Archaeologia Polona, vol. 30:1992, 27–38
PL ISSN 0066–5924

Ethnoarchaeology, experimental archaeology and inference building in ceramic research

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Ceramic remains are one of the most frequently found artifacts throughout the world. Consequently, nearly every aspect of past human behavior, from social organization and ethnicity to diet and demography, has been inferred with ceramic data. Recent ceramic research has demonstrated how new types of information can be obtained by experimentation and by the study of material culture in ethnographic contexts. Although neither of these approaches are new, it is argued that by combining the two strategies important new information can be obtained. In this paper, revised definitions for experimental archaeology and ethnoarchaeology are offered, and two case studies illustrate the types of information that can be obtained. I demonstrate how such information can be profitably combined with prehistoric analyses to develop better inferences about the past.

KEY-WORDS: ceramics, ethnoarchaeology, experimental archaeology, theory

Ethnoarchaeology and experimental archaeology, once only weekend diversions for the prehistorian, have established themselves as productive means for exploring the complex relationships between material culture and human behavior. Both strategies of archaeology can boost of numerous accomplishments, some of which are now considered established tenets of archaeology. Many of the important ideas of lithic technology (*e.g.,* Crabtree 1968), pottery production and use (*e.g.,* DeBoer and Lathrap 1979; Longacre 1981; Nelson 1991), or formation processes (Deal 1985; Jewell and Dimbleby 1966) were established with experimental and ethnoarchaeological data. Although much has been accomplished, ethnoarchaeology and experimental archaeology can and should be even more productive in the years ahead.

This paper has several objectives. First, I offer slightly revised definitions of ethnoarchaeology and experimental archaeology. Second, I demonstrate, with case studies, that combining the two strategies can be a very important means to

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understand pottery technology (*i.e.,* pottery production, performance and use) (see also Longacre 1992). Finally, I argue that a combined approach helps narrow the gap between prehistory and experimental/ethnoarchaeological results.

ETHNOARCHAEOLOGY AND EXPERIMENTAL ARCHAEOLOGY DEFINED

Both experimental archaeology and ethnoarchaeology have long but slightly divergent histories (see Skibo 1992:9—30 for a more complete discussion). In American archaeology, there was an initial interest in each subfield around the turn of the century during the "classificatory-historical period" (see Willey and Sabloff 1980), and then a renewed interest beginning in the 1950s and into the era of "new archaeology." Because the use of ethnoarchaeology and experimental archaeology and the data that they generate have changed over these decades, there is a need for reevaluation as we enter the next century.

The term "ethnoarchaeologist" was coined by Jesse W. Fewkes (1900:578—79) to refer to his research among the Hopi of the American Southwest. This early concern with ethnographic material reflects interests in cultural evolution by American archaeologists around the turn of century. In many areas of North America, occupation by native groups could be traced into prehistory, and abandoned sites were logical places to follow the evolutionary trajectories of material and cultural traits.

Interest in ethnographic material changes beginning in the first half of the 20th century as archaeology became concerned primarily with placing cultural elements of the prehistoric record into the correct historical arrangement. Although this phase in archaeological method and theory was inspired by the great ethnographer Franz Boas, archaeologists through this period had little use for the ethnographic record. Though one can see a growing dissatisfaction with this restrictive focus of archaeology (*e.g.,* Bennet 1943; Martin 1938:297; Steward and Setzler 1938), and even some direct attacks on the discipline (Kluckhohn 1940:42; Taylor 1983 — originally published 1948), there is not real change in the use of the ethnographic record by North American archaeologists until the dawn of what has been labeled the "new archaeology."

The renewed interest in modern peoples is signaled by archaeologists doing ethnographic work (*e.g.,* Thompson 1958) or at least suggesting that it be carried out (*e.g.,* Kleindienst and Watson 1956). This growing concern with archaeological explanation culminated with Binford and his colleagues who believed that the ethnographic record serves as a source of hypotheses for testing archaeological data (Binford 1968; Deetz 1965; Hill 1970; Longacre 1970). The interest in ethnographic investigation by archaeologists continues to the present as increasing numbers of prehistorians actually have done research among living people or at least employ such data in their explanations of the past. This onslaught of such research necessitates that we re-evaluate the role of the ethnographic record in prehistoric explanation, and refine the definition of ethnoarchaeology as a strategy of archaeology.

The definition of ethnoarchaeology consists of four parts (see Skibo 1992:9—30). First, ethnoarchaeology should be conducted by an archaeologist (Longacre 1991:1) because ethnographers are not concerned with the types of data useful to archaeology (Kleindienst and Watson 1956; Yellen 1977:xi). Second, any living people can be the focus of ethnoarchaeology (Gould and Schiffer 1981; Wilson *et al.* 1991), and we need not restrict our investigations to nonindustrial people as suggested by Stanislawski (1974:15). Third, the focus of ethnoarchaeology should be on archaeologically motivated questions (Thompson 1991:231), and finally, the objective of the research should be to help understand the past (Reid *et al.* 1975).

Although experimental archaeology is identical theoretically to ethnoarchaeology (Schiffer 1978:230; Tringham 1978:170), the former is defined as "the fabrication of materials, behaviors, or both, in order to observe one or more processes involved in the production, use, discard, deterioration, or recovery of material culture" (Skibo 1992:18). Experimental archaeology has a longer history than ethnoarchaeology because simple experiments were often conducted to determine how various antiquities were made and used (see Coles 1973, 1979). Because of the vast range of experiments in archaeology, they can be divided into two categories: controlled laboratory experiments and field experiments.

CONTROLLED LABORATORY EXPERIMENTS

The key term in this category of experiments is replicability, which requires a high degree of control of the variables. Experimental results should be used to establish general principles that describe the relationship between a technological property and some behaviorally meaningful unit. Examples include Young and Stone's (1990) study of the thermal properties of textured ceramics, Bronitsky and Hamer's (1986) investigation of the effects of temper on thermal shock resistance, and Skibo *et al.* (1989a) research into how temper affects pottery performance. The results of controlled laboratory experiments are often abstract and seemingly far removed from an archaeological inference of the past. But these low-level principles generated experimentally are not designed to speak directly to a question in prehistory. Any one low-level principle, or correlate, must be combined with many other such principles and sources of information before archaeologists can proceed to an inference (*cf.* Schiffer 1988). Correlates generated with controlled laboratory experiments must be seen as primary building blocks not as an end in itself.

To create other such building blocks and eventually move toward a reliable archaeological inference, one could begin performing experiments at less controlled and natural conditions — what I call "field experiments".

FIELD EXPERIMENTS

In these experiments, some of the variable control is relaxed to test hypotheses under more natural conditions. For example, if one wanted to investigate the relationship between temper size and thermal shock resistance, it would be best to begin by controlling all the variables (like firing temperature, clay type, and specimen size and shape) except size of the temper. This type of controlled laboratory experiment would probably produce positive results — thermal shock resistance increases with temper size. But if one observes in the archaeological record an increase in temper size through time, does that mean potters were making this adjustment to increase thermal shock resistance? Not necessarily. To answer this question requires experiments that replicate the prehistoric material. That means producing vessels that replicate the firing temperature, clay type, temper, *etc.* These are field experiments, which also generate low-level principles but at a far less abstract level. After such experiments one would be on firmer inferential footing and could more readily describe and explain past behavior. Ideally, one could also explore this relationship ethnoarchaeologically, a situation with virtually no control of the variables. The ethnoarchaeological work could help establish some of the factors related to performance that cannot be established experimentally (*e.g.*, symbolic reasons for using a type of temper).

COMBINED APPROACH

To illustrate the integration of both ethnoarchaeological and experimental work, I will describe two case studies that investigate pottery technology. These examples demonstrate that different levels of information can be obtained about pottery technology, performance and use by combining ethnoarchaeological with experimental studies (see also Longacre 1992). Over the past several years, there have been numerous experiments (controlled laboratory type) that explore the relationship between pottery manufacture and use (*e.g.*, Bronitsky and Hamer 1986; Schiffer 1990; Schiffer *et al.* n.d.; Skibo *et al.* 1989a; Young and Stone 1990). Such experiments focus on performance characteristics, which are the capabilities a pot must possess in order to perform its functions (Braun 1983; Hally 1986; Schiffer and Skibo 1987:599; Schiffer *et al.* n.d.). All pottery vessels (in fact all artifacts) are designed to be used — perform some utilitarian function (or technofunction). A pot must be able to be placed over a fire without cracking and heat up its contents in a reasonable time. Similarly, a shelter must stand up to provide protection, and a stone tool must be able to cut. But artifacts can also be designed to perform nontechnofunctional performance characteristics; the shape of the vessel may confer social identity or the house type may symbolize greater status. These nontechnofunctional performance characteristics (referred to as socio- and ideofunctions) are also important in the design and use of material items (for a more complete discussion, see Schiffer and Skibo 1987; and Schiffer *et al.* n.d.). But there are several reasons why I think that pottery technofunctions are unique and can be readily discerned through experimentation (Skibo 1992:34—5).

First, as mentioned above, pots are made to be used — perform one or more technofunctions. A water pot must hold liquid (and possibly keep the contents cool), and a cooking pot must perform its technofunctions at an acceptable level. Although a cooking pot, for example, may often perform sociofunctions, any alterations to the physical attributes of the vessel to serve this purpose must not severely impact how the vessel performs its technofunction (*i.e.,* cooking). If such alterations in physical properties of the vessel do negatively alter technofunctional performance, individuals have the option of altering the way the pots are made. This is one important way that pottery change occurs (see Schiffer *et al.* n.d).

The second reason why technofunctional performance characteristics are important is that they are closely related to subsistence. Several studies have shown how changes in diet are related to alterations in pottery technology (*e.g.,* Braun 1983). Finally, archaeologists are now best equipped to investigate technofunctions. Through the experiments described below, I will illustrate how controlled laboratory experiments can clearly link pottery attributes to technofunctional performance. I am not implying that technofunctional performance is more important to vessel design, only that socio- and ideofunctions are best explored only after the utilitarian functions are understood.

EXPERIMENTAL APPROACH

Controlled laboratory experiments have been shown to be an effective way to understand pottery technofunction because pottery technology is closely linked to pottery use. Discrete changes in attributes such as temper size and shape (Skibo *et al.* 1989a; Vaz Pinto *et al.* 1989), firing temperature (Mabry *et al.* 1988; Skibo *et al.* 1989a), shape and form (Smith 1985, 1988), and surface treatments (Schiffer 1990), do alter significantly the performance of the vessel (for a review see Rice 1987:207—42). One recent experiment (*i.e.,* Schiffer *et al.* n.d.) explores the relationship between surface treatments and thermal shock resistance, an important performance characteristic of cooking. In this study, small identical vessels were made by coiling commercial clay into a plaster mold. A variety of interior and exterior surface treatments, which included polish, resin, texture, slip, and stucco, were then applied. The vessels were filled with water, heated over a gas flame, and thermal shock resistance was assessed.

The results of this controlled laboratory experiment are clearcut — thermal shock resistance is influenced greatly by both interior and exterior surface treatments. In this experiment, thermal performance of the pot was evident by either basal cracking or exterior thermal spalls. We found that any interior surface treatment that decreased vessel wall permeability would increase the chance of basal cracking. Treatments like organic resins that seal the interior surface and thus make the vessel better at transferring heat to its contents, also make the pot very prone to thermal cracking.

Vessels that lacked an interior treatment and thus had high rates of water permeability were subject to exterior spalling. This occurs as the water passing through the vessel turns to steam near the surface and spalls off a small chip of the exterior wall. Exterior texturing and stuccoing (a technique that involves applying a temper-rich paste to the bone-dry exterior of an unfired vessel) were found to greatly reduce and even eliminate thermal spalling. For spalling to occur, the exterior surface must have a lower permeability than the interior of the vessel wall. Both texturing and stuccoing, by creating a very rough exterior, increase the surface permeability thereby permitting steam to escape from the vessel wall without spalling.

Despite the interesting and conclusive results of the surface treatment experiment (see Schiffer *et al.* n.d. for a detailed discussion of the results), there are two limitations to this type of study and any form of controlled laboratory experiment (Skibo n.d.). First, controlled laboratory experiments focus primarily on technofunction. Although this is also a strength of experimentation, certainly performance characteristics related to technofunction are not the only determinants of pottery design. Pottery surface treatments do influence technofunctional performance, but this study cannot determine how factors like group identity or gender roles are reflected in specific surface treatments. As mentioned earlier, controlled laboratory experiments alone have difficulty with pottery variability related to socio- and ideofunction.

A second limitation of controlled laboratory experiments is that they can be used to infer intended but not actual pottery function (Skibo 1992:39–42). Using experimental data combined with morphological information from a particular vessel type, a researcher could at best infer that a pot was designed to meet a certain utilitarian need. But to make more accurate inferences about the relationship in prehistory between pottery manufacture and use, what is necessary are the means to determine actual pottery use.

These two limitations spurned on an ethnoarchaeological study of pottery use. The first limitation (*i.e.*, that controlled laboratory experiments can only investigate technofunction) is discussed elsewhere (see Aronson *et al.* n.d; Skibo n.d.).

What I will focus on here is that part of the study that explores ways to determine actual pottery use (Skibo 1992).

ETHNOARCHAEOLOGICAL APPROACH

The pottery use-alteration study was part of a year-long ethnoarchaeological project among the Kalinga (see Longacre and Skibo n.d.; Longacre *et al.* 1992). The Kalinga, living in the rugged mountains on the north end of the Philippine island of Luzon, are wet-rice agriculturalists who still make and use pottery on a household basis. The pottery use-alteration study took place in Guina-ang, a village of about 100 tightly clustered houses. All vessels in the village were inventoried, and census and economic data were taken. But the majority of the use-alteration data were collected by watching people use pottery over a period of several months. At the conclusion of the study, new pots were traded for used vessels, which are now housed in the Arizona State Museum and serve as the study collection. The idea was to correlate activities of pottery use observed during my stay with use-alteration traces that remained on the vessel.

The Kalinga use two basic types of ceramic cooking vessels; one used to cook rice (*ittoyom*) and the other to boil vegetables and meat (*oppaya*). The vessels can be discriminated based upon minor morphological differences (primarily the constrictiveness of the neck). Cooking rice and boiling vegetables and meat entail very different activities and these were clearly seen in the use-alteration traces.

Use alteration traces occurred in three forms: abrasion, absorbed residues, and interior and exterior carbon deposits. It was found that each of these traces occurred in patterned ways on the Kalinga vessels. The analysis of absorbed residues focused on fatty acids, which occur in different amounts and combinations in every plant and animal species. Although many have attempted to link organic residues to pot contents (*e.g.*, Biers and McGovern 1990; Rottlander 1990), there are two areas in this line of research that required further study. The first is how closely specific foods can be discriminated through an analysis of organic residues. Because I know what was cooked in the Kalinga vessels, this study provided an opportunity to investigate, under real conditions, how fatty acids may change through cooking, and the effect that cooking many types of foods has on the fatty acid profile. The second area that needed further study was fatty acid preservation. Several researchers have demonstrated that fatty acids can survive long periods in the depositional environment but not without some change. Sherds excavated from a local midden served as a means to test fatty acid preservation under real and harsh conditions (Kalinga live in a tropical rain forest).

The fatty acids were extracted from the interior of the vessel wall to avoid contaminates on the pot surface. The analysis with gas chromatography/mass spectroscopy demonstrated that the two types of vessels could be discriminated based just on fatty acid residue. The residue absorbed into the vessel wall of the rice pot could be clearly linked to rice. The vegetable/meat pots, however, were more problematic because they are used to cook a variety of plant and animal foods; but the residue analysis could determine that many plant and animal foods were prepared in the vessels. The fatty acids in pots used to cook numerous items appear to be an amalgam of the many foods, and the identification of specific plant or animal species is difficult.

In the study of organic residue preservation, fatty acids were found in the Kalinga midden sherds but the residue had been transformed into a state that does not permit identification. The high temperature, high rainfall environment characteristic of the Kalinga region was conducive to a form of decomposition that changed all fatty acids into a single form (referred to as adipocere).

The residue analysis has two basic findings. First, the study demonstrated that fatty acids and foods can be linked in real cooking conditions. The second finding is that under some harsh conditions, fatty acids will not survive in a state that will permit identification. For residue analysis to be a useful tool for the archaeologist (and I think it will), all aspects of fatty acid preservation must be understood.

Attrition to the vessel surfaces, similar to use-wear analysis of stone tools, is also an instructive trace. Activities of use such manipulations during cooking, storage, and washing, left traces on nine separate areas on the interior and exterior of Kalinga vessels. With the help of low-power microscopy, it was found that the exterior of both rice and vegetable/meat pots had similar attritional traces that reflected identical behaviors associated with washing and storing. But the interior of each vessel type had very different use attrition patterns that reflects different cooking activities. For example, the vegetable/meat cooking pots have more evidence of stirring and manipulation of the contents, and the rice cooking vessels have thermal spalls on the interior mid-section suggesting that they were placed next to the fire.

Carbon deposits were the final form of use-alteration traces analyzed. Exterior carbon, or soot, provide information about how a vessel was positioned over a fire, and interior patches of carbonized food can be used to determine what was cooked and how the cooking took place. For example, it was found that Kalinga rice cooking pots have a carbonized patch on the middle interior side from being next to the fire in the final stage of rice cooking. In general, the rice and vegetable/meat pots had very distinctive interior and exterior carbon deposition patterns. Because all three forms of use-alteration traces could be closely linked to activities of use, the archaeologist should now be able to apply these findings to prehistoric material. The objective of this study was not to understand Kalinga pottery use, but rather to develop the general principles of use-alteration trace formation, permitting the archaeologist to apply the findings in their ceramic analysis.

Both ethnoarchaeology and experimental archaeology have particular strengths that make a combined approach very instructive. In the above example, it was shown that clear links can be made between pottery surface treatments and thermal performance characteristics related to cooking. Although useful, the data generated from this type of controlled laboratory experiment alone cannot reach its full potential in archaeological inference. In the pottery experiment it was demonstrated that applying this type of information to archaeological ceramics requires that actual pottery use can be determined prehistorically. To this end, an ethnoarchaeological project was initiated to develop the means whereby an archaeologist can reconstruct pottery function from use-alteration traces.

TOWARD INFERENCE BUILDING IN CERAMIC ARCHAEOLOGY

I agree with Dean Arnold (1991) that ceramic ethnoarchaeology (and I would add ceramic experimental archaeology) can and should have a greater impact on archaeological inference. He maintains (Arnold 1991:323—33) that ethnoarchaeology is stuck in the role of cautionary tales because archaeology, by its nature, is very particularistic; an archaeologist with this type of training becomes overwhelmed by the complexities of material culture in a living context and is unable to come up with data that can be used in archaeological inference.

Although I agree in part with Arnold, I would suggest that there is a more specific problem that plagues ceramic ethnoarchaeology; there is a disjunction in the units of analysis used by ethnoarchaeologists and prehistorians (Skibo *et al.* 1989b). The unit of analysis for the prehistorian is usually the sherd, whereas the ethnoarchaeologist focuses on the whole vessel. The solution to this problem is for ethnoarchaeologists and prehistorians alike to reframe their questions. Sherds are an inevitable part of ceramic archaeology, but to make inferences about past ceramic behavior, the prehistorian must still focus on whole vessels. One immediate solution is for the prehistorian to implement extensive refitting and matching of their sherd material (See Skibo *et al.* 1989b; Sullivan 1983); this permits the archaeologist to frame their questions in terms of whole vessels and be on firmer footing for behavioral inference.

But experimental archaeology and ethnoarchaeology do share some of the burden for the less than enthusiastic acceptance by prehistorians of their findings, and they should focus on putting their results into a form that is more easily applied in archaeological inference (Skibo 1992:26—8). In ethnoarchaeology, this requires making explicit the linkages, that many find so difficult, between prehistoric and ethnoarchaeological data. A recent study by Philip Arnold (1991) provides a clear example of how this is done. He first does an ethnoarchaeological study of pottery production and consumption patterns, and then applies it directly to Mesoamerican prehistoric data. Such a study leaves no doubt of how ethnoarchaeological data can be applied to understand the past.

Experimental archaeology shares the same problem of being integrated into archaeological inference, but for a different reason; experimental studies must deal with the problem of behavioral significance, which refers to differences in performance that are apparent to the vessel user (Schiffer and Skibo 1987:602; Schiffer *et al.* n.d.). When one does an experiment, positive results are often obtained. In the previous example on surface treatments, it was found that various treatments like texturing or stuccoing can improve thermal shock resistance. But applying these results in archaeological inference requires that one deal with the question of behavioral significance. That is, would improvements in thermal shock resistance as a result of changes in surface treatment observed in an archaeological assemblage be perceptible to the pottery users? Moreover, when do people actually act upon perceived differences, because not all such differences are behaviorally significant.

Schiffer *et al.* (n.d.) suggest that one way to cope with the issue of behavioral significance is to foster long-term experimental programs. Most experiments have been done as short-term exercises, often weekend projects. Although sometimes interesting results can be obtained with the weekend variety experiment, most issues like pottery technology and change are best attacked by long-term research. Under these conditions, the complexities of a particular issue can be explored and more behaviorally significant results can be attained through experimentation. Finally, archaeological inference that deals with the relationship between pottery and human behavior may be best served by combining both experimental and ethnoarchaeological data with prehistoric analyses. As Longacre (1992) states, this may be the "perfect marriage" and provide the foundation for much profitable research in the years ahead.

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