone debris are more ubiquitously scattered. These data are consistent with the interpretation that all three hearths were enclosed in huts. Additionally, if the hearths were not, one must ask why the tools are constrained to the areas that they are, rather than dispersed among a wider set of work areas.

Sixth, the stratigraphy of the hearths is most parsimoniously understood if all three were used simultaneously rather than sequentially. Each is similar in having two carbonaceous deposits separated by a thin lens of sediment. It would appear that there were two periods of use of all three hearths, separated by a brief period of site abandonment and water washing. This contrasts with Binford's reconstruction of the singular and sequential use of Hearths 2 and 3 in response to a change in wind direction.

The hearth stratigraphy concords with Guillien and Perpere's assessment, using independent faunal data, that habitation no. 1 was occupied discontinuously during two seasons, in winter and late spring. It is neither discordant with nor reinforced by Gordon's findings of winter and spring kills.[1] The stratigraphic data do not bear on the question of whether the hearths were outdoor or indoor features.

[1]It is not currently possible to conclude from faunal analyses whether the two periods of occupation of habitation no. 1, evidenced by all three hearths' stratigraphy, were shorter periods in different seasons (winter, late spring) of the same or different years, or longer periods of winter through spring in two different years.

Seventh, the deposits in each hearth are physically contained and reasonably compact, rather than unconstrained and broadly scattered. These are criteria that Binford (1983:158) attributes to indoor hearths. The deposits occur in round basins, approximately 20 cm deep, as opposed to on ground level where they might have been more easily strewn. Their diameters are about 50 cm.

Eighth, the three hearths are aligned and are approximately equally spaced (*ca.* 3 m, center to center). Also, the distances between them are such that their respective debris scatters do overlap, which probably would not be the case if the hearths had been used sequentially and placed so as to occupy fresh work space (Yellen 1974; Binford 1978; Hayden 1979; O'Connell 1979). All three characteristics point toward the simultaneous use of an integrated living space. However, they do not bear directly on whether the hearths were exterior or interior features.[2]

Thus a wide diversity of contextual data converge on the identification of the hearths at Pincevent habitation no. 1 as indoor hearths that were used simultaneously. Leroi-Gourhan and Brézillon's use of these data is good in several ways. First, many of the data are strong but would probably have been overlooked had general models for identifying hearths and model-specified data been focused upon. Second, by using many kinds of data and looking for mutually reinforcing identifying patterns, some patterns that by themselves are only moderately suggestive of past formation processes could be assigned meanings with higher probabilities of accuracy. This would not have been possible had the process of identification proceeded on each pattern individually. Third, by taking an inductive, exploratory approach and looking for mutually reinforcing patterns, the

[2]In particular, the equal spacing of the hearths at habitation no. 1 does not suggest whether they were outdoor or indoor features. Gamble (1986:258–263) has suggested that equispacing of hearths at approximately 3 meter distances, like the toss-and-drop pattern, can help to identify them as multiuser outside hearths. In Binford's model, he attributes the 3-meter regularity to the "size of the human body and the spatial geometry that multiple users of a common facility . . . produce when engaged in the commonplace social activities of conversation, eating, passing the time and throwing things away" (p. 258). In support of this, he cites several ethnographic examples of hunter–gatherer camps. However, there are both substantive and logical problems with Gamble's "3-m spacing principle." First, the ethnographic examples he cites include not only Nunamuit (Binford 1968) and Aborigine (Hayden 1979) camps that lack huts, but also !Kung camps (Wiessner 1974; Yellen 1977) that have huts with doorway hearths. Huts of the !Kung are individually very similar to the Pincevent hut modules (Figure 3a) and are sometimes built in groups similar to the Pincevent hut group (Figure 3b; Yellen 1977). One cannot logically support a principle that links 3-m hearth spacing to exterior hearths with ethnographic data on exterior and interior hearths. Second, the ethnographic data that Gamble cites include sleeping arrangements (Hayden 1979:Ngayuwa and Tapatapa's camp) in addition to multiuser outside hearths. Both Binford (1983:160–163) and Gamble (1986:262–263) consider interhearth spacings different (smaller) in sleeping arrangements than in multiuser outside hearths. Again, irrelevant ethnographic data are cited in support of the principle. Finally, it is not clear that the spacings, and some of the factors contributing to the spacings, of multiuser outside hearths do not also pertain to doorway or central interior hearths.

different kinds of data were used as a holistic system of observations, and it was possible to develop a consistent system of facts. Leroi-Gourhan's and Brézillon's and my own reconstruction of the huts at Pincevent involved the development or use of facts about primary artifact deposition, secondary deposition, the spatial distributions of different activities, site seasonality, site reoccupation, weather (wind direction and temperature), and architectural design. Fourth, the diversity of data that were used and that became internally consistent provide the reconstruction greater plausibility, in Hemple's sense (1966:34).

At the same time, Leroi-Gourhan and Brézillon's analysis suffers from its lack of fully explicit argumentation. Middle-range propositions that associate the characteristics of archaeological remains with their identity via formation processes were often left implicit, as assumed professional knowledge (Leroi-Gourhan and Brézillon 1966:especially 325–371). Also, the roles of some kinds of data in the inferential process were not explicitly defined. I have tried to correct some of these problems here.

The drawbacks of implicit argumentation in archaeology and more generally in science are well known (Binford 1968, 1977; Watson *et al.* 1971; Carr 1985a:40–41). In particular, archaeological knowledge has not been formalized to the point where bridging propositions are well tested and can be left unstated. Only by stating such propositions and the data pertinent to them can they be criticized, can logical discordances among them be found, and can advances in theory be made in a systematic fashion.

Finally, like Binford, Leroi-Gourhan and Brézillon did not evoke and evaluate alternative models for their relative degrees of fit to the data. Only the occurrence of three contemporaneous huts was explicitly proposed and evaluated (although alternative processes of formation of various individual features and relationships were considered).

6.4. Combining Models and Contextual Data

Binford's and Leroi-Gourhan and Brézillon's methods of reconstruction are complementary in their use of models and contextual data and inductive exploratory and deductive confirmatory strategies. It is not hard to envision a very plausible argument about the nature of the hearths at habitation no. 1 that would use both the explicit models of formation processes and the diverse contextual data cited above to weigh the two alternative identifications. Also, analytic processes could have been used whereby both inductive exploratory and deductive confirmatory logic, models, and techniques are combined in a stepwise, cyclical manner to investigate data. These are well known in outline (Carr 1985a; Kemeny 1959; Williams *et al.* 1973:215–237) and becoming better operationalized (Tukey 1977, 1980; Carr 1985b:316–328; Read 1985). I will not elaborate on them here. An example of their use to identify depositional sets of artifacts at Pincevent has been presented elsewhere (Carr 1985b).

However, to let this critique of Binford's and Leroi-Gourhan's analyses of Pincevent rest with their mechanical integration would be to miss the dynamics and synergy of combining inductive exploratory and deductive confirmatory logic, models, and contextual data. It is through their combination that creativity in developing identifications (or explanations) is maximized. This creative logic can be called *abduction,* to extend a term of Hanson's (1972). Abduction is a conceptual *gestalt.* It is the simultaneous discovery of a pattern and its significance in suggesting a possible identity or cause. It occurs as one searches data in an exploratory mode or examines residuals in a confirmatory mode in the midst of a larger cycle of exploratory and confirmatory work. It takes the approximate form of thought, "this pattern could be explained if new hypothesis X were true," although this statement does not capture abduction's gestalt quality. Abduction involves both the perception of a previously unperceived pattern and its identification or explanation by retroduction.

One essential step for combining inductive exploratory and deductive confirmatory strategies is developing and envisioning the data from the perspective of multiple alternative models. Abduction is facilitated by this stereoscopic, higher level point of view. When multiple models are used, multiple possible identifications run through the researcher's head as the data are explored inductively or their various residuals from different models are displayed in a confirmatory mode. Common dimensions of fit of the models, directionality in their degrees of fit, or mutually reinforcing patterns, among the residuals from different models—all higher levels of patterning than that exposed by examining the data from the perspective of a single model—may suggest new identifications or interpretations. These factors are among the most critical for gaining the insights that are necessary to make an abduction.

During my initial analyses of habitation no. 1 (Carr 1985a), I examined the data in both exploratory and confirmatory modes in order to assess the contemporaneity of the hearths, whether they were interior or exterior ones, and a number of other behavioral and formation issues. In the process of simultaneously considering these multiple, alternative possibilities, a variety of reconstructions beyond those favored by Leroi-Gourhan and Brézillon and Binford were suggested to me (abductin) and partially evaluated. These are as follows:

First and second, one or two hearths might have been outside hearths and the other(s) interior hearth(s), rather than all three of the same kind. Various combinations might be considered. Binford (1983:157, Figure 93) mentions this in passing, suggesting that only Hearth 1 might have been sheltered by a hut.

There are certain differences among the hearths in their forms and in the assemblage of artifacts around them, especially between Hearth 1 and Hearths 2 and 3, that are suggestive of this. (1) The basin of Hearth 1 is filled primarily with charcoal deposits, indicating a major source of fire, whereas the basins of Hearths 2 and 3 are filled more with fire-cracked rock, which might have been used in stone boiling or indirect heating (Leroi-Gourhan and Brézillon 1966:367). (2) Areas immediately adjacent to Hearths 2 and 3 exhibit much higher frequencies of tools and debris that indicate tool manufacture, tool maintenance, and fabrication of goods than do areas around Hearth 1. These include cores, burins, burin spalls, becs, some kinds of scrapers, backed bladelets, and unbacked blades. This difference between the hearths is one of degree rather than kind (Carr 1985b:449). (3) Occurring around Hearths 2 and 3, but not 1, are large blocks of stone that would have been useful as seats. Theses are surrounded by concentrations of tools and debris in possible work areas.

At the same time, a quantitative analysis of the polythetic structuring of depositional sets at Pincevent (Carr 1985b:441–451) showed a second pattern. Areas around Hearths 1 and 2 were more similar to each other and distinguished from areas around Hearth 3 in the relative proportions and patterns of asymmetry found among artifacts in the same depostional sets. These similar or different artifact proportions and asymmetries indicate similarities and differences in the formation processes that operated around the hearths (Carr 1985b:328–373).

Third, it is possible that three huts occurred at habitation no. 1 but that the modules were not interconnected so as to form a single structure with a common gallery. This reconstruction would affect estimates of the covered floor area and site population, length of occupation, and the nature of the social unit(s) that inhabited the site. One must consider that scattered over most of the 1.5 ha of Pincevent are many hut modules that are similar to those of habitation no. 1 but that occur as single units.

Fourth, it is possible that the hearths, or some of them, were outside hearths used in some kind of specialized extraction activity, rather than men's outside hearths. One possible activity is the making of bone grease through stone boiling (Leechman 1951). Leroi-Gourhan and Brézillon (1966:367) and I (Carr 1985b:426, Table 8) have suggested that this activity occurred around the hearths, based in part on the concentration of grease-producing bones (humeri, femurs, radio-cubitals) and rocks that surround the hearths. The strong spatial association of these debris classes and their probable unity as a depositional set were indicated in a quantitative analysis that I made (Carr 1985b:426, depositional set 4). Also, there are debris-free areas, 20 to 30 cm in diameter, around each hearth. Leroi-Gourhan and Brézillon (1966:367) suggested that in these locations, there might have stood racks that supported skins for making grease or broth by stone boiling. Finally, the great density of bone and stone around the hearths, which created a very rough floor in their vicinity (Figure 11), need to be evaluated relative to the alternative activities of sitting, dropping, and dumping.

If one or two of the hearths were outside hearths used for making bone grease and the other(s) were inside habitation(s), the proximity of the hearths to each other must be considered. Making bone grease is a messy activity. Messy activities, which create much debris, obnoxious odors, or residues that attract vermin or carnivores, tend to be found at a distance from permanent habitations both ethnographically (Watanabe 1972; Yellen 1974; O'Connell 1979) and archaeologically (Brose and Scarry 1976; Carr 1977). In contrast, the Pincevent hearths are closely spaced, calling this reconstruction into question. However, one must also grant that our understanding of the distribution of messy activities in habitations is based primarily on warm climate or warm season sites rather than cold season, frozen-ground sites. Factors such as vermin, carnivores, and odors might not be as important in this context.

If all three hearths were used for making bone grease, habitation no. 1 might actually represent a reindeer kill and processing site rather than a habitation site or hunting stand. Pincevent is located on the banks of the Seine between the confluences of the Loire and Yonne rivers. This would have been a natural ice crossing for migrating reindeer herds in winter (Gordon 1988) and an optimal kill location. An analogous, well-documented game kill and processing station, where the making of bone grease did occur, is the Olsen-Chubbuck bison kill site (Wheat 1972). At the same time, habitation no. 1 might have been only the processing area of a larger processing–habitation camp, the huts of which are represented by other debris scatters within Pincevent's 1.5 ha expanse.

In a complete analysis of habitation no. 1, it would be desirable to seriously consider each of these alternative reconstructions or some combination of them and to systematically outline the data that support and refute them and the data that are ambiguous. Such data searching might, in turn, lead to the abduction of additional possibilities. In contrast, only some of the possible data relationships, upon which the preceding reconstructions focus, have been weighed and reported here and elsewhere (Carr 1985b). This task is beyond the scope of these papers. The evaluations presented in the previous two sections on Binford's and Leroi-Gourhan and Brézillon's reconstructions are the end product of this process and reflect my current position.

7. CONCLUSION

The nature of the archaeological record, philosophy of science, and recent philosophical and technical developments in statistics each suggest the importance of using contextual information when identifying archaeological observations and patterns. The archaeological record often provides ambiguous data. Single characteristics can be unreliable indicators of single processes or simultaneously reflect multiple processes. As a consequence, first, the strategy of identifying individual kinds of archaeological observations in separation from each other is often less successful than one where multiple kinds of observations are analyzed simultaneously as a coherent system for their mutually reinforcing patterns. Second, using multiple models to explore the observations inductively from several different perspectives, rather than a single model in a deductive confirmatory mode, is often necessary for finding mutually reinforcing identifying relationships or unanticipated, critical ones. Those who have used factor analysis or other multivariate, model-variable search techniques are well aware of both of these constraints on archaeological analysis and inference. Implicit in both constraints is the fact that observations often need to be analyzed and identified in their own contexts of relevant observations, of varying scope, if identification is to be successful.

That contextual data can be critical to the identification process is also apparent from the philosophy of science. The plausibility of an identification in part depends on the diversity of the data that are evoked. A contextual-sensitive approach to identification draws on more kinds of observations than a model-focused one.

Finally, the general philosophy and techniques of EDA and CEDA encourage one to use contextual data in order to find unanticipated or case-specific identifying patterns. Emphasis is placed on inductive data exploration and on using multiple models to view the data from different perspectives. These tactics can reveal context-specific identifying patterns that might be overlooked when using a single model in a deductive, confirmatory mode.

Building, testing, and applying models is essential to the growth of archaeological theory and to our knowledge of prehistory. However, the process of applying a model to data in confirmatory mode in order to identify a phenomenon is usually only the final step in a longer sequence and cycle of analytic tasks that are necessary for identification; model application should not be confounded with these. The analysis that leads to an identification often requires using diverse contextual data as well as explicit models and model-specified data. And it requires data exploration as well as model confirmation. It is with this understanding that statistics has shifted from deductive hypothesis testing and modeling to a synthesis of exploratory and deductive strategies over the past decade. It is hoped that this chapter encourages a similar synthesis in archaeology and a revitalized status for contextual data.

Acknowledgments

I wish to thank Brian C. Gordon for generously sharing his faunal analysis and interpretation of Pincevent habitation no. 1 with me. Marc Stevenson provided me with ethnographic references and his own information on the accumulation of artifacts near walls of tents, for which I am very appreciative. Michael Schiffer offered a number of helpful comments on a previous version of this chapter.

8. REFERENCES

Ascher, R., 1968, Time's Arrow and the Archaeology of a Contemporary Community. In *Settlement Archaeology* (K. C. Chang, ed.), National Press Books, Palo Alto, pp. 47–79.

Binford, L. R., 1968, Archaeological Perspectives. In *New Perspectives in Archaeology* (S. R. Binford and L. R. Binford, eds.), Adeline, Chicago, pp. 5–32.

Binford, L. R., 1977, General Introduction. In *For Theory Building in Archaeology* (L. R. Binford, ed.), Academic Press, New York, pp. 1–10.

Binford, L. R., 1978, Dimensional Analysis of Behavior and Site Structure: Learning from an Eskimo Hunting Stand, *American Antiquity* 43(3):330–361.

Binford, L. R., 1980, Willow Smoke and Dogs' Tails: Hunter–Gatherer Settlement Systems and Archaeological Site Formation, *American Antiquity* 45(1):4–20.

Binford, L. R., 1983, *In Pursuit of the Past: Decoding the Archaeological Record,* Thames and Hudson, New York.

Brose, D. S., and Scarry, J. R., 1976, The Boston Ledges Shelter: Comparative Spatial Analysis of Early Late Woodland Occupations in Summit County, Ohio, *Midcontinental Journal of Archaeology* 1(2):179–228.

Butzer, K. W., 1971, *Environmental Archaeology* (2nd ed.), Aldine, Chicago.

Butzer, K. W., 1982, *Archaeology as Human Ecology,* Cambridge University Press, Cambridge.

Cahen, D., and Keeley, L. H., 1980, Not Less than Two, Not More than Three, *World Archaeology* 12(2):165–180.

Campbell, J. B., 1977, *The Upper Paleolithic of Britain,* Oxford University Press, Oxford.

Carr, C., 1977, *The Internal Structure of a Middle Woodland Site and the Nature of the Archaeological Record,* Preliminary Examination Paper, Department of Anthropology, University of Michigan, Ann Arbor.

Carr, C., 1982, *Handbook on Soil Resistivity Surveying,* Chapter 5, Center for American Archaeology, Evanston, Illinois.

Carr, C., 1984, The Nature of Organization of Intrasite Archaeological Records and Spatial Analytic Approaches to Their Investigation. In *Advances in Archaeological Method and Theory, Volume 7* (M. B. Schiffer, ed.), Academic Press, New York, pp. 103–222.

Carr, C., 1985a, Getting into Data: Philosophy and Tactics for the Analysis of Complex Data Structures. In *For Concordance in Archaeological Analysis: Bridging Data Structure, Quantitative Technique, and Theory* (C. Carr, ed.), Westport Press, Kansas City, pp. 18–44.

Carr, C. 1985b, Alternative Models, Alternative Techniques: Variable Approaches to Intrasite Spatial Analysis. In *For Concordance in Archaeological Analysis: Bridging Data Structure, Quantitative Technique, and Theory* (C. Carr, ed.), Westport Press, Kansas City, pp. 302–473.

Clarke, D. L., 1968, *Analytical Archaeology,* Methuen, London.

Dodd, W. A., 1984, *The Use of Domestic Space by Sedentary Households: Some Organizing Principles*, Paper presented at the annual meetings of the Society for American Archaeology, Portland.

Gamble, C., 1986, *The Paleolithic Settlement of Europe,* Cambridge University Press, Cambridge.

Goodenough, W., 1965, Rethinking "Status" and "Role": Toward a General Model of the Cultural Organization of Social Relationships. In *The Relevance of Models for Social Anthropology* (M. Gluckman and F. Eggan, eds.), Association of Social Anthropologists of the Commonwealth, Monograph 1, pp. 1–24.

Gordon, B. C., 1988, Of Men and Reindeer Herds in French Magdalenian Prehistory, *British Archaeological Reports, International Series,* 390. British Archaeological Reports, Oxford.

Guillien, Y., and Perpere, M., 1966, Maxillaires de Rennes et Saisons de Chasse (habitation 1 de Pincevent). In *L'habitation Magdalénienne no. 1 de Pincevent près Montereau (Seine-et-Marne)* (A. Leroi-Gourhan and M. Brézillon, eds.), *Gallia Préhistoire* 9(2):373–377.

Hanson, N. R., 1972, *Patterns of discovery*, Chapter 4, Cambridge University Press, Cambridge.
Hayden, B., 1979, *Paleolithic Reflections.* Institute of Aboriginal Studies, Canberra, Australia.
Hartwig, F., and Dearing, B. E., 1979, *Exploratory Data Analysis,* Sage Publications, Beverly Hills.
Hemple, C. G., 1966, *Philosophy of Natural Science,* Prentice-Hall, Englewood Cliffs, New Jersey.
Hodder, I., 1982, Theoretical Archaeology: A Reactionary View. In *Symbolic and Structural Archaeology*(I. Hodder, ed.), Cambridge University Press, Cambridge, pp. 1–16.
Keeley, L. H., 1977, The Functions of Paleolithic Flint Tools, *Scientific American* 237:108–126.
Kemeny, J. G., 1959, *A Philosopher Looks at Science,* Van Nostrand-Reinholt, New York.
Leechman, D., 1951, Bone Grease, *American Antiquity* 16:355–356.
Leroi-Gourhan, A., and Brézillon, M., 1966, L'Habitation Magdalénienne no. 1 de Pincevent prés Montereau (Seine-et-Marne), *Gallia Préhistoire* 9(2):263–385.
O'Connell, J., 1979, *Site Structures and Dynamics among Modern Alyawara Hunters,* Paper presented at the annual meetings of the Society for American Archaeology, Vancouver.
Planchais, N., 1976, La Végétation au Pléistocène Suprieur et au Début de L'Holocène dans le Bassin de Paris et les Plaines de la Loire Moyenne. In *La Préhistoire Française* (Henry de Lumley, ed.), Éditions du Centre National de la Recherche Scientifique, Paris, pp. 534–538.
Read, D., 1985, The Substance of Archaeological Analysis and the Mold of Statistical Method: Enlightenment Out of Discordance? In *For Condordance in Archaeological Analysis: Bridging Data Structure, Quantitative Technique, and Theory* (C. Carr, ed.), Westport Press, Kansas City, pp. 45–86.
Sackett, J. R., 1982, Approaches to Style in Lithic Archaeology. *Journal of Anthropological Archaeology* 1:59–112.
Salmon, M. H., and Salmon, W. C., 1979, Alternative Models of Scientific Explanation, *American Anthropologist* 81:61–73.
Samuels, S. R., 1983, *Spatial Patterns and Cultural Processes in Three Northwest Coast Longhouse Floor Middens from Ozette.* Ph.D. Dissertation, Department of Anthropology, Washington State University, Pullman.
Schiffer, M. B., 1972, Archaeological Context and Systemic Context, *American Antiquity* 37(2):156–165.
Schiffer, M. B., 1976, *Behavioral Archaeology,* Academic Press, New York.
Schiffer, M. B., 1983, Toward the Identification of Formation Processes, *American Antiquity* 48(4):675–706.
Stevenson, M. G., 1985, The Formation of Artifact Assemblages at Workshop/Habitation Sites: Models from Peace Point in Northern Alberta, *American Antiquity* 50:63–81.
Stevenson, M. G., 1987, *What Now! Beyond the Formation of Hearth Associated Artifact Assemblages.* Paper presented at the annual meetings of the Society for American Archaeology, Toronto.
Taylor, W., 1948, *A Study of Archaeology.* Southern Illinois University Press, Carbondale.
Tukey, J., 1977, *Exploratory Data Analysis,* Addison-Wesley, Reading, Massachusetts.
Tukey, J., 1979, Comments to "Nonparametric Statistical Data Modeling," *Journal of the American Statistical Association* 74:121–122.
Tukey, J., 1980, We Need Both Exploratory and Confirmatory, *American Statistician* 34(1):23–25.
Tukey, J. W., and Wilk, M. B., 1970, Data Analysis and Statistics: Techniques and Approaches. In *The Quantitative Analysis of Social Problems* (E. R. Tufte, ed.), Addison-Wesley, Reading, Massachusetts, pp. 370–390.
Watanabe, H., 1972, *The Ainu Ecosystem,* University of Washington Press, Seattle.
Watson, P. J., Le Blanc, S. A., and Redman, C. L., 1971, *Explanation in Archaeology,* Columbia University Press, New York.
Wheat, J. B., 1972, *The Olsen-Chubbuck Site: A Paleo-Indian Bison Kill,* Society for American Archaeology, Memoirs 26.
Wiessner, P., 1974, A Functional Estimator of Population from Floor Area, *American Antiquity* 39:343–350.

Williams, L., Thomas, D. H., and Bettinger, R., 1973. Notions to Numbers: Great Basin Settlements as Polythetic Sets. In *Research and Theory in Current Archaeology* (C. L. Redman, ed.), John Wiley, New York, pp. 215–237.

Wood, W. R., and Johnson, D. L., 1978, A Survey of Disturbance Processes in Archaeological Site Formation. In *Advances in Archaeological Method and Theory, Volume 4,* (M. B. Schiffer, ed.), Academic Press, New York, pp. 315–381.

Yellen, J. E., 1974, *The !Kung Settlement Pattern: An Archaeological Perspective,* Ph.D. Dissertation, Harvard University, Cambridge.

Yellen, J. E., 1977, *Archaeological Approaches to the Present: Models for Reconstructing the Past,* Academic Press, New York.

The Interpretation of Archaeological Spatial Patterning

Edited by

ELLEN M. KROLL and T. DOUGLAS PRICE

University of Wisconsin
Madison, Wisconsin

Plenum Press • New York and London

Library of Congress Cataloging-in-Publication Data

The Interpretation of archaeological spatial patterning / edited by Ellen M. Kroll and T. Douglas Price.
p. cm. -- (Interdisciplinary contributions to archaeology)
Papers presented at a symposium organized at the 52nd Annual Meeting of the Society for American Archaeology held in May 1987 in Toronto, Ont.
Includes bibliographical references and index.
ISBN 0-306-43645-0
1. Social archaeology--Congresses. 2. Excavations (Archaeology)--Congresses. 3. Spatial behavior--History--Congresses. 4. Ethnoarchaeology--Congresses. I. Kroll, Ellen M. II. Price, T. Douglas (Theron Douglas) III. Society for American Archaeology. Meeting (52nd : 1987 : Toronto, Ont.) IV. Series.
CC72.4.I57 1991
930.1--dc20 90-19444
CIP

ISBN 0-306-43645-0

A Division of Plenum Publishing Corporation
233 Spring Street, New York, N.Y. 10013

Printed in the United States of America