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## SYMMETRY AND SYMBOLISM IN BAN CHIANG PAINTED POTTERY

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*This essay examines the relation between symmetry and symbolism in design production, in order to understand the process of creating symbols. The evidence for the argument is a sample of painted pottery vessels from the area of Ban Chiang, northeast Thailand, tentatively dated from the first millennium B.C. The vessels were probably part of a complex burial ritual. The limitations of working with museum collections are discussed, and a cultural interpretation of these designs is defined. In order to construct a culturally appropriate burial urn, an artist must possess certain technological, social, and symbolic knowledge, some of which is also available to the analyst. Although symbolic knowledge is difficult to retrieve, symmetry is a useful constraint which can be defined mathematically, yet be related to symbolism. Certain symmetry classes offer the potential for alternate interpretations by both artist and observer, and are ambiguous. Ambiguous designs permit or encourage representational interpretation. Other strategies for increasing the informational content of design systems are discussed.*

ALTHOUGH ANTHROPOLOGISTS HAVE been increasingly interested in the study of symbolism over the last few decades, there remains a significant problem in understanding the process of creating symbols. In this essay, I will examine the relation between symmetry and symbolism in design production. The evidence for such an argument comes from the study of the complex designs painted on a sample of pottery in use in the first millennium B.C. in northeast Thailand.

Ban Chiang is a site in Udon province, northeast Thailand, presently being excavated by the Thai Fine Arts Department and the University of Pennsylvania Museum. Although it was first discovered in the 1960s, professional excavators have only recently taken over from pot hunters and amateur excavators who threatened to destroy the site entirely. Summarizing from the brief reports published (cf. Gorman and Charoenwongsa 1976), Ban Chiang was occupied from about 3500 B.C. to 250 B.C. by rice farmers skilled in bronze metallurgy and ceramic production. Excavation of the low cemetery mound revealed a ritual pattern of extended burials with extensive grave goods, including bronze axes and moulds, crucibles, bracelets and wire necklaces, iron implements, pottery vessels, animal and human figurines as well as substantial quantities of animal bone (Higham 1975:247). The decorative techniques used on the pottery change through time. Black incised and burnished pottery is earliest, followed by cord-marked, incised and painted ware, red on buff painted pottery, and finally a cruder red slipped and burnished ware (Gorman and Charoenwongsa 1976:26). It is the red on buff painted pottery tentatively dated from 1000-500 B.C. that is of concern in this paper. This pottery was directly associated with human burials and may be considered funerary ware.

Since my work with Ban Chiang painted pottery is from studying museum and private collections in Thailand,<sup>1</sup> there are several obvious limitations to the kinds of problems I can address. I have no knowledge of immediate burial context, or distribution of this painted pottery in time and space. I cannot, then, generalize about the domain of painted pottery in any distributional sense, nor even discuss linked changes in specific design elements (similarity seriation, cf. Rowe 1961:63) or the frequency of appearance of one design element with some other element.

I am limited, then, to discussing features that can be systematically related to an arbitrary selection of vessels, and can be derived from a theory that is not dependent on information regarding distribution in time and space.

I recognize another problem which my colleagues may or may not sympathize with. Using fairly subjective, ethnocentric aesthetic standards, the painted pottery from Ban Chiang is attractive, striking—even beautiful. The enclosed plates give some idea of the quality of rendering. This, to me, was a distinct problem. As Bayard writes, “I am far more interested in both culture process and culture content in northeast Thailand, than I am in waxing rhapsodic on the beauties of Ban Chiang painted pottery” (Bayard 1978:34). I agree with him completely, but it is unfortunate that an anthropologist must, in effect, apologize for working with aesthetically pleasing objects of material culture that might be of interest to art historians, for example. Such disclaimers become necessary only if there is no means for interpreting the designs on painted pottery objectively and from some explicit theoretical position in cultural anthropology. I contend that it is possible to do so, even though contextual and distributional information would, of course, be extremely valuable. My case, however, would be easier to make if the vessels were ugly and totally unappealing.

#### A CULTURAL INTERPRETATION

I want to present a cultural interpretation of Ban Chiang painted pottery. What does a cultural interpretation entail? First, let me make my assumptions about culture explicit: I assume that culture consists of mental constructs in the minds of individuals, and, thus, cannot be “shared” in any real sense (cf. Crissman 1975, Keesing 1972). This creative, constructive quality of mind is emphasized by scholars outside the domain of anthropology proper (cf. Chomsky 1968, Piaget 1970, Cicourel 1974, Berger and Luckmann 1966), as well as anthropologists. Both cognitive and structural anthropologists assume that it is possible and profitable to examine the process by which individuals make sense of their world.

Further, I assume that there is a relation between what is in a person’s head and that person’s behavior, and that an anthropologist should be primarily concerned with explicating that relation. In the words of Wagner, individuals (including anthropologists) “invent their own cultures” (Wagner 1975) and attribute a culture to others. Culture, then, consists of “mental constructs that include the knowledge that allows a person to behave in ways that are understandable to others, and to interpret others’ behaviors” (Crissman 1975:4).

A cultural interpretation of Ban Chiang painted pottery must try to construct a theory that a Ban Chiang artist might have used to produce designs on pottery. Note that I cannot claim to be able to replicate *the* theory of design production used by a Ban Chiang artist. For one reason, we are in totally different contexts; my theory derives meaning from the fact that I label myself an anthropologist, the artist’s, from the context of living in northeast Thailand in the first millenium B.C. Although I have argued that “culture” is a property of individuals and not groups, it is clear that the theories produced by individual artists are alike to a certain extent. If we assume that the designs on the painted pottery communicated something in that community, we must attempt to recognize how information is communicated

to the participants. In this attempt, we can learn something about pattern maintenance and creativity in that society.

#### KNOWLEDGE OF DESIGN PRODUCTION

Let us assume that the painted decorations on a single vessel are the product of one craftsman. In order to construct a culturally appropriate burial urn, the artist must possess certain knowledge, some of which is also available to the investigator. The artist constructing this vessel must construct a theory from: 1) observation of the completed vessels around him or her at any one time; 2) watching craftsmen construct and decorate a vessel; 3) practice, until skilled, of the motor habits involved in the construction and decoration of a vessel; 4) explicitly stated instructions that an accomplished craftsman might verbalize from time to time; and 5) criticisms by others, or self-criticism of his or her finished products.

An analyst, on the other hand, is limited to observing a sample of completed vessels, and practice in rendering the designs. The critical problem here is to relate the theory of the artist to the theory of the observer in some clearly definable way. I assume that the artist's theory must have included technological, social, and symbolic knowledge.

Technological knowledge includes procedures and techniques, knowledge of materials such as clay, temper, paints, brushes, and standards of workmanship (Bartusiak-Link 1974:9). Technological knowledge also includes instructions for producing total designs, including planning the layout and choosing the line quality.

Some technological information is directly retrievable by thin sectioning of pottery samples, or refiring experiments, for example. Bayard writes that the pottery from Ban Chiang is prepared clay tempered (Bayard 1977:92). Although I have no access to experimental evidence, since I was working with collections, I have noted that construction is often quite sloppy, with pedestal or neck segments slapped on off-center.

In addition to such technological knowledge, the potter must have possessed social knowledge, including, for example, his or her identity in relation to the rest of the group, the identity of the social group living at Ban Chiang in relation to other groups in the area, and, possibly information about the identity of the person, or category of person, for whom the vessel was intended. Social identity might include markers for sex, rank, ethnic affiliation, and wealth.

And lastly, the artist probably possessed knowledge we may designate as symbolic. The artist must have known what designs were appropriate for burial vessels. Such knowledge may have included designation of meaning to abstract parts of the design, how the vessel was to be used in a specific burial ritual, and how a specific ritual "fitted in" with broader "religious" concepts defining man's place in the universe.

I am not dealing with the problem of how technological, social, and symbolic knowledge must be integrated in a single cognitive system. This question might be posed as the integration of plans (cf. Miller, Galanter, and Pribram 1960), or the relation between everyday and esoteric knowledge (cf. Gatewood 1975).

Social and symbolic knowledge that the artist must have possessed is not retrievable from the archaeological record, and can never be known directly. Such knowl-

edge must be gained through inferences, which are a legitimate way to advance knowledge in archaeology, as long as their basis is made explicit. Of course, the recent spate of "ceramic sociology" in archaeology has not been received without criticism (cf. Stanislawski and Stanislawski 1974). Leach, for example, would like to put social and symbolic knowledge in a black box, and assume that it cannot be investigated by archaeologists (Leach 1973). He errs, I believe, in assuming that other anthropologists have the means to observe social and cognitive structure directly. We are indeed on shaky ground in attempting to reconstruct symbolic or religious contexts directly from archaeological evidence; however, I am not yet prepared to inter them in a black box.

The context in which the painted pottery is found, that of human burials, implies ritual activity. Ritual, in order to communicate, must be based on broadly recognized public symbols (cf. Firth 1973). It is this symbolic system that I wish to investigate, through the pottery designs.

Previous attempts to interpret these designs have emphasized the content or meaning of design elements directly. A single element, such as a spiral, might be equated with the path of life, or the creative energy of the universe (You-Di 1972: 34-38, Charoenwongsa 1973:100-106). Similarly, an art-historical perspective identifies the center of concentric designs as a zoomorph (Stout 1977:8).

Another approach has focused not on the meaning of design elements, but on the distribution of grave goods and faunal remains in the cemetery. Higham has hypothesized that the Ban Chiang community practiced an ancestor cult. While I admire his scholarship and his prompt publication of basic information about the Ban Chiang site, his observations are open to other interpretations. In discussing the burial techniques at Ban Chiang, he suggests that ". . . its long duration at the same site, its application to people of all ages, however, are compatible with the presence there of an ancestor cult" (Higham 1975:285). If men, women, and children are all treated alike, then it is reasonable to assume that their status is ascribed. But ancestor cults may also focus on certain individuals, such as the eldest son in a patrilineal system, with reduced emphasis on women and children. His hypothesis rests partly on finding a suitable ethnographic analogy, in this case, the present inhabitants of the Malagasy Republic.

Another productive approach would require an examination of comparative ethnographic evidence in Southeast Asia. Of particular note would be the widespread practice of animal sacrifice in the feasts of merit of upland tribal groups, and the importance of ceramic urns as burial offerings or funerary containers. The metaphorical relation of ceramic pots with the tree of life, rice, rice wine, boats, the underworld, or animal sacrifice has been proposed by anthropologists such as Heine-Geldern (1966), de Josselin de Jong (1965), Loeffler (1968), and Schärer (1963). There is a strong implication, in these later works, that ceramic vessels are critical to defining cosmology and explaining an individual's place in the universe.

These approaches to interpreting Ban Chiang painted pottery, however fascinating, focus on the content of that symbolic system. They depend on the application of an appropriate ethnographic analogy, or on ethnocentric intuition. Either method is difficult to defend theoretically.

## SYMMETRY AND SYMBOLISM

Is there another approach to symbolism that is less dependent on the content of symbolic systems? Bateson, in an essay on Balinese art, suggests that, rather than focus on the content of symbolic systems, we should examine their form. To him, the code, as well as the message, is a source of information about the artist and his culture (Bateson 1972:130). An examination of the form of the code of Ban Chiang painted pottery designs may reveal content or message, as well.

Pattern, or order, is one of the fundamental conditions of human existence. One basic property of pattern is symmetry, i.e., rules for the arrangement and position of regularly repeated parts of a design. The relation between symmetry, patterns of design, and symbolic systems has been explored in other cultural contexts, and is most clearly represented in cosmological systems. Pattern in Buddhist mandala (Arguelles 1972, Tucci 1960), in Inca festivals (Earls 1973), in Walbiri iconography (Munn 1973), in Islamic architecture (Critchlow 1976) reflects order in the universe.

The Islamic example is most explicit, since in this literate tradition, mathematics and philosophy became the foundation for, and are reflected in, Islamic art. Critchlow writes:

Geometry is a language ideally suited to the expression of this fundamental principle (wholeness) and to the experiencing of parts and a whole. It is in symmetry—the principle of repeating by reflection—that this can be shown most clearly (Critchlow 1976:74).

Symmetry is potentially valuable, because the theories of both the Ban Chiang artist and the analyst are constrained by symmetry rules. According to Shepard (1948, 1971) and Birkhoff (1933), there are only seven possible classes of one-dimensional infinite band designs, and 17 possible classes of two-dimensional infinite all-over designs. Choice of symmetry, then, is limited by universal constraints, and we have direct access to this information.

Symmetry is further useful to the analyst, in that it is the quality of design that is easiest to define consistently. It is possible to state with mathematical precision what is meant by a certain class of symmetry. The definition of symmetry classes developed from methods used to classify the shape of crystals (cf. Shubnikov and Koptsik 1974). They can also be used to describe two-dimensional plane figures, which are defined in Figure 1. Further, we can relate symmetry rules to the behavior of decorating a pot. The motions of reflecting (making a mirror image), rotating a design segment around a point, and the combination of reflection and rotation, producing radial figures, are all ways to fill a space with designs.

Most importantly, symmetry choices made by these artists may be related to choices made by artists in any society. What can be said about design construction among Ban Chiang artists can be brought into relation with other work on the anthropology of art, or cognitive theory, for example, and need not remain isolated, particularistic description. Similarly, there is no need to resort to untestable hypotheses, such as the psychic unity of man, archetypes, Freudian symbols, or even diffusion, when similar designs are found in disparate traditions. We could, more productively, consider symmetry constraints on design production.

## SYMMETRY IN BAN CHIANG PAINTED POTTERY

Examination of symmetry in the painted designs may assist us in the interpretation of the symbolic world of the Ban Chiang artist.<sup>2</sup> Using the seven classes of one-


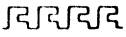





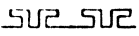





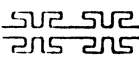


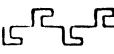
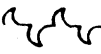

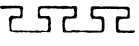

1				translation
2				longitudinal reflection
3				transverse reflection
4				bifold rotation
5				longitudinal and transverse reflection
6				slide reflection
7				alternate rotation and transverse reflection

Figure 1. Classes of One-Dimensional Infinite Design, after Shepard 1948:219.

dimensional infinite designs illustrated in Figure 1, the artist's use of symmetry can be defined more precisely. Class one, translation, is used on pedestal and neck motifs, and to extend radial figures and spirals in a band. Class two, longitudinal reflection, is rarely used alone. It can be identified in multiple line designs where it is a reduced form of radial symmetry. Similarly, class three, transverse reflection, is seldom used alone. It, too, occurs in multiple line designs as a reduced form of radial symmetry. Class four, bifold rotation, produces meanders and zigzags, continuous line designs occurring on necks and pedestal bases. Bifold rotation is the internal symmetry of double spirals, a common design element in Southeast Asia. Class five, a combination of longitudinal and transverse reflection producing a radial figure, is the symmetry motion most utilized by these artists. Radial figures may then be translated. Note that class two and three designs may be a deliberate or accidental reduction of class five symmetry. Class six, slide or glide reflection, is absent in these painted designs, or used extremely rarely in combination with other classes. Class seven, alternate rotation and transverse reflection, is the second most popular symmetry motion in Ban Chiang painted pottery. It is the basis of the complex sigmoid designs, and it also used on pedestal and neck designs, since it forms a continuous band.

What is the significance of this interpretation of design by reference to a set of symmetry rules? Why are class five and seven symmetries the most prevalent motions used by the Ban Chiang artists? Both these classes produce four fundamental portions in a single design unit. I propose that they are favored by these artists because they permit, and even encourage, experimentation with structurally ambiguous designs.

There is more than one way for the producer, or the observer to interpret these designs. Shepard (1948:220) writes of these classes:

there are other methods of generating designs of classes five and seven in consequence of the equivalence of certain combinations of bifold rotation with either transverse or longitudinal reflection. Class seven can be produced by combining slide reflection with either transverse reflection or bifold rotation.

It is not by chance that the Ban Chiang artists favored these two symmetry classes. The use of these higher-level symmetries has at least two structural advantages. First, they offer the potential for alternate interpretation by artist and observer. Thus, they may be regarded as ambiguous designs, which may permit or even encourage representational interpretation. Some individuals may see the connection between the design and a representation such as a snake, and heighten it. The potential is there, if an artist wishes to play with this avenue for expression, and it is culturally appropriate in that symbolic system.

Plates 1a,c,d,e and 2b,e show designs which could be interpreted as snakes, hocker or heraldic figures, faces, and genital organs. They are the direct result of the application of these symmetry operations, and with a little “playing”—the addition of an eye, a tooth, etc.—the possibility is there for representational interpretation. Choosing high-level symmetry rules may constrain the artist structurally, but it opens up new possibilities for visual punning. These designs, based usually on symmetry class five or seven, may be recognized in any design style utilizing bifold rotation, or alternate rotation and transverse reflection. Recall, here, that we can avoid diffusionist or psychoanalytic explanations for the common appearance of some of these simple designs.

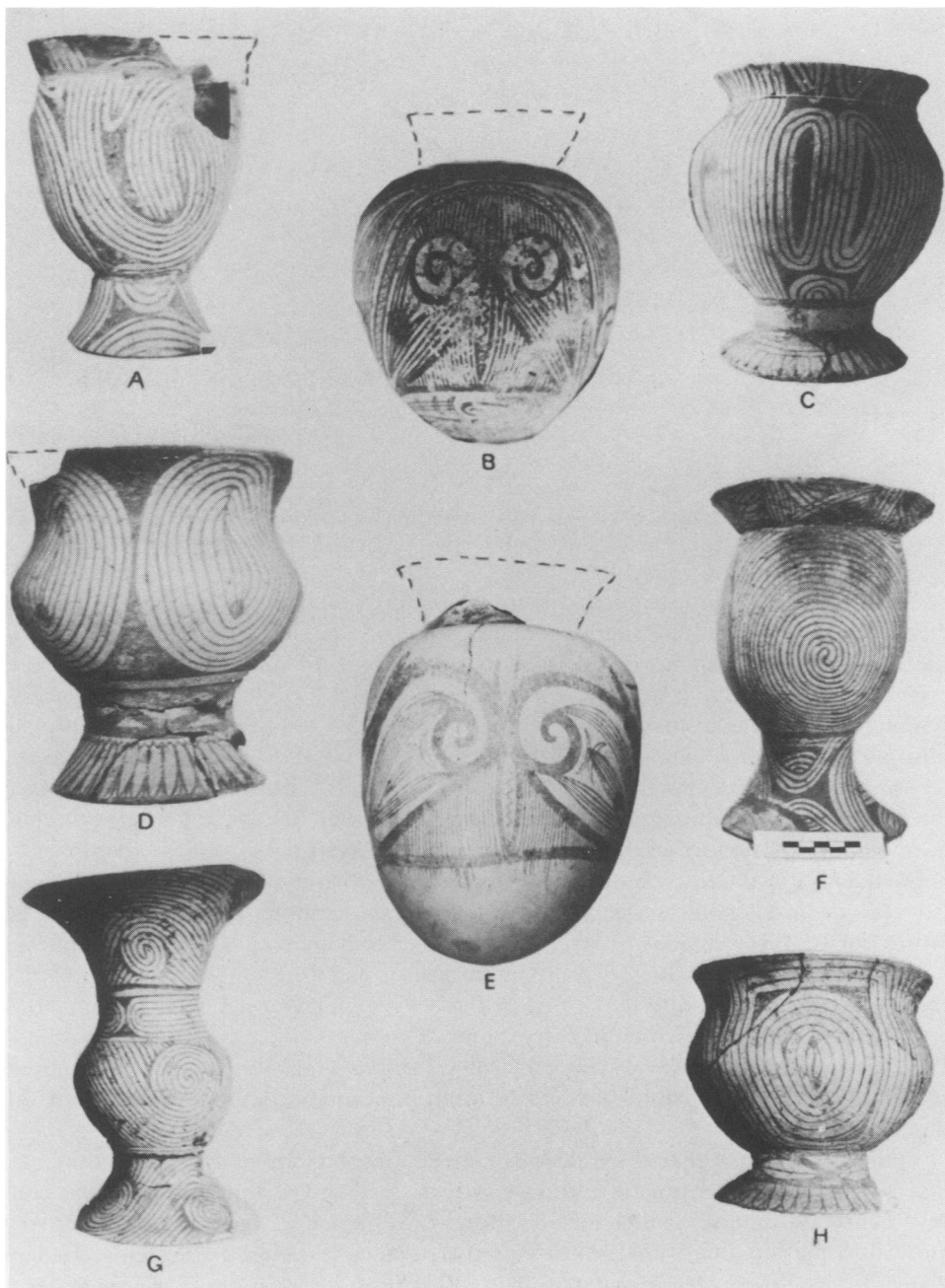
A second advantage of using higher-level symmetry classes is that it allows the artist to “reduce” the higher-level symmetry to a lower level, if the design does not conform to all the constraints inherent in a higher level. The overall impression of symmetry is preserved and maximum order maintained, although the artist, perhaps, did not realize the full intent of the design. For example, radial figures (class five) may be represented by longitudinal reflection (class two), or horizontal reflection (class three), instead of radial symmetry.

#### SYMMETRY AND COMMUNICATION

In *Symmetry in Science and Art*, Shubnikov and Koptsik (1974:351) conclude that, “art, as a depictive form of the cognition and modeling of the world around us, should reflect, and indeed does reflect, the structural aspect of that world.” If such relations exist between art and cognitive structure (and anthropologists have not yet defined the nature of that relationship), then art as a form of communication must have great adaptive significance for social groups. Alland (1977:41) writes that art “is an emotionally charged and culturally central storage device for complex sets of conscious and unconscious information.” From the perspective of communication theory, then, can ambiguous designs capable of multiple interpretations carry more information? Consider three categories of design used in the painted pottery from Ban Chiang: asymmetric units, such as spirals; units displaying low-level symmetry (bilateral reflection), such as concentrics; and units displaying high-level symmetry (commonly class five and class seven), such as sigmoid units. Figure 2 illustrates the relation between these designs.







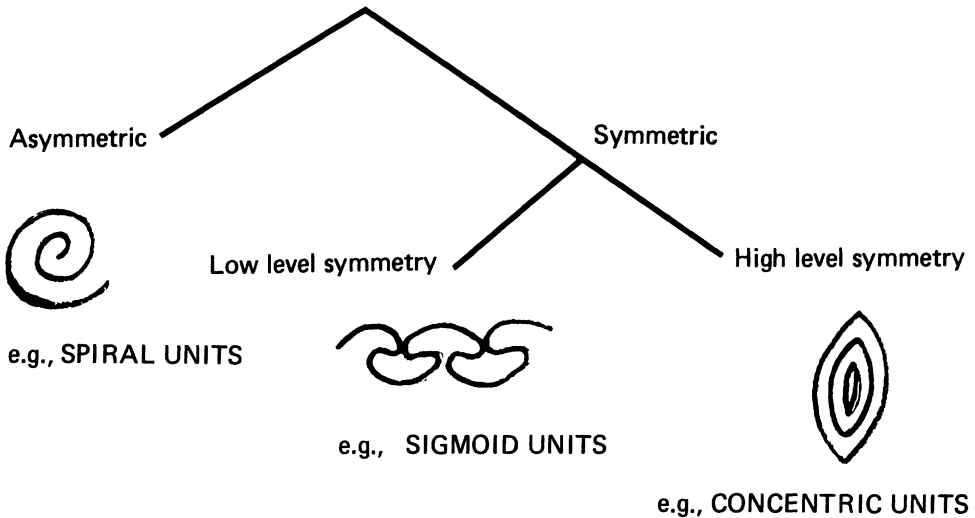


Figure 2. Relation Between Asymmetric and Symmetric Design units.

Asymmetric designs, since they contain the greatest amount of new and unpredictable elements, and are the least redundant, may be characterized as containing the highest amount of information. But a message with maximum information is essentially random and without form, and is virtually unintelligible. Conversely, symmetrical designs displaying low-level symmetry contain the least amount of new information, and are almost totally predictable and redundant; but a message with too much redundancy is trite or banal, even though it has the greatest potential intelligibility. Presuming that the Ban Chiang designs were meant to convey symbolic meaning, their structure must be recognizable. The aesthetic problem, then, can be defined as follows: How can a system be designed with maximum information and yet still be intelligible—a system midway between random and predictable? The artists solved this problem by utilizing higher-level symmetry. Choosing symmetry over asymmetry gives their designs intelligibility and interpretability. It provides some order or pattern. But, they chose high-level symmetry over low-level symmetry, to give them the greatest opportunity to avoid total redundancy and predictability. The use of these higher-level symmetry rules, for example, allowed them to produce ambiguous designs, capable of multiple interpretations both by the artist and the observer.

Further evidence that these designs convey meaning comes from the condensation of design information in certain contexts. Not only is more information conveyed through the use of high-level symmetry, but some of these designs also carry more information than others. For example, the large sigmoid urns illustrated in Plate 1b,c,g,e, carry designs that utilize all design rules used on all sigmoid urns.<sup>3</sup> Put another way, these designs encapsulate all design information necessary to produce any sigmoid design. Other designs, such as the middle band on zoned vessels

(Plate 1h), encapsulate information on design construction from other design classes—spirals, concentrics, and sigmoids. Similarly, banded pedestals (see Plate 2d,h) encapsulate most information regarding pedestal designs. Asymmetric multiple-line designs (illustrated in Plate 2a) could be interpreted as the end products of design-processing rules for spiral and concentric designs. This encapsulation suggests that these designs were public, not private symbols (cf. Firth 1973). In Ortner's (1973) classification of key symbols, these would clearly be symbols which summarize.

Other expressions of artistic complexity include a tendency to obscure structural lines to create ambiguity; the creation of illusions of depth by techniques such as shadowing, and placing an image within an image; and constructing concentric designs out of spiral units (see Plate 2c,d,h). Most designs are rendered slightly asymmetric to increase the complexity of the design, even if the overall layout of the design is, say, bilaterally symmetrical. Although symmetry is often more pleasing than asymmetry, perfect symmetry, rare in nature, would be quite boring. It has been suggested that if the symmetry law is too simple, and can be recognized immediately, the design ceases to be attractive and becomes quite irksome (Shubnikov and Koptsik 1974:7).

#### CONCLUSION

To convey meaning, symbols must be recognizable. A symbolic message must be readable to the audience, but an audience skilled at reading symbolic messages may derive meaning from interpreting ambiguities. Visual puns may be the most important arena for negotiating shared meanings in a social group. Punning and paradox are important in many forms of symbolic communication; Davis (1974:9) points out that ambiguities in northern Thai myth and ritual, for example, are "anomalies which fit into a classificatory schema in more than one way" (c.f. Douglas 1966). Hamnett (1967), too, relates the function of riddles in society to ambiguity. I have argued here that many Ban Chiang designs have alternate orderings, or alternate derivations. Turner (1967) might argue that these symbols are multivocalic; that is, the symbol is capable of interpretation in more than one way. This exploration into the relation between symbolism and symmetry suggests another way to look at the production or creation of symbols. Following the argument of Wessing (1978) and Lehman (1978), it is the antecedent object which is multivocalic, and it is from these multivocalic antecedent objects that symbolic meanings are created. In other words, symmetry classes five and seven, the antecedent objects, are multivocalic: from them symbolic significance arises. Regardless of how symbols are created (and anthropologists know very little about such processes), it is generally agreed that phenomena that are variously interpretable have great symbolic force.

It is possible that the Ban Chiang artists and their audience "symbolized," so to speak, differently or more effectively than modern literates. As in figure-ground experiments, we tend to impose one order at a time on visual stimuli, the Ban Chiang artists, like artists in other nonliterate traditions, may have been capable of grasping alternate orderings simultaneously—parallel processing of visual images—which we in a literate tradition have not developed extensively (cf. Goody 1977, Carpenter 1966). Evidence for this argument would, again, go back to symmetry relations. Shepard (1948:226) notes that the ability even to recognize pattern classes

depends on the capacity to visualize spatial relations; the Ban Chiang artists' ability to relate different design classes reflects this visual capacity. Their preference for complex symmetry is a clue to their aesthetic standards, to their pleasure in the process associated with discovery and manipulation of symmetry rules, in switching back and forth from one image to another.<sup>4</sup>

Why should symmetry be a vehicle for a symbolic code? Symmetry and asymmetry define aspects of the environment of all humans. Although the natural environment is largely asymmetric (or imperfectly symmetric), leaf arrangements, flowers, and lower animals may provide models of reflection and radial symmetry. There is a model for symmetry and asymmetry available to all participants of a culture, in the form of their own bodies. We are basically bilaterally symmetrical on the vertical plane, the most easily recognized plane of symmetry (Corballis and Beale 1976:11). We are, at the same time, asymmetric, with the potential for vast elaborations on the discrimination 'left hand, right hand,' for example (Hertz 1960; Needham 1973).

Symmetry is a code that unites biological, physical, and cultural systems. Anthropologists may find it particularly valuable, because it may be utilized in a variety of domains. Its importance lies in the fact that it may be readily and simultaneously transformed into other modes and symbolic systems. In material culture, it may be useful in the analysis of decorative art, textiles, carving, body painting, or architecture, and, at the same time, it might also provide a potential model for social structure through a study of kinship and marriage or political alliances.

Unless we permit ourselves ethnocentric flights of fancy or strained ethnographic analysis, this may be as close as we can get to the minds of Ban Chiang artists. We will never know the content of their beliefs, but, through an analysis of their use of symmetry, we can learn something of the code through which their beliefs were expressed.

#### NOTES

1. The study of this material is described in *Cognition and Design Production in Ban Chiang Painted Pottery* (Van Esterik 1976), available through Ann Arbor microfilms. I photographed over 1,000 vessels, 416 in museum collections, 764 in private collections registered with the Fine Arts Department of Thailand. In the study, 924 vessels with painted designs were used.

2. For the purpose of this paper, the unit under analysis is the compositional structure of the design on the body of the vessel. In the Ban Chiang designs, almost all designs are extended by translation, or are themselves continuous band designs. In the analysis of other design systems, it would be necessary to specify and relate the symmetry choices of particular motifs and the composition of the entire design space.

3. The analysis of spiral, concentric, and sigmoid designs proceeded from writing a set of

formal rules, which specified operations (usually symmetry operations) that produced design fields. In the case of these complex sigmoid urns, none of the rules specified were blocked.

4. I am not an artist, and I cannot speculate to what extent these rules of symmetry were conscious. In the case of the Ban Chiang artists, I would suspect that they were not; in the case of M. C. Escher, I would suspect that they were applied consciously. In a booklet put out by the International Union of Crystallography (Utrecht), artist Caroline Macgillivray discusses the symmetry aspects of Escher's work, and comments on her own experience of creating designs with similar constraints (Macgillivray 1965:vii): "While drawing, I sometimes feel as if I were a spiritualist medium, controlled by the creatures which I am conjuring up. It is as if they themselves decide on the shape in which they choose to appear."

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