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Behavioral Chain Analysis: Activities, Organization, and the Use of Space

by
MICHAEL B. SCHIFFER

INTRODUCTION

The view once widely held that archaeological remains must remain forever silent on the subject of social organization is seldom placed in print today. Since the early 1960's, numerous studies have demonstrated that it is possible to design methods that can successfully retrieve information on topics such as a breakdown in matrilocal residence (Deetz, 1965), the identification of uxorilocal residence units (Longacre, 1964, 1970; Hill, 1966, 1970a, b), differential acculturation of sex roles (Deetz, 1963), and the functional differentiation of puebloan rooms (Hill, 1968, 1970a; Dean, 1969a), among many others.

Aiming to provide a general method for discovering how puebloan task units structured their activities in space, Hill (1970b) has generalized the method he used at Broken K pueblo to demonstrate the similarity in the past patterning of activity space (and presumably local groups) with patterns observed among the ethnographically-known western pueblo groups. This method leads to (or from) hypotheses concerning the organization of households and other local groups in terms of the recurrent sets of activities that were conducted within similarly patterned sets of bounded spaces (pueblo rooms). A major portion of this method is aimed at demonstrating that certain formal differences in pueblo rooms were related to differences in function (i.e., the activities that were conducted there). On the basis of the artifact and ecofact content of similar room types among western pueblos, a set of test implications is deduced for the archaeological case. The fit between expectations and actual archaeological evidence is compared, and the functional hypotheses are accepted, modified or rejected.

The purpose of this paper is to point out several weaknesses in Hill's method that might possibly make it unsuitable for more general use in its present form. Of primary concern are the two important problems posed by cultural formation processes (Schiffer, 1972), on the one hand, and variations in activity space partitioning, on the other. These problems are discussed in some detail and Hill's method is modified to take them into account. The modified approach makes use of *behavioral chain analysis*—an explicit procedure for hypothesizing past activities and deducing their archaeological test implications.

CULTURAL FORMATION PROCESSES

A principal assumption of Hill's method is the following:

> . . . where different kinds of activities are carried out within a community, one would expect to find different kinds of artifacts; and the presence of different artifacts in particular rooms or areas within an archaeological site should be usable as evidence in inferring the activities of these rooms and areas—assuming that one can identify the uses of the artifacts involved (Hill, 1970b, p. 19).

If one proceeds on the basis of this assumption, at least one additional assumption has been implicitly accepted: artifacts are discarded at their locations of use within a site. While this may be true for some kinds of sites (Schiffer, 1972), in many sedentary villages and larger sites highly developed refuse transport and discard systems must have been developed. This set of variables relates to the important but usually untreated problem of cultural formation processes—how does the *systemic context* of artifacts and features (their participation in a past behavioral system) relate to their *archaeological context* (Schiffer, 1972)? In examining this problem I have found it useful to distinguish between three fundamentally different kinds of refuse (Schiffer, 1972). *Primary refuse* is discarded at its use location, while *secondary refuse* is transported away from the location of use and discarded elsewhere. *De facto refuse* consists of those items which are not discarded during the normal operation of a cultural system but abandoned as the occupants leave the site. Although most of the material at Broken K is secondary refuse, enough primary and *de facto* refuse was present to permit the successful application of Hill's method. But this is not so at all sites.

The implicit merging of archaeological context and systemic context can be seen at several points in Hill's (1970b) paper. For example, in discussing how test implications may be derived from ethnographic data he suggests that:

> An examination of the activities performed in the modern room types would then yield a series of test implications for each (in terms of artifacts and their relative

frequencies and spatial distributions), and the investigator would turn to the archaeological evidence to determine the degree to which his expectations are met . . . (Hill 1970b, p. 30).

In the cases where he presents test implications for functionally different rooms, they are simply statements about what is found in rooms of the same type occupied by the ethnographically-known Hopi and Zuni. Unfortunately, the pueblo (or other) structures we excavate no longer are part of an ongoing behavioral system; and our methods must take account of the way such systems produced archaeological remains.

ACTIVITY SPACE PARTITIONING

The second major problem in generalizing Hill's method concerns the wide cross-cultural variety in the way that social units partition their activity spaces. In other words, there may be more or less compartmentalization in the partitioning of activity space by the systems that generated other sites. What we now require is a means by which we can discover how any society, pueblo or non-pueblo, spatially bounded its recurrent activity sets. In many cases the use of ethnographic analogies will not permit restriction of the range of possibilities. Ideally, the modified method must be potentially free from dependence on *specific* sets of ethnographic data.

Hill briefly addresses the problem of discovering patterns of room use different from the Broken K paradigm. He offers the following two approaches for describing intra-community task organization:

The first is to begin by describing the variability in room types, plazas, and other areas within the site and then ask the question, "What kinds of activities were being performed in these rooms and areas?" The other approach is to begin with a specific list of *activities* that are of interest to the archaeologist and ask the question, "Where were these activities being performed?" (Hill, 1970b, pp. 28-29, emphasis in original).

The latter approach, discussed briefly in the context of addressing the problem of "missing activities," has the potential for discovering previously unsuspected patterns of space utilization.

This situation [missing activities] may be avoided by focusing less attention on the test implications of rooms and areas and more attention on the test implications of individual *activities*. In this approach, the investigator would first consider the kinds or clusters of cultural remains that are expected to have been associated with particular activities and then study the spatial distributions of these clusters within the site (Hill, 1970b, p. 32, emphasis in original).

This approach, when divorced of its implicit merging of archaeological and systemic context, appears promising because it is the distributions of the activities themselves that are being compared. A modification of this approach, based on explicit consideration of cultural formation processes will now be elaborated.

In constructing the general method, several assumptions are made. The first is that we possess data from an already excavated site. It is further assumed that a rigorous program of sampling was applied and all data relevant to the problem at hand were recorded. And finally it is assumed that the site has a known regional context, and information from other excavated sites can be brought into the analysis.

BEHAVIORAL CHAINS

The first task at hand is the determination of what activities took place at the site. Only after these have been identified can the question be raised concerning their locations in space. After excavation of the site, analysis begins through the application of hypotheses gleaned from general anthropological knowledge and regional information. One way of ordering and extending these activity hypotheses is by narrowing down from broad categories to more specific activities in the "life" of all elements of the past cultural system. Using broad categories of basic processes intersected by major classes of cultural elements (see Schiffer, 1972, for the basic processes) one can derive a hierarchy of activity sets (fig. 26). Once one has deduced a specific process in the systemic context of a single element, the problem is then visualized in terms of *behavioral chains* and their *chain segments*. Behavioral chains lead directly to archaeological test implications for determining whether or not a specific activity was conducted at a site.

A behavioral chain is the sequence of all activities in which an element participates during its "life" within a cultural system. A chain segment is then simply a specified portion of a given chain. For the sake of convenience, the example used throughout this paper derives directly from ethnographic data. A partial behavioral chain of maize for the Hopi (circa A.D. 1900) has been reconstructed from the works of Bartlett (1933, 1936), Stephen (1936), Beaglehole (1937), Whiting (1939), and Turner and Lofgren (1966). Unfortunately, none of these ethnographic accounts is adequate for the purpose at hand. Even though a composite chain was drawn from the data of the several villages at several points in time, many entries had to be guessed at. Table 9 presents the completed chain in which all plausible entries made by this author are indicated by a

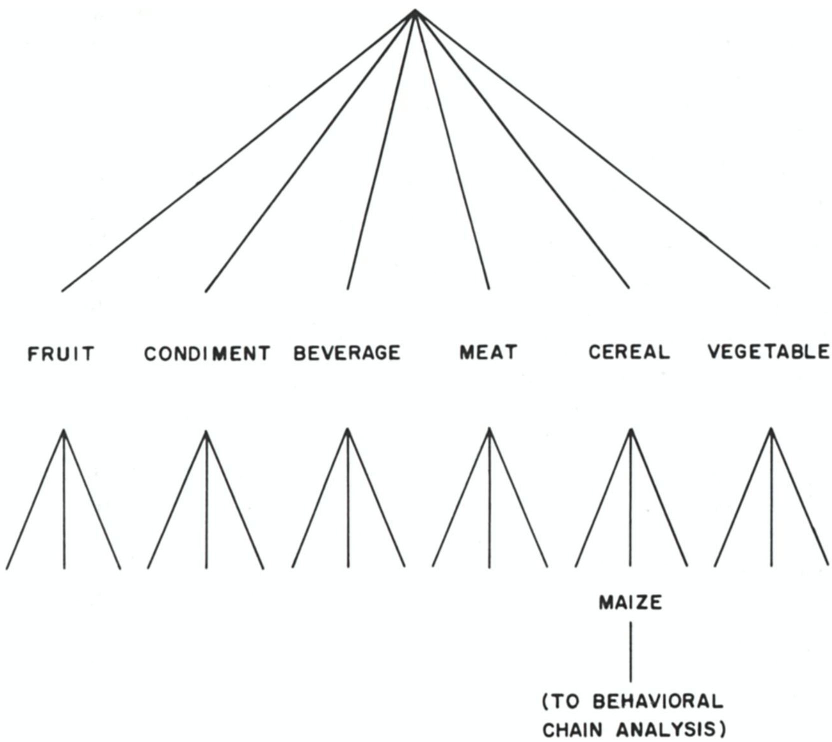

FIG. 26. A hierarchical taxonomy of food preparation activities of the Hopi, ca. 1900.

lack of explicit citation to other authors. The ultimate accuracy of this particular case is irrelevant for illustrating the basic principles of construction and use of behavioral chains.

Behavioral chains are not new in archaeology. I have simply made explicit and given a name to one form of reasoning employed to arrive at the activities that were performed at a site and their test implications. In this presentation, I have been heavily influenced by Harris (1964). My emphasis on the life-history of system elements differs somewhat from the actor-activity orientation of Harris. The reason for this shift in perspective relates to the material nature of the archaeological record and some of the predictive properties of behavioral chains—properties that permit the investigator to circumvent the apparent limitations of the archaeological record.

Although the actual behavioral chain is represented by the sequentially related activities in the systemic context of any cultural element,

TABLE 9. Partial behavioral chain of maize for the Hopi, circa A.D. 1900

ACTIVITY	ENERGY SOURCES: SOCIAL UNITS / NON-HUMAN	CONJOINED ELEMENTS	TIME AND FREQUENCY	LOCATION	OUTPUTS	INTERSECTIONS: ADDITIONS / DELETIONS
HARVEST	ABLE VILLAGERS OF BOTH SEXES 3,4	BASKETS 4	SEVERAL DAYS IN SEPTEMBER 4	FIELDS OF H.H. 3,4	STALKS, WASTED OR UNHARVESTED MAIZE	
TRANSPORT	ABLE VILLAGERS OF BOTH SEXES 3,4	BASKETS BLANKETS 3,4	ONCE IN SEPTEMBER	FROM FIELDS TO ROOF OF H.H. AREA	POLLEN	
HUSK	WOMEN OF H.H. AND OTHER FEMALES 3,4	WOODEN OR BONE PEG 6	ONE OR SEVERAL DAYS IN SEPTEMBER	ON ROOF OF H.H. AREA 3,4	POLLEN	/ HUSKS
DRY	/ 4 SUNLIGHT	ROOF OF H.H. AREA 4	SEVERAL DAYS IN SEPTEMBER	ON ROOF OF H.H. AREA 3,4	POLLEN	
TRANSPORT	WOMEN OF H.H.	BASKETS	ONCE IN SEPTEMBER	FROM H.H. AREA TO STOREROOM	OCCASIONAL KERNELS, POLLEN	
STORAGE		STOREROOM 3,4,6	1 TO 100 WEEKS · 6	STOREROOM 3,4,6	OCCASIONAL KERNELS, POLLEN	
TRANSPORT	WOMEN OF H.H.	BASKETS	SEVERAL MORNINGS WEEKLY	FROM STOREROOM TO HABITATION ROOM		
REMOVE KERNELS	WOMEN OF H.H. 3	SHORT STICK YUCCA BASKET 3	SEVERAL MORNINGS WEEKLY	HABITATION ROOM	OCCASIONAL KERNELS, POLLEN	/ COBS
COARSE GRIND	WOMEN OF H.H. 1	MEALING BIN, STICK, COARSE MANO AND METATE, YUCCA BASKET · 1,2	SEVERAL MORNINGS WEEKLY	HABITATION ROOM 1	WASTED KERNELS AND MEAL POLLEN	
REMOVE CHAFF	WOMEN OF H.H. / WIND	YUCCA BASKET 3	SEVERAL MORNINGS WEEKLY	OUTSIDE OF STRUCTURE	CHAFF	
MEDIUM GRIND	WOMEN OF H.H. 1	MEALING BIN, STICK, MEDIUM MANO AND METATE, BOWL 1,2	SEVERAL MORNINGS WEEKLY	HABITATION ROOM 1	WASTED MEAL	
FINE GRIND	WOMEN OF H.H. 1	MEALING BIN, FINE MANO AND METATE STICK, BOWL 1,2	SEVERAL MORNINGS WEEKLY	HABITATION ROOM 1	WASTED MEAL	
TRANSPORT	WOMEN OF H.H.	BOWLS 2	SEVERAL MORNINGS WEEKLY	HABITATION ROOM TO STOREROOM	WASTED MEAL	
STORAGE		BOWLS 2	SEVERALS DAYS TO A WEEK	STOREROOM	WASTED MEAL	
TRANSPORT	WOMEN OF H.H.	BOWLS 2	TWICE DAILY	STOREROOM TO HABITATION ROOM	WASTED MEAL	
MAKE DUMPLINGS	WOMEN OF H.H.	COOKING JAR, BOWL	TWICE DAILY	HABITATION ROOM	WASTED MEAL	WATER, OTHER INGREDIENTS /
COOK	/ FIRE	JUNIPER TWIGS COOKING JAR FIRE PIT · 6	TWICE DAILY 3	HABITATION ROOM	SPILLAGE-WASTE	
SERVE	WOMEN OF H.H.	SERVING BOWLS COOKING JARS LADLES · 5	TWICE DAILY 3	HABITATION ROOM	SPILLAGE-WASTE	
EAT	ENTIRE H.H.	BOWLS 5	TWICE DAILY 3	HABITATION ROOM	WASTE	
DIGEST TRANSPORT	ENTIRE H.H.		ALMOST CONTINUOUSLY	LOCATIONS OF H.H. MEMBERS		OTHER FOODS /
DEFECATE DISCARD	ENTIRE H.H.	A BROAD LEAF	ONCE DAILY	AWAY FROM OCCUPIED ROOMS	A BROAD LEAF, RESIDUES	

KEY

1 · BARTLETT (1933)
2 · BARTLETT (1936)
3 · BEAGLEHOLE (1937)
4 · STEPHEN (1936)
5 · TURNER AND LOFGREN (1966)
6 · WHITING (1939)
H.H. HOUSEHOLD

behavioral chain analysis consists in part of hypothesizing and using the *components* of each individual activity. The smallest segment of a behavioral chain is a single *activity*. An activity is defined as the patterned interaction between at least one energy source (human or non-human) and at least one other cultural element (Schiffer, 1972). Each activity is described for the purpose of behavioral chain analysis by listing the following *components:*

1. A behavioral description of the activity.
2. The nature of the constituent human and/or non-human energy source(s).
3. The element(s) conjoined or associated with the one under consideration.
4. The time(s) and frequency of activity performance.
5. The location of activity performance.
6. The pathways created to the archaeological record by the outputs of activity performance.
7. The points at which other chains of elements integrate with or diverge from the element under consideration.

These essential components of any activity will now be given more explicit definition. One is again referred to the example of a behavioral chain segment of maize among the Hopi (table 9).

Activity definition

The nature of the activity is one of the most important components. Activities should be described in terms of the dynamic relationships among the various interacting elements. For example, in using the term "grinding" one is attempting to be precise in designating a set of behaviors. Grinding implies that the object of the activity, such as maize, is being worn down by the application of a tool. Because the attributes of tools make them more or less suitable for being used in a certain way, the precise specification of behavior can lead to a listing of the attributes a conjoined element must have possessed (or acquired through use). These inferences are made possible by application of general principles (correlates) that state relationships between attributes of objects, behavior, and results of behavior in terms of the attributes of the objects (Schiffer, 1973). The construction and experimental testing of correlates depends not only upon looking at activities differently but also developing a specialized language for describing behavior. Such terms as "grinding," "pounding," etc., may turn out to be hopelessly crude for use in the kinds of predictive principles archaeology must and will eventually possess.

Energy sources

The number and nature of human energy sources is a designation of the social unit of activity performance (cf. Freeman, 1968). This unit consists of any and all humans associated with the element during a specific activity. The concept of social unit of activity performance applies minimally on two levels: the individual, and the societal level which is recurrent. For example, one might point out that among the Hopi a post-pubescent woman does the coarse grinding of maize. At another level of analysis, one might want to specify that the recurrent social unit of maize-coarse-grinding is all post-pubescent women of a society. One can shift the level of analysis to suit specific needs. It should also be possible to consider and describe patterned internal variability in a society for a social unit of activity performance. Non-human energy sources include the sun, wind, fire, machines, animals, etc.

Conjoined elements

Conjoined elements are those associated with the one under consideration during an activity excluding the energy source. They should be conceived of in terms of the attributes critical to their interaction (cf. Dunnell, 1971). This implies that not all attributes of form are relevant for the description of an element or its identification. For example, "maize coarse-grinding" requires at least two elements with hard surfaces capable of breaking the endocarp of maize kernels, at least one of which is capable of sustained manipulation by the human energy source. Clearly, not all objects at a site will possess the requisite attributes; of those that do, one can select the correct elements on the basis of other attributes such as wear, etc. This hardly begins to exhaust other classes of data for testing "functional hypotheses," such as association, spatial location, or quantity and relative frequency.

Times and frequency

The times and frequency of activity performance are relatively easy to define (but often very difficult to determine). Reference is made here to the class of usual performance times and frequencies with the stipulation that variability can be encompassed in specific applications. As an example, among the Hopi the activity of metate stone procurement took place once yearly, in the winter (Bartlett, 1933).

Location

The location of activity performance ordinarily refers to a location or class of like locations within an area; they can be specified relative to each other or with respect to stationary features.

Outputs or pathways

At every point in the behavioral chain that is labeled "output" a path exists through which materials may become a part of the archaeological record. In the case of outputs such as waste during storage, including pollen grains and some seeds, the material may undergo no further cultural transport or discard. Other pathways are more complex. For example, waste products from cooking or mixing activities constitute an obvious inconvenient and unsanitary residue that would most likely be cleaned up, transported, and discarded as secondary refuse. In societies with highly developed refuse disposal systems, most elements make their way into the archaeological record at locations other than those of their use, and it is necessary to specify in the output component of the behavioral chain exactly how and where these discard activities take place (this has not been done for the Hopi maize example).

In addition to the pathways by which waste products begin their way into the archaeological record during activity performance, there exists an additional and extremely important source of outputs. Elements conjoined with the one under consideration in an activity may terminate their use-life during an episode of activity performance. If each instance of activity performance is defined as one use for all constituent elements (except consumables Schiffer, 1972), then the quantity of any element terminating its use-life during an instance of activity performance may be expressed as follows:

$$C = 1/b$$

Where,

C = the number of elements exhausted during one instance of activity performance. This variable is termed the *output fraction.*

b = the total number of uses of which an element is capable during its use-life. In cases where reference is made to a class of like elements, b designates the average number of uses per use-life.

As a result of this relationship, one would expect an instance of activity performance to create the following pathways to the archaeological record (when there is no re-use):

$$Y = C_1 + C_2 . . . + C_n$$

Where,

Y = the total number of elements (1 . . . n) exhausted during one instance of activity performance.

$C_1 . . . C_n$ = the respective output fractions of all elements (1 . . . n) of an activity.

The principles for describing and explaining the various pathways to the archaeological record are in their initial stages. The above equations are part of a network of laws purporting to explain some cultural formation processes of the archaeological record (Schiffer, 1973).

Chain intersections

In constructing the behavioral chain of the element under consideration, it may be necessary for some problems to specify when another element has become attached, or when a diverging chain segment is created. For example, spices and other ingredients become a part of the maize behavioral chain during "dumpling preparation" activities. In the case of divergence, one can cite the separation of kernels and cobs; the latter forms a new divergent chain segment (fig. 26).

BEHAVIORAL CHAIN ANALYSIS

The above discussion, it must be emphasized, presents a framework for describing the interrelations between behavioral and spatial-material aspects of activity performance with reference to the life-history of cultural elements. This orientation demands that the description of activities performed at an archaeological site be expressed in terms of highly specific hypotheses on an empirical, behavioral level. To deduce the test implications of so broad an activity category as "food preparation" (fig. 26) is a trying if not impossible task; evidence for such a demonstration is always ambiguous. But, with more exact definition of activities one is led to consider conjoined elements, spatial location, and outputs, thereby facilitating the task of specifying relevant test data. By postulating past activities and describing them in terms of behavioral chain components, one can follow the cultural pathways to the archaeological record and make activity documentation more secure.

In addition to the cultural pathways of archaeological record formation, there exists a set of non-cultural formation processes which may eliminate elements (organic decay, etc.), modify them (natural deposition, weathering), or redeposit them. One can extend the concept of behavioral chain to include these processes. The resulting chains contain pathways that lead directly from the performance of activities in the past to the actual proveniences of material in the archaeological record (or the point in time when they disappear). I have not failed to notice the implications of these formulations for constructing simulation models (Schiffer, 1973).

An important property of behavioral chains lies in their ability to facilitate the prediction of activities that, although not directly indicated, must have occurred at a site. To justify this claim, three general principles are offered below. Quite clearly, these principles have many exceptions and are not universally applicable, but it is hoped that their judicious use will lead to many specific hypotheses about the activities conducted at a site, and the kinds of data that might confirm their presence.

The first principle is:

> When two non-sequential activities in the behavioral chain of an element occur at a site, then the activities that took place between them on the chain also occurred at that site.

For an example, let us return to the behavioral chain of maize among the Hopi. If it is known that storage (between drying and kernel removal) took place at a site, and one finds coprolites with direct evidence for the consumption and discard of maize, then one can deduce by the above principle that the intervening activities of grinding, mixing, and cooking also took place at that site. The past occurrence of these hypothesized activities can be determined on basis of independent archaeological evidence implicated by output components.

Use of the above principle in this manner presupposes the availability of sufficient data to create generalized behavioral chains for different kinds of elements. At present, we can operate only at very general levels, and only for a few kinds of elements. Experimental studies, ethnoarchaeology, and a careful search of extant ethnographies should provide data to build additional chains which can be used as models for archaeological testing. James T. Rock (pers. comm.) is constructing behavioral chains for such elements as utilitarian pottery and foodstuffs in western pueblo societies. Many of these chains may be useful beyond puebloan society since they rest ultimately on general principles of human behavior.

Another much weaker principle is offered here whose careful use may allow further generation of activity hypotheses.

> If one activity in the life history of an element occurred at a site, then the activities which followed it on the behavioral chain (to and including discard) also occurred at that site.

Again, great caution is urged in its application, but as a device used simply for obtaining hypotheses, it should serve well.

When dealing with stationary elements, an additional principle is presented that will facilitate numerous behavioral deductions:

> For stationary cultural elements, all activities of the behavioral chain segment from the beginning of manufacture through discard

occurred at that site, and probably at that location (adapted from Schiffer, 1972, p. 161).

One would expect this principle to hold true because the behavioral chains of stationary elements, such as a pit or house, have a constant locational component (at least for activities of manufacture through discard). Let us turn, for example, to the ubiquitous subterranean storage pit. From the presence of such a facility on a site one can infer the past occurrence of specific manufacture and use activities. Because pits of this type must have been excavated by the site occupants with, most likely, a pointed object (and this can often be tested by direct examination of the pit's wall), one can thereby deduce that at least one other element (e.g., an antler, wood, or stone digging tool) was conjoined with the pit during its initial excavation. The elements conjoined can be determined by the use of behavioral-material correlates. These principles indicate the attributes that an element possesses in order to be used in a specified behavior.

To this point in the presentation it has been taken for granted that one can identify with relative ease the constituents of an activity that has been inferred through the use of behavioral chains. Let us return to the activity of maize cooking; the investigator desires to know what were the conjoined elements of maize in the cooking activity. By applying the relevant behavioral-material correlates to deduce properties and attributes of some of the conjoined elements, the nature of the conjoined elements can be determined with a high degree of probability by using site- and region-specific information.

Cooking, by boiling, is an activity in which chemical and physical changes are produced in consumable elements through the indirect action of a heat source. The occurrence of such an activity requires minimally a source of stored energy, a location for its transformation into heat, and a facility for containing the element to be cooked, one that is resistant to heat. Given knowledge about the main artifact classes of the site, and of other similar sites, one can select the most likely element from among the feature classes as the one used to produce heat for maize cooking. In the case of the Joint Site (Hanson and Schiffer, this volume), this might be a firebox or firepit.

A second implication of this type of cooking is that the heat source is not in direct contact with the consumable. We would expect the presence on the site of a facility capable of withstanding as well as transferring heat. Knowledge of the site contents would lead one to examine the pottery, from which certain types (painted, but unglazed wares) could be immediately eliminated from consideration on the basis of their inability to withstand repeated contact with heat. Employing some of Linton's (1944) behavioral-material correlates, one can identify the vessel shapes most suitable for this type of cooking from the remaining pottery classes. Ordinarily, one would not boil food in a bottle, dish, or uncovered bowl. At this point, the probable cooking vessels might be limited to several different sizes of a given shape (wide-mouth jars), within a particular pottery class (corrugated). The remaining size variation might be attributable to differences in either cooking activities or social unit size (Turner and Lofgren, 1966). Additional specific testing on independent data (such as soot and other chemical residues) might support these inferences. Further testing is facilitated by the use of behavioral chains, especially the output components, and usually, behavioral-material correlates, behavioral-material-spatial correlates, and *c-transforms* (principles that describe cultural formation processes).

The identification of conjoined elements is not as difficult as might initially be expected, but does require considerable knowledge of extant correlates and site- and region-specific information.

Beginning with only a few cultural elements, an investigator can, by following the ramifications and intersections of behavioral chains, touch one or more times on every activity conducted at a site. In practice, such comprehensive reconstructions are seldom attempted for the obvious reasons that they require very broad interests and ample analytical resources. The use of behavioral chain analysis for a large-scale activity reconstruction would facilitate a fine-grained analysis of space utilization at a site.

ACTIVITY LOCATIONS

Given a possible range of discard activities and locations at a site, the problem remains to determine from the distributions and associations of elements, where they were used in their respective activities.

Let us begin with those activity areas subjected to complete removal and transport of refuse. Under such conditions, only materials not susceptible to the available technology of refuse removal and transport would be expected to remain at locations of activity performance. For example, pollen should be found where maize is stored or husked. In addition, if no recycling or scavenging activities (Ascher, 1968; Schiffer, 1972) occurred, fixed features (such as pits, hearths, and mealing bins) should also be found at their use locations. The investigator must determine from the available data and behavioral chain activity hypotheses the most likely activities that were conducted in these locations. In other parts of the site (or at other times during site occupation) refuse disposal systems could have operated imperfectly, or have been poorly developed, producing quantities of primary refuse. Under these conditions, and when *de facto* refuse is also produced, one can deduce with greater certainty the occurrence of activities at a location. One begins with the assumption that all materials within the bounded (presumably habitation) spaces are found at their locations of use (except for those abandoned spaces—used as dumps). This means that the present location of such elements can only be accounted for in terms of their past participation in certain activities there. The presence of some material elements may be sufficient to suggest the occurrence of one and only one activity, while others may of course be involved in several activities and implicate (potentially) them all.

What one must do first is examine activity spaces for the most specific indices of activities and record their presence among the activity spaces. Next one turns to those elements or element fragments that indicate more than one activity. Using behavioral chains and relevant correlates, one can identify the other activities likely to have been spatially associated with the one under consideration. The identification of spatially-associated activities provides one way of discriminating between alternative possibilities.

The most difficult set of data to work with in attempting to identify activity locations is secondary refuse. In an earlier paper (Schiffer, 1972) I have suggested some of the conditions under which one might expect secondary refuse associations to be based on associations of elements within the use process. These hypotheses are still untested, but may be useful here if only as assumptions awaiting further testing. One must first determine the relationships between activity locations and secondary refuse deposits. By consulting the conjoined elements and output components of the behavioral chain and applying some of the above-mentioned hypotheses, it is possible to deduce probable secondary refuse associations. In any case, the exact nature of the refuse storage, removal, transport, and discard activities must be stipulated in order to predict associations and other patterns within secondary refuse. The verification of such predictions is likely to remain at a very crude level until excavation techniques have been adjusted to the range of questions raised by a study of this sort. It should be possible to excavate secondary refuse so as to recover discrete discard episodes (materials that were discarded at the same time and by the same social unit).

To optimize the information potential of each available kind of refuse one should design a multi-phase testing procedure. First, employing behavioral chain analysis, one arrives at a listing of the probable activities that were conducted at a site. The next question is to locate these activities in space. Using all material suspected to be primary or *de facto* refuse, an attempt is then made to identify as many of these activities as possible at these locations. Next, one deduces further implications for the secondary refuse. By this multi-phase testing procedure it should be possible to arrive at highly credible statements about activity locations, as well as explain the occurrence of many classes of data in the archaeological record (and their spatial and associational patterns).

ORGANIZATION AND ACTIVITY SPACE

After all channels of reconstruction have been exhausted and the likely activity constituents of any and all units of bounded space (or any units for that matter) at a site have emerged, the question can be raised as to the possible existence of regularities in the data that might correspond in some way to functional differentiation in the use of these spaces. To answer this question, one must apply an appropriate computer-aided analysis to determine which rooms or spaces are similar in terms of the activities performed there. Although it would be preferable to have a computer program designed specifically for the analysis of archaeological data, either factor or cluster analysis should be adequate for the task at hand. More refined studies must await the development of archaeological statistics.

If activity spaces contained overlapping sets of activities, a factor analysis of these activities with respect to rooms should bring out sets of related activities. The factor scores on each room indicate its approximate activity composition.

A cluster analysis of rooms with activity variables will yield a typology of rooms, indicating similarity of activity composition among rooms within a cluster. In most cases, it is advisable to attempt both factor and cluster analyses on the data.

Because of the complex patterns of cultural formation processes that operated to produce the remains of sedentary village systems, a statistical analysis of artifacts and features alone, even if found in floor proveniences, is likely to give erroneous or incomplete results. Activities were differentially partitioned in space; not artifacts. It should be stressed that *activities,* not artifacts, must be clustered. This point cannot be overemphasized.

Once one possesses a room typology based on an understanding of how activities were structured within bounded spaces, it can be hypothesized that such units are in some sense related to various resident social units.

The notion of recurrence in activity sets is the basic clue to discovering the past patterns of social organization (for most cultural systems). For, the detection of recurrent activity sets, performed in analogously partitioned spaces, suggests similarity in the social units responsible for these activity sets. The most abundant room types (or activity factors) are likely to be associated with domestic or commensal units of some sort.

One potentially valuable result of the statistical analysis may be the occurrence of exceptions or anomalous cases. It is these exceptions that may provide clues to meaningful variability in the activity structure that can serve as a basis for generating or testing further hypotheses about past organization. It is also necessary to consider explanations for variability in the use of space caused by developmental cycles in domestic groups (Wilcox 1971; Rock, 1972), and "devolutionary cycles" (David, 1971). These organizational hypotheses can be tested on the myriad sets of unused data that remain from the activity analysis. These might include, for example, the location of different kinds of rooms with respect to each other, patterns of construction (see Wilcox, this volume), patterns of doorways and communication (Rohn, 1965, 1971), and design attributes of element classes (Hill, 1970a; Longacre, 1970).

SUMMARY OF METHOD

The method outlined above can be simplified into a set of steps for deriving the past spatial partitioning of activity sets, and the generation of organizational hypotheses to explain them.

1. General anthropological knowledge and site- and region-specific information yield broad classes of activities.

2. Behavioral chains, correlates, and c-transforms and all data classes yield a list of specific activities conducted at the site.

3. The list of site activities, behavioral chains, correlates, c-transforms, and primary and *de facto* refuse lead to statements about the activities conducted per unit of activity space.

4. The list of activities, behavioral chains, secondary refuse data, correlates, and c-transforms yield additional activities for each unit of activity space.

5. Statistical analysis of activities and activity spaces produces room types and major sets of recurrent activities.

6. Room types and activity sets provide basic data for hypothesizing aspects of social organization.

7. Organizational hypotheses, correlates, c-transforms, and other sets of data, especially stylistic, yield tests of hypotheses.

8. Examination of residual room types or unexplained activities, and negative tests in 7, are recycled to step 6 and repeated until the organizational hypotheses provide a best fit to the archaeological data.

CONCLUSION

Behavioral chain analysis, a technique of determining past activities and their performance locations at a site, has been applied to generalize the approach to behavioral and organizational reconstruction that Hill found so useful at Broken K Pueblo. Behavioral chain analysis provides a means to cope with cultural variations in the way that activity space is structured and used, and more importantly, indicates how an investigator can take into account different and complex cultural formation processes. These modifications of Hill's method do not provide a polished program for organizational reconstruction at any site, but are intended to serve as a trial research design subject to experimentation, criticism, and revision. Behavioral chain analysis is simply one attempt at finding a way of more securely tying inferences about past cultural systems to the remains that they produced.

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