Mortuary Practices and the Study of Prehistoric Social Systems

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There are a variety of ways in which a review might be written. Organization of research in a chronological framework is one possibility; discussion of substantive results of research would be another. The present review will follow a different course. In a field in which the literature detailing substantive results has proliferated considerably, a review organized chronologically, or as a listing of research results, might become tedious. More important, such approaches might not yield a clear picture of the strengths and weaknesses of the concepts and analytical methods underlying research. This review is primarily oriented toward a discussion of these latter topics. Among the points to be discussed are the extent to which different concepts of the social significance of mortuary remains, and the analytical methods that derive from these concepts, may be expected to augment our ability to study social variation and change. If the archaeological study of mortuary practices does not ultimately contribute to the general anthropological study of social change, then our research may ultimately prove to be of limited interest. This review is, then, not concerned so much with the past accomplishments of mortuary studies, as with the present and the future. With these points in mind, it is hoped that the present review will show that the study of mortuary practices currently aspires to increasingly objective and quantitative methods of analysis, to concepts that are increasingly sensitive to the recognition of how mortuary remains may reflect social phenomena, and to explicit
evaluation of concepts and methods by reference to ethnographic mortuary systems.

MORTUARY PRACTICES: BASIC CONCEPTS

The conceptual framework that underlies the use of mortuary data for social inference has been set forth by Saxe (1970) and Binford (1971). Saxe's approach uses elements of anthropological role theory developed by Goodenough (1965). Goodenough has developed a set of terms defining elements of social interaction that have archaeological implications.

Goodenough's term social identity corresponds to what otherwise might be called a social status. Examples of social identities might be chief or commoner, professor or student, mother or mother's brother's daughter, and the like. When two or more identities engage in a proper social relationship, this is termed an identity relationship. The parties to a social relationship do not usually interact in terms of only one social identity at a time. An individual might manifest the identities of faculty advisor, friend, and coauthor, all in the course of a single interaction. Not all identities that a person could manifest are appropriate for each interaction. The composite of several social identities selected as appropriate for a given interaction is termed the individual's social persona for the interaction.

The kind of social persona that a person may manifest for an interaction will be determined by the organizational characteristics of the social system. Hence, a set of social personae will reflect, and contain information about, the organizing principles of a particular society (Saxe 1970:7). Knowledge of this fact is useful for archaeological inference. In societies organized on differing levels of complexity, social identities will vary as to the number of identity relationships that it is possible for them to have. In egalitarian societies infants will have few social identities, whereas adults will have acquired many. Drawing on this principle, Saxe (1970:8) points out that, if archaeologists find infants buried in a manner indicating a social persona larger than that possessed by some adults, a principle of social ranking by birth is probably indicated.

With this array of concepts derived from role theory, Saxe proceeds to formulate a comprehensive approach to the analysis of mortuary data. We shall have occasion to discuss Saxe's work at many points in this review.

Ethnographic confirmation for concepts relating to mortuary practices is crucial for archaeology. Saxe (1970) and other practitioners (Tainter 1975b; Goldstein 1976; Vehik 1975) have devoted considerable effort to this area. But perhaps the most important survey of ethnographic mortuary procedures is that of Binford (1971). In this case the word "important" is used not simply because Binford has consulted a substantial body of ethnographic literature, but also because the results of his survey confirm beyond serious contention the argument (still rated skeptically by some) that variability in mortuary practices must be understood in terms of variability in the form and organization of social systems, not in terms of normative modes of behavior.

Binford set out to test the following two propositions: (1) that "there should be a high degree of isomorphism between (a) the complexity of the status structure in a socio-cultural system and (b) the complexity of mortuary ceremonialism as regards differentiated treatment of persons occupying different status positions," and (2) that "there should be a strong correspondence between the nature of the dimensional characteristics serving as the basis for differential mortuary treatment and the expected criteria employed for status differentiation among societies arranged on a scale from simple to complex." (1971:18–19). Rephrasing this last proposition, Binford argues that in an ethnographic survey we should find that among egalitarian hunters and gatherers age and sex should commonly serve as bases for mortuary distinction, whereas among more complex societies of agriculturalists social position (varying independently of age, sex, and subgroup affiliation) should more frequently be the basis for distinctions in mortuary treatment.

Binford acknowledges that his ethnographic sample is not ideally structured and suffers some operational problems. For example, since it was not possible to directly measure social complexity from the ethnographic literature, this was done indirectly by noting means of subsistence. Binford bases this procedure on the "generally accepted correlation between forms of subsistence production and societal complexity" (1971:18). Subsistence mode was grouped into four categories: hunters and gatherers, shifting agriculturalists, settled agriculturalists, and pastoralists.

Despite this problem the results obtained were meaningful. Binford considered the following points to be satisfactorily demonstrated.

1. The specific dimensions of the social persona commonly given recognition in differentiated mortuary ritual vary significantly with the organizational complexity of the society as measured by different forms of subsistence practice.

2. The number of dimensions of the social persona commonly given recognition in mortuary rituals varies significantly with the organizational complexity of the society, as measured by different forms of subsistence practice.

3. The forms, which differentiations in mortuary ritual take, vary significantly with the dimensions of the social persona symbolized (1971:23).

Binford concludes: "These findings permit the generalization that the form and structure which characterizes the mortuary practices of any
society are conditioned by the form and complexity of the organizational characteristics of the society itself” (1971:23).

PROBLEMS IN THE INTERPRETATION OF MORTUARY REMAINS

In a discussion which suggested that archaeologists should be cautious in the interpretation of mortuary remains, Ucko (1969:273) noted a case which he referred to as “an archaeologist’s nightmare.” The Ashanti follow a general rule that an interred body should not face the village. But some Ashanti say that immediately after burial the body turns itself around to face the village. Some, but not all, Ashanti cope with this dilemma by placing the body facing the village, knowing that it will turn itself around to the correct orientation.

The game of “archaeologist’s nightmare” is an easy one to play with ethnographic data. Consider the following example from western Australia.

The Lyne River people have a unique custom of dividing the bones of adults into three bundles. The arms, shins, hands, shoulder-blades, collar-bone, and ribs are placed in one. The thighs, feet, hips, spine, and teeth are bestowed in a second. The knee-caps, breast-bone, top of spine, and jaw are assigned to the third. One bundle is taken to the pool where the deceased was first “found” as a spirit child by his or her father. Another bundle is interred at the place the deceased’s umbilical cord is buried. The third is taken by a mother’s brother to the place where the man was initiated or the woman rubbed with charcoal after birth. A man’s skull is put under the stone which commemorates his first killing of a kangaroo. A woman’s skull is carried to the place where she first crawled (Davidson 1949).

There are many possible reactions to such ethnographic cases. Perhaps the easiest would be to simply shake our heads, mutter something unrepeatable, and conclude that interpretation of mortuary remains is impossible. Such a reaction is, unfortunately, not unknown in the archaeological profession. The goal of any science, however, is to make sense out of seeming chaos, to find the common factors linking apparent diversity. None of the persons whose work is reviewed in this chapter have ever claimed, or implied, that the analysis of mortuary remains is simple, straightforward, or easy. The diversity of approaches that have been developed for mortuary analysis clearly indicate the contrary. If the factors conditioning mortuary ritual, and its archaeological preservation, are complex, this circumstance should not be thought of as a detriment, but rather as an opportunity. To suggest that complexity of mortuary ritual renders burial data inscrutable is to suggest that we ignore an opportunity to understand a major component of the archaeological record.

Any listing of ethnographic “archaeologist’s nightmares” will clearly indicate that the form of a mortuary ritual is a complex interplay of ritual, social, and environmental factors. The archaeological transformation of mortuary remains adds yet another level of uncertainty to attempts at modeling past societies. The literature reviewed in this chapter concentrates on the social dimensions of mortuary practices. Perhaps one criticism to be voiced is that the other factors that condition mortuary practices ought to be treated as systematically as have social dimensions. For those archaeologists who are primarily concerned with the nature of past societies, the advantage of systematic treatment of the ritual and environmental aspects of mortuary practices would be the potential for discriminating, in archaeological data, those variables that genuinely reflect social factors. To a degree, this can be accomplished within the state of our present knowledge, but not to a sufficient degree as to warrant complacency that the problem has been solved.

The archaeological transformation of mortuary ritual provides further nightmares. All archaeologists with anthropological training are familiar with examples of people who bury their dead in trees, in rivers, at sea, and so forth. Although there are sound reasons (to be discussed shortly) for believing archaeological remains to reliably reflect the social information communicated through mortuary ritual, nevertheless the archaeological recovery of mortuary remains clearly presents a sampling problem. Attempts to characterize prehistoric societies from mortuary remains require that we obtain information about all kinds of burial practiced in a society. This is obviously impossible in many cases. Rather than find this a discouraging limitation, we might see it as a genuine opportunity. There may well be patterns in the extent to which mortuary remains are not recoverable archaeologically. Similarly, it may be possible to obtain positive information from such negative conditions as absence of burials. For example, the extent to which certain age or sex classes are absent from an archaeological mortuary population may reflect significant social factors. We shall see later in this review that such a negative condition as the absence of formal cemeteries is a very informative characteristic.

In short, the complexity of mortuary ritual, and the problems of archaeological analysis, should be viewed as opportunities rather than detriments. Such a view does not imply that analysis of mortuary remains may be considered a simple procedure. There are good reasons to believe that common factors condition the social dimensions of mortuary ritual in varying cultural contexts. However, these common factors are of a highly abstract nature; their archaeological application will vary with each case.
being considered. Thus, the concepts to be discussed here should not be taken as a tool kit for archaeological interpretation, but rather as a base for deriving interpretive principles appropriate for each individual case.

THE SIGNIFICANCE OF MORTUARY DATA

To evaluate the usefulness of mortuary data for social modeling, two criteria may be discussed. These are the range of social information that may be derived from mortuary remains, and the reliability of burial data as indicators of social phenomena.

In his discussion of the archaeological application of role theory, Saxe (1970:6) noted that the occasion of death will involve an interaction between the deceased person and many of the persons with whom he or she had engaged in identity relationships during life. It can be seen then that death and mortuary ritual call forth a fuller representation of an individual’s various social identities than does any occasion during life. Hence, the archaeological record of mortuary ritual should contain a greater range of information about the social identities present in a past society than does any other category of information. Additionally, since individuals acquire social identities by virtue of membership in the structural parts or components of a social system, mortuary ritual will simultaneously convey information about the nature of a past society. Indeed, to the extent to which a mortuary population contains individuals who held membership in the various components of a society, that mortuary population can be expected to reflect the structure of the extinct society (Tainter 1977b:70). There does not appear to be any other category of archaeological data for which this claim might be so confidently advanced.

Given that mortuary ritual has such potential for extensive representation of social phenomena, we must consider whether archaeological mortuary remains will reliably reflect the information conveyed through mortuary ritual. This, of course, is the question continuously raised by the skeptics and critics of social modeling. Deriving an answer to this question will involve a discussion of topics that will figure prominently in later sections of this review.

Much of Saxe’s work deals with the application of formal analysis to mortuary data, an approach pioneered by Brown in the middle 1960s (but not published until 1971). Formal analysis is a technique used to evaluate and display the combinations of mortuary attributes found in a mortuary domain. Such combinations of attributes are often displayed as a branching diagram, or key, as shown in Figure 4.1.

The key in Figure 4.1 is a perfect tree. A perfect tree is an absolutely redundant structure in that the decision made at any one contrast set (for example, whether the person merits formal or casual treatment) automatically prescribes the choices available in subsequent contrast sets. Thus, if a person is to be disposed of casually, the question of whether the corpse should be publicly displayed is inapplicable. Instead, the next choice to be prescribed is whether the disposal should be on land or on water. Similarly, disposal in a forest redundantly emphasizes the fact that disposal was on land, and was carried out casually.

In polar contrast to a perfect tree is a perfect paradigm. In a perfect paradigm all attributes are independent. Choice of one attribute does not prescribe or limit subsequent contrast sets. Hence, the redundancy is zero. A perfect paradigm is illustrated in Figure 4.2.

Techniques for measuring whether a key represents a tree or a paradigm are available from the field of information theory. In a situation
To measure actual entropy we tabulate the number of burial modes (or significata) actually observed. This will be referred to as $S_{\text{actual}}$. The entropy of $S_{\text{actual}}$ will be

$$e = \log_2 S_{\text{actual}}$$

where $e$ is a measure of actual entropy.

Relative entropy ($RE$) is measured as

$$RE = e/E$$

And conversely, to measure redundancy ($R$) we apply the formula

$$R = 1 - RE$$

For a perfect paradigm $R$ will equal zero, whereas for a perfect tree it will have a value of 1 (Saxe 1970:102–107).

There are many implications of Saxe’s application of information theory to mortuary remains. For the moment we shall consider only the following (Tainter 1975b:107–109).

Mortuary ritual is basically a communication system in which certain symbols are employed to convey information about the status of the deceased. As in any communication system, the messages generated through mortuary ritual are subject to noise, which may induce errors or distortion, or inject extraneous material into a message. Since noise can alter the meaning or significance of a message, it is necessary for reliable communication to develop codes that allow transmission of information in the presence of noise. This is accomplished by building redundancy into the code (Shannon 1949:75).

As we have seen, where some symbols are used jointly to designate a number of disposal types (as in a paradigm), the redundancy is low. And where each set of symbols pertains exclusively to only a single burial type (as in a tree), redundancy is high. In the former situation, archaeological identification of socially distinctive individuals will be difficult, because certain symbols will pertain to a variety of burial modes. In situations of high redundancy the opposite will be true. More important for our present purposes, where redundancy among the symbols employed in mortuary ritual is high, the reliability of the archaeological record will be high. This is so because the elements of mortuary ritual that are preserved in the archaeological record will redundantly reaffirm the same message that was conveyed by nonpreservable elements of the ritual. Hence, the archaeological loss of certain aspects of mortuary ritual will, in situations of high redundancy, not result in loss of information about the social characteristics of the deceased individuals.

Using the equations detailed above, Saxe investigated the amount of
redundancy in three ethnographic mortuary domains (Ashanti, Bontoc Igorot, and Kapauku Papuans). Although his sample was small, the results obtained were meaningful. Saxe (1970:230) found redundancy values of .764 (Kapauku Papuans), .834 (Ashanti), and .88 (Bontoc Igorot). These values are consistently high, indicating tree-like keys, and suggesting that mortuary ritual as a communication system may universally employ a highly redundant code. This finding suggests a high degree of reliability for the archaeological record in respect to the information communicated through disposal of the dead.

THE USE OF SOCIAL TYPOLOGIES IN MORTUARY STUDIES

One of the basic problems in the study of prehistoric societies has been the development of scales on which archaeological societies may be placed for comparative purposes. The scales most frequently used are derived from ethnology, primarily from the work of Service (1962) and Fried (1967). (Service has since retracted his typology (1971:156–157), although many archaeologists continue to employ it.) These scales aspire to an ordinal level of measurement in that a societal typology is developed in which kinds of societies are ranked according to increasing degrees of structural complexity and increasing numbers of mechanisms for organizing populations.

The use of evolutionary typologies as analogues for archaeological societies has dominated mortuary studies. Some examples will suffice to illustrate the types of conclusions usually derived when evolutionary typologies are employed.

... data from the cemetery at Rincon suggest ... an egalitarian society [Stickel 1968:227].
... the Mrr-27 cemetery seems most likely to reflect a society in which ascribed rank was an important element of the social structure [King 1970:22].
... social stratification ... existed among the Northern Chumash at least as early as 300 A.D. [Tainter 1971:16].

The mortuary patterning of the CCo-308 Middle Horizon components is consistent with the patterning predicted for egalitarian societies [while the Late Horizon witnesses the emergence of a rank society in Fried’s sense [Fredrickson 1974:62,64].

The mortuary patterns at Spiro fulfill some of the requirements of an adaptive level of organization called a chiefdomship [Brown 1971:102]. It is suggested that a chiefdom model should continue to be employed in research involving the Dallas archaeological culture [Hatch 1974:251].

The Moundville Phase mortuary data fulfill the expectations of hypotheses which have as their premises that the Moundville Phase was a ranked society [Peebles 1974:191].

This listing could continue much further, but the point has certainly been made that the archaeological study of the social dimensions of mortuary practices has been overwhelmingly dependent on evolutionary typologies. This being the case, it is appropriate to devote some discussion to the logic and the limitations of this approach.

The ethnologists who have developed evolutionary typologies have largely conceptualized social variables as dichotomous, and have utilized such dichotomies as the basis for abstracting societal "types." Typical of evolutionary typologies are statements such as the following:

Band society, out of which tribes grew, was egalitarian [Service 1962:114]. Leadership is personal—charismatic—and for special purposes only in tribal society [Service 1962:114].

Tribes are integrated by pan-tribal sodalities, but chieftoms are not, though, like bands, they may have a few minor sodalities for limited purposes [Service 1962:165]. Apart from age and sex, there is little significant division of labor [in rank societies] [Fried 1967:109].

A stratified society is one in which members of the same sex and equivalent age status do not have equal access to the basic resources that sustain life [Fried 1967:186].

It is combinations of such dichotomous attributes that are used to define societal typologies. Given that categories of societies are conceptualized as combinations of discrete attributes, it would follow that the means by which a newly discovered society (whether ethnographic or archaeological) can be assigned to a proper evolutionary slot is by a process of keying the society, on its various dichotomous attributes, until the final combination of elements indicates its appropriate designation.

Leaving aside the question of whether social characteristics can indeed be considered discrete attributes, we shall consider the archaeological application of these principles. If prehistoric societies are to be assigned to an evolutionary slot by means of an identifying key, then the archaeologist should proceed to the analysis of data with a list of criteria for identifying each dichotomous attribute that contributes to the keying procedure. Such a process is logically intrinsic to evolutionism, but is not consistently applied. Instead, archaeologists working within an evolutionary framework regularly abridge this keying procedure by identifying only a limited number of social characteristics, most often rank differences, and from these inferring the appropriate typological designation for the society in question. The implicit assumption in this approach must be that the dichotomous attributes defining societal types are so strongly associated, and so highly redundant, that identification of one implies all the others, as well as the abstracted societal form they collectively designate. This assumption has never been subjected to rigorous testing, and so must be viewed with caution.
One recent archaeological study that has avoided the pitfall of determining a typological designation for a prehistoric society on the basis of only one or two social variables is Renfrew's (1973) evaluation of social organization in neolithic Wessex. Renfrew proposes that the large earthworks and monuments that typify the later portions of this time period reflect the existence of chiefdoms. To test this hypothesis, Renfrew abstracts from the formulations of Service (1962) and Sahlin (1968) twenty defining characteristics of chiefdoms. He lists these as follows:

(1) a ranked society
(2) the redistribution of produce organized by the chief
(3) greater population density
(4) increase in the total numbers of the society
(5) increase in the size of individual residence groups
(6) greater productivity
(7) more clearly defined territorial boundaries or borders
(8) a more integrated society with a greater number of sociocentric statuses
(9) centres which coordinate social and religious as well as economic activity
(10) frequent ceremonies and rituals serving wide social purposes
(11) rise of priesthood
(12) relation to a total environmental situation favouring specialization in production (and hence redistribution)—i.e. to some ecological diversity
(13) specialization, not only regional or ecological but also through the pooling of individual skills in large cooperative endeavors.
(14) organization and deployment of public labor, sometimes for agricultural work (e.g. irrigation) and/or for building temples, temple mounds, or pyramids
(15) improvement in craft specialization
(16) potential for territorial expansion—associated with the ‘rise and fall’ of chiefdoms
(17) reduction of internal strife
(18) pervasive inequality of persons or groups in the society associated with permanent leadership, effective in fields other than the economic
(19) distinctive dress or ornament for those of high status
(20) no true government to back up decisions by legalized force [Renfrew 1973:543].

Armed with these indicators, Renfrew proceeds with an analysis of the neolithic Wessex archaeological data, eventually concluding that the documented or inferred presence of the majority of these characteristics indicates the existence of chiefdoms.

Renfrew's analysis is satisfying in many ways, including not only its relative completeness but the explicitly stated recognition that the chiefdom concept is a catchall that lacks specificity. Indeed, Renfrew suggests that the chiefdom analogue "will have to make way for, or be refined to yield, subtler and less inclusive concepts" (1973:357). This realization is refreshing, but some disturbing aspects of Renfrew's analysis remain. Most serious is his handling of the list of chiefdom characteristics. Although many linkages can be discerned among these twenty attributes, the reader is still left with the impression that Renfrew regards a chiefdom not as an adaptive system, but as a list of traits. Renfrew seems to advocate what might be termed the checklist approach to social modeling.

In a subsequent work, Renfrew has accepted his own challenge to substitute for the chiefdom analogue "subtler and less inclusive concepts." His solution is to subdivide the category of chiefdom into two varieties: group-oriented chiefdoms (chiefdoms with little evidence of differential access to wealth, but considerable evidence of communal labor), and individualizing chiefdoms (chiefdoms that display material indications of ranking, but only a minimum of monumental construction) (Renfrew 1974:74). Renfrew is careful to point out that this is not intended to be an exercise in typology. Yet it is not hard to envision what the outcome of this approach might be. Taken to its logical conclusion, this solution to deriving "subtler and less inclusive concepts" will bring us an endless proliferation of new pigeonholes in the evolutionary typologies, as each archaeologist discovers that his or her prehistoric chiefdom was not quite like all the others. And ultimately the literature may become filled with endless debates concerning whether this or that set of archaeological data reflects Chiefdom Type 32a or Chiefdom Type 32b! Clearly the development of "subtler and less inclusive concepts" will lead nowhere as long as such concepts focus on the proliferation of new labels to apply to prehistoric societies. To concentrate our research effort worrying over what to call a past society is a waste of that effort. If one of our objectives is to study social variation and change, then we should concentrate on the development of truly quantitative scales for measuring social characteristics. Such quantitative methods have been developed and will be discussed shortly.

**CLASSIFICATION OF MORTUARY DATA**

Certainly basic to any analysis of mortuary data is the problem of classification. The purpose of classifying mortuary data is to isolate clusters of burials, which can be interpreted as socially distinctive. The use of formal analysis (Brown 1971; Saxe 1970) for this purpose has been discussed previously. Saxe has taken the techniques of formal analysis and developed a system of interrelated hypotheses concerning the social dimensions of mortuary practices. Among these hypotheses are the following.

The Components of a Given Disposal Domain Cooperate in a Partitioning of the Universe, the Resultant Combinations Representing Different Social Personae [Saxe 1970:65].
Putting it in other words, Saxe postulates that each burial type represents a different social persona.

Within a Given Domain Personae of Lesser Social Significance Tend to Manifest Fewer Positive Components in Their Significata Relative to Others, and Conversely [Saxe 1970:69].

The reasoning behind this last hypothesis is that social personae of higher significance will engage larger numbers of persons in identity relationships (usually status obligations) than will personae of lesser significance. These identity relationships will be symbolized in mortuary ritual, and reflected as positive components (or in other words, positive attributes) in the burial domain. Hence, personae of higher significance will display more positive components. Parenthetically, it might be added that in his ethnographic survey Saxe found support for the former hypothesis, whereas the latter tested ambiguously.

These hypotheses clearly underscore the potential of formal analysis. It will be useful to evaluate how the technique has actually been applied to archaeological materials.

Following Brown’s exposition of the use of formal analysis (original paper 1966, published 1971), the technique was applied to several archaeological data sets in California (Stickel 1968; Decker 1969; Finnerty et al. 1970; T. King 1970) and was used in one case involving the lower Snake River region in southeastern Washington (Rodeffer 1973). Viewed from the perspective of Saxe’s work, several of these studies display a common problem. When applied to archaeological data, formal keys tend to focus the classification process on variables that reflect idiosyncratic variations peculiar to individual burials. The resultant classifications often yield burial types represented by only one individual each. When formal classification procedures isolate individual burials, it is difficult to gain information concerning the structure and the organizing principles of social systems. Social positions that existed in past societies can be identified archaeologically by isolating sets of burials manifesting similar social personae, not by keying out individual burials.

These negative results do not imply that formal analysis may not be used archaeologically, or that Saxe’s hypotheses may not be operationalized. The mortuary attributes used in a formal classification should be selected carefully. The criterion for selection must be that such attributes display common variance.

As an alternative to formal analysis, mortuary data might be classified through the use of multivariate statistical techniques. Such techniques are ideally suited for the task of isolating sets of interrelated variables that display common variance. Unfortunately, when different kinds of multivariate procedures are applied to the same set of mortuary data, the results obtained may vary widely. This review is perhaps not the proper place to discuss the nuances of multivariate statistics, so we shall restrict ourselves to citing the results of an experiment in classifying mortuary data using a variety of statistical procedures (Tainter 1975a). The results of this experiment seemed to indicate that polythetic classification procedures (Clarke 1968:37) are not entirely suitable for mortuary data because the clusters derived through these procedures are not satisfactorily homogeneous. In a set of experimental classifications polythetic techniques yielded clusters of burials containing members of several rank grades. An alternative set of techniques are available, known as monothetic–divisive procedures. These procedures progressively subdivide a population in such a way that the resulting subgroups, at each hierarchical level, are maximally homogeneous. A stopping rule is applied to halt the divisive process at the proper point. Of the various algorithms available for deriving the hierarchical arrangement of attributes on which the population is divided, two of the most common are various functions of chi-square (Whallon 1972) and the information statistic (Peebles 1972). In a test using Middle Woodland mortuary data the latter statistic gave superior results (Tainter 1975a), and it has proved useful in analysis of a large variety of archaeological data sets (Peebles 1972, 1974; Tainter 1973b; T. King 1976; Goldstein 1976).

**SELECTION OF DATA FOR MORTUARY STUDIES**

The selection of categories of archaeological data for use in mortuary studies must be based on the variety of means by which social positions are symbolized in mortuary treatment. Many archaeological studies have neglected the diversity of symbolic forms which may be employed in mortuary ritual, and have assumed instead that the most significant information may be derived from one data class: grave associations. As a result, a rather elaborate interpretive framework has been built around the study of grave associations. Initiated by Binford (1962), this framework has been elaborated by Stickel (1968). Stickel’s goal was to develop criteria for determining whether a set of mortuary data reflect a society that was egalitarian or ranked. For an egalitarian society, Stickel (1968:217) proposed that grave associations should reflect the following characteristics:

1. A predominance of artifacts that served primarily in the technological sphere
2. Status symbols of the sort attainable by individual achievement
3. Within such status groups as exist, grave associations that distribute differentially among individuals rather than groups
4. Noninheritance of status symbols, potentially signified by inclusion of status symbols in graves

In contrast, among the members of a society characterized by class ranking, grave associations should pattern in a contrasting fashion (Stickel 1968:217), as follows:

1. Increased frequency of status symbols
2. Possession of specific status symbols by groups
3. Considerable individual variation in mortuary associations
4. Inheritance of status symbols

Applying these concepts to the 1700 B.C. southern California Rincon cemetery, Stickel (1968:227) concluded that the mortuary remains reflected an egalitarian society.

Stickel’s paper proved to be a stimulus for research into the social organization of California hunter-gatherers. Subsequent studies documented the evolution of complex, ranked social systems in several areas of California beginning about 2000 B.P. (T. King 1970, 1974, 1976; Tainter 1971; Fredrickson 1974). Such complex social systems, unusual for hunter-gatherers, are clearly documented in the ethnographic literature, as well as in the archaeological record. Late prehistoric cemeteries, for example, seem to reflect the ethnographic situation of differentially ranked kinship groups (King 1969; Finnerty et al. 1970).

Despite the florescence of productive research stimulated by Stickel’s paper, some nagging questions about this approach remain. Much of Stickel’s framework boils down to a distinction between differentiation in quantity of grave associations and differentiation in quality. In an egalitarian society there will be few structural status positions that need to be symbolized through exotic material items. Thus, grave associations in such a society will be restricted, as Stickel proposes, to differentiations in quantity of items. Differentiation of burials in terms of quality or type of status markers will be minimal, since few status positions exist that require use of such markers. In a ranked society there are more structural status positions, and there exists a corresponding need for more kinds of material items to denote status distinctions. In addition to differentiation in quantity of items, deceased members of a ranked society should also be distinguished in terms of the kinds of status markers placed in the grave. Of course, both egalitarian and ranked societies will be characterized by burial differentiation in both quantity and quality of material associations. But it is to be expected that in egalitarian mortuary populations differentiation in quality or type of grave association will be less pronounced than in a ranked population.

There are ethnographic data that create doubts about archaeological use of the concepts presented above. The northern California Modoc practiced cremation of their dead. In addition to the corpse, the clothing and personal possessions of the deceased were placed on the pyre to be consumed. Rarely, though, were valuable items lost in this way. Any individual attending the ceremony might remove an object from the pyre and replace it with a quantity of shell beads, or perhaps render some service such as fire-tending (Ray 1963:116–117). For the archaeological record the consequences of such actions are significant. In the case of the Modoc the material items accompanying the deceased person are initially differentiated in terms of type and quality of materials. In Stickel’s framework (as interpreted here) this would seemingly indicate a ranked society. Yet such evidence of ranking would apparently not make its way into the archaeological record. Instead, the initial distinction in type and quality of grave associations is ultimately collapsed to mere differentiation in quantity of shell beads, an archaeological characteristic that might be interpreted as reflecting egalitarianism!

Many archaeological studies have paralleled Stickel’s approach by relying on grave associations as the sole or primary class of data for deriving social inferences (in addition to the studies cited above, see Winters 1968; Larson 1971; Peebles 1971, 1974; Hatch 1974; Rathje 1970, 1973; Autry 1974; Baker 1974; Clark 1969; Randsborg 1974, 1975; Rothschild 1973; Shennan 1975). In most cases in which other variables enter the analysis (type of interment facility, location of grave, etc.), these characteristics are not used as independent sources of information, or used in conjunction with grave associations to derive social information. Instead, grave associations are consistently treated as the major information source, with other categories of mortuary data treated in a wholly subsidiary fashion.

There is no logical or empirical basis for this approach. Mortuary ritual is a process of symbolizing. The nature of a symbol is such that the relationship between the form of the symbol and its referent is arbitrary, or, at most, expedient. Given this, there is no intrinsic reason why social distinctions must be symbolized by mortuary associations. Indeed, in a recent survey of ethnographic mortuary systems (Tainter 1974:125), it was found that the use of material inclusions to signify status distinctions was a decidedly minor practice, used in less than 5% of all cases (n = 93). This result alone suggests that the extensive reliance archaeologists place on grave associations is likely to be inappropriate.

We are left then with the question, On which dimensions of mortuary
ritual should archaeologists concentrate their analysis? To answer this question directly would essentially entail listing all dimensions of mortuary ritual that have ever been observed, either archaeologically or ethnographically. Such a list would not only be ponderous, but, without a valid interpretive framework for each such dimension, it would be meaningless. Instead, the next section of this review will concentrate on a discussion of mortuary variables that seem most suitable for comparative analysis.

MORTUARY STUDIES: CROSS-CULTURAL PERSPECTIVES

If the study of past social systems is ever to aspire to the study of social process, then archaeologists must develop the ability to model prehistoric societies in ways that yield comparable results. Two of the factors involved in the development of comparable social models are explicit consideration of the dimensions of a social system that are being investigated, and the development of cross-culturally valid criteria for isolating and measuring these dimensions.

Any social system is differentiated along a number of dimensions. Archaeologists dealing with past societies generally neglect this crucial consideration, deriving only those social inferences that are most easily obtained from a set of data, rather than specifying in advance which social dimension is the objective of the study. Blau provides a characterization of the concept of dimensions of differentiation:

A dimension of differentiation is any criterion on the basis of which the members of an organization are formally divided into positions, . . . or into ranks, . . . or into subunits . . . . A structural component is either a distinct official status . . . or a subunit in the organization. . . . The term differentiation refers to the number of structural components that are formally distinguished in terms of any one criterion (1970:203–204; emphasis in original).

Failure to consider the important concept of dimensions of differentiation has led archaeologists to derive an impressive array of information about past societies, but has rarely led to the production of information that is comparable. Thus, where archaeologists working in one region of the Southwest infer the existence of uxorilocal residence units (Longacre 1970; Hill 1970), an archaeologist working nearby discovers a society with hereditary ranking (Clark 1969:82–83). Investigators wishing to study social variation and change in these adjacent regions are left at a loss.

Given that we should be explicit about the dimensions of a social system we are attempting to model, we must tackle the more difficult question, How may comparable social information be derived from mortuary data? The means by which social differentiation among the dead is symbolized at burial varies considerably, even among groups living in geographical proximity (Kroeber 1927). The problem confronting the archaeologist has, for this reason, been the lack of ability to develop general principles for interpreting mortuary remains that could be applied cross-culturally. This lack of generalizing power has produced a situation where nearly every set of mortuary data must be approached with a unique strategy for social inference. And yet we have seen that at least one attempt to produce an objective, cross-culturally valid strategy for mortuary analysis (Stickel 1968) contained unforeseen shortcomings. We may ask, then, if it is feasible or conceptually realistic to search for analytical frameworks intended to produce comparable information.

At present, two social dimensions have been singled out for the development of comparable analytical frameworks. These are (a) descent group differentiation and (b) rank differentiation. Treating the first characteristic, Saxe proposed the following hypothesis:

To the Degree that Corporate Group Rights to Use and/or Control Crucial but Restricted Resources Are Attained and/or Legitimized by Means of Lineal Descent from the Dead (i.e., Lineal Ties to Ancestors), Such Groups Will Maintain Formal Disposal Areas for the Exclusive Disposal of Their Dead, and Conversely (1970:119).

Saxe’s hypothesis is provocative, for it helps account for a number of questions that have long puzzled archaeologists. The factors determining whether burials are present or absent in a particular location, or, if present, whether they are clustered, dispersed, randomly distributed, or associated with certain types of features, such as houses, are undoubtedly multiple. Saxe’s hypothesis suggests that much of the variation in burial distribution may be accounted for by social factors, and that we may use such distributional variations to gain certain types of social information. More specifically, Saxe’s hypothesis offers an opportunity to derive comparable information concerning the number and nature of corporate descent groups making up prehistoric communities.

Saxe initially tested this hypothesis against his sample of three ethnographic societies and found consistent confirmation. More recently, Goldstein (1976) has tested this hypothesis on a more extensive sample of thirty cases. The results of this test seem to indicate (a) that the presence of formal disposal areas is consistently associated with corporate groups practicing lineal descent and (b) that most, though not all, such groups use formal disposal areas. Thus, the presence of formal disposal areas will strongly indicate that the archaeologist has isolated individual corporate groups, and the absence of formal cemeteries will suggest, with a probability that is high but less than unity, the absence of social groups of this sort. This last interpretive ambiguity must be kept in mind.
Two recent applications of Saxe's hypothesis have shown its usefulness. Goldstein (1976) has found the concept useful in elucidating the significance of the spatial organization of two Mississippian cemeteries in the Illinois Valley. In the Kaloko cemetery, located in the Hawaiian Islands, the spatial organization of the cemetery appears to be hierarchically arranged (Tainter 1976). The entire Kaloko community was organized as a single corporate unit, reflected in the fact that the region contains a single temple, and is physically separated from adjacent settlements by unoccupied zones and boundary cairns (Tainter and Cordy 1977). Ethnographically, such settlements corporately held the land on which they were situated. Hence, it is not surprising that Kaloko contains but a single, formal cemetery. At the same time though, both the cemetery and the community were subdivided into smaller units. There appear to have been a total of four residential units at Kaloko, each of which maintained a separate agricultural area seemingly for its exclusive use. This subdivision of the larger community into smaller corporate groups is reflected in a similar subdivision in the cemetery. Within the larger disposal area there are a number of subareas that are discrete and bounded. Each of these subareas in the cemetery may correspond to one of the residential groups of the community, or, alternatively, two or more cemetery groups may have been linked to form a single residential unit. This second alternative is indicated by the fact that, although there are only four residential units, the cemetery seems to contain at least nine corporate descent groups (Tainter 1976).

Coupling Saxe's hypothesis with some hindsight allows us to see the significance of distributional patterns observed in earlier mortuary studies. Chumash cemeteries along the southern California coast, between about 2000 B.C. and the historic period, seem to contain evidence of at least two differentially ranked descent groups: a higher ranking one in the western part of the cemetery, and a lower ranking group in the eastern segment (L. King 1969; Tainter 1971). Viewed from the perspective of Saxe's hypothesis, and with archaeological and ethnographic knowledge about social ranking in native California, these patterns might have been anticipated. More recently, T. King (1976) emphasized locational considerations to demonstrate the existence of politically differentiated communities of hunters and gatherers about 2000 B.C. in the southern Sierra foothills of California.

The analysis of social ranking similarly benefits from objective and cross-culturally valid criteria for analysis. We have previously discussed the use of formal analysis for classifying the components, or attributes, or mortuary domains. From the use of formal analysis Saxe has developed the following hypothesis:


The reasoning behind this hypothesis was discussed in the section of this chapter dealing with the classification of mortuary data. Although the logic behind the hypothesis is consistent, ethnographic testing proved dubious (Saxe 1970:226–227). In operational terms, we have already seen that the archaeological use of formal analysis tends to focus the classification on idiosyncratic attributes, producing keys that isolate individual burials.

An alternative approach to isolating rank distinctions is derived from Binford's (1971:17, 21) observation that the form of a mortuary ritual will be determined by, among other factors, the size and composition of the social aggregate recognizing obligatory status responsibilities to the deceased. Binford proposes that such a larger array of duty-status relationships (which is characteristic of persons of high rank) will entitle the deceased to a larger amount of corporate involvement in the act of interment, and to a larger degree of disruption of normal community activities for the mortuary ritual. Expanding on this, Tainter (1973) has suggested that both the amount of corporate involvement and the degree of activity disruption will positively correspond to the amount of energy (or labor) expended in the mortuary act. Directionally, higher social rank of a deceased individual will correspond to greater amounts of corporate involvement and activity disruption, and this should result in the expenditure of greater amounts of energy in the interment ritual. Energy expenditure should in turn be reflected in such features of burial as size and elaborateness of the interment facility, method of handling and disposal of the corpse, and the nature of grave associations. Reversing this reasoning, when sets of mortuary data cluster into distinctive levels of energy expenditure, this occurrence will signify distinctive levels of social involvement in the mortuary act, and will reflexively indicate distinctive grades or levels of ranking.

The use of energy expenditure for determining rank grading may provide a solution to some dilemmas encountered by archaeologists. Energy expenditure allows the analysis of rank patterns in situations where grave associations are not present. Indeed, the energy expenditure argument was first formulated for the analysis of a cemetery where the primary dimensions of variation were the size and elaborateness of the interment facility (Tainter 1973). Energy expenditure provides a preferable alternative to interpretive frameworks that focus on only one dimension of mortuary ritual, such as grave associations. In the case of the Modoc, we observed that an initial contrast in the type and quality of items associated
with individuals was transformed into a situation where the archaeological record would reflect only quantitative contrasts in grave associations. Such a situation confounds the interpretive framework specified by Stickle (1968). The use of energy expenditure as the analytical criterion would solve this dilemma, for rank differences would still be apparent if the archaeological record of Modoc mortuary practices were viewed from this perspective.

The proposition linking energy expenditure in mortuary ritual to the rank of the deceased has been tested on an extensive ethnographic sample. In a set of 103 ethnographic cases, the energy expenditure argument was not contradicted once (Tainter 1975b). A selection of examples from these ethnographic cases will illustrate the kinds of energy expenditure contrasts that are consistently found in the literature.

**Complexity of Body Treatment**

Selecting an example to illustrate variations in the complexity of body treatment is difficult, but only because so many cases might be cited. Among the Salinan Indians, near San Antonio Mission, California, “the most distinguished dead were cremated, while persons of no particular importance were merely buried” (Mason 1912:167). A Papuan group in the Fly River region buried commoners in a sewn mat. In contrast, a chief’s only child, or a respected person would be exposed on a wooden platform, the skull removed, decorated, and placed in a specially erected building, and the other bones collected and buried (Riley 1925:166, 170). Ngadju-Dayak communities of Borneo practice a type of secondary burial associated with considerable economic expenditures. Only the economically more successful households are able to afford this ritual (Miles 1965).

**Construction and Placement of the Interment Facility**

Two interesting examples illustrate energy expenditure contrasts in these variables. Among the Padju Epat Ma’anyan Dayaks, the final resting place for the bones of a deceased individual is in the tambak, an ornately carved box used by the bilateral descendants of the person who founded it. The establishment of a new tambak is an expensive affair, but such an act symbolizes the attainment of an almost unique social and economic status by the founder. When an individual achieves such a social and economic level that he wishes to disassociate himself from his natal group, he commissions the construction of a new tambak to be used by himself and by his descendants (Hudson 1966). In the Morobe District of New Guinea, the body of a deceased individual was ordinarily placed in the ground and allowed to decompose for a period of five months. After that time, the skeletal remains were taken to a cliff face where they were interred. The amount of energy expended in disposing of the remains in the cliff varied with the status of the deceased. Children and women were left at the foot of the cliff, or placed on lower ledges. Important men were placed on higher ledges, and the remains of the highest ranking members of the community were carried to the highest ledges of the cliff (McWilliam 1936).

**Extent and Duration of Ritual Mortuary Behavior**

Two missionaries’ accounts of early Hawaiian mortuary practices, both dating to the same time period, clearly illustrate how differences in rank may be reflected in the extent and duration of ritual mortuary behavior, and correspondingly in energy expenditure. The two accounts relate mortuary procedures for community outcasts, and for persons of chiefly rank. These two social classes represent the extremes of the Hawaiian rank system. In the early 1820s, Charles S. Stewart noted that social outcasts (including those with physical abnormalities) were often simply left where they fell, or, if necessary, were removed from the living area of the community. Stewart described one example of such a means of disposal (quoted in Bowen 1961:74).

An instance recently came to our knowledge in which a poor wretch thus perished within sight of our dwelling, after having lain uncovered for days and nights in the open air, most of the time, pleading in vain to his family, still within the hearing of his voice, for a drink of water! And when he was dead, his body, instead of being buried, was merely drawn so far into the bushes, as to prevent the offense that would have arisen from the corpse, and left a prey to the dogs who prowled through the district in the night.

Ellis described a starkly contrasting level of social involvement on the death of a local chief on the Island of Hawaii.

... the whole neighborhood exhibited a scene of confusion, wickedness, and cruelty, seldom witnessed in the most barbarous society. The people ran to and fro without their clothes, appearing and acting more like demons than human beings; every vice was practised, and almost every species of crime was perpetrated. Houses were burnt, property plundered, even murder sometimes committed, and the gratification of every base and savage feeling sought without restraint [1969:177].

Two additional categories of energy expenditure that have been recorded ethnographically are material contributions to the ritual, and human sacrifice. Ethnographic examples of these will not be detailed at this point, since the Modoc might be cited as an example of the former category, and the latter is relatively unambiguous.

The ethnographic literature seems to indicate clearly, then, that energy expenditure in mortuary ritual is directly related to rank grading. As is
often the case, however, the archaeological application of this idea is not without ambiguity. One major problem is measuring energy expenditure, and determining what constitutes a meaningful energy contrast in types of burial. At present, measurement of energy expenditure can only be accomplished on an ordinal scale with burials ranked by greater or less (apparent) energy expenditure. In some cases decisions concerning ordinal ranking are difficult to arrive at. A second, and potentially more important, problem is the extent to which archaeologically apparent distinctions in energy expenditure always reflect rank differences. The ethnographic literature provides numerous examples of mortuary practices that might appear archaeologically as energy expenditure variations, but in fact are not. The ossuary burials of the Huron are a case in point. Among the Huron, the bones of deceased individuals were periodically gathered and placed in a communal cemetery. Most ossuary interments had the flesh removed from the bones, but this was not done to individuals who died shortly before the reburial ceremony (Bushnell 1920:74–75). Archaeologically, a Huron ossuary would then display both articulated and disarticulated individuals, a contrast that might be mistakenly interpreted as a variation in energy expenditure.

Such an ethnographic example underscores a caution suggested previously. Although it is possible to develop abstract generalizations concerning mortuary practices, archaeological application of such generalizations will always require careful study of individual data sets. With careful scrutiny it should be possible to isolate many of the archaeological contrasts in energy expenditure that do not reflect rank differences. Ubelaker (1974), for example, has properly noted that degree of skeletal articulation in a Maryland ossuary probably reflects the amount of time that passed between death and ossuary interment (as among the Huron). With careful application the energy expenditure perspective does offer a cross-culturally valid criterion for deriving comparable information about rank differentiation in varying contexts. Its usefulness is ultimately illustrated by the number of archaeological studies in which it has been employed (Buikstra 1972; Brown 1973; Tainter 1973, 1975a,b, 1976, 1977a,b; Tainter and Cordy 1977; T. King 1976; Peebles 1974).

**QUANTITATIVE MODELING**

Ultimately, our goal in studying past societies must be to monitor and explain variation and change. Such a goal presupposes that we possess a scale against which social variables may be measured. In archaeological studies the scales used for this purpose have largely consisted of evolutionary typologies. Previously, we found reason to doubt whether such typologies are really suitable for this purpose. Fortunately, there are sophisticated and sensitive alternatives to evolutionary typologies. As in some earlier sections of this review, we find two basic approaches to quantitative modeling: one based on formal analysis, the other linked to the evaluation of energy expenditure.

In developing his comprehensive approach to the analysis of mortuary practices, Saxe proposed the following hypotheses:

The **More Paradigmatic the Attributes Evidenced in the Key Structure of the Domain, the Less Complex and More Egalitarian the Social Organization. Conversely, the More Tree-Like the Attributes, the More Complex and the Less Egalitarian the Social Organization [1970:75].**

The **Simpler a Sociocultural System the Greater Will Be the Tendency for There To Be a Linear Relationship Between Number of Components in Significa, Number of Contrast Sets Necessary To Define Them, and the Social Significance of the Significa; and Conversely [1970:112].**

The former hypothesis is based on the application of information theory to key structures. We have already discussed this application, as well as the procedure for measuring the extent to which any given key represents a tree or a paradigm. It is timely at this point to recall one of Saxe's previous hypotheses: that persons of higher social significance manifest more positive components (positive attributes) in their disposal domains than do less significant persons. If this is so, then not all attributes would be equally applicable to all burial modes as would be the case in a perfect paradigm (see Figures 4.1 and 4.2). Furthermore, persons of greater social significance should evidence more and more kinds of mortuary treatment that are not applicable to less significant persons. Hence, as social complexity increases, the mortuary domain should become less paradigmatic.

This hypothesis indicates a quantitative measure for social complexity. Ethnologically, Saxe (1970:230–231) could not find demonstrable support for it, most likely because of incomplete ethnographic reporting. Archaeologically, the information measures for mortuary keys have been applied by Thomas King (1976) to data from the Buchanan Reservoir, located in the southern Sierra foothills of California. The resulting measures indicated highly tree-like structures. For comparative purposes, King computed the same measures for keys of Late Woodland mortuary systems from the Illinois Valley (Tainter 1975b). The results of this application are of uncertain significance, for in both archaeological cases the keys were produced through statistical techniques designed to minimize the degree of entropy in the resulting classification.

The latter hypothesis is complex (Saxe 1970:112–118). It uses two scales: the Depth of Persona (D) scale and the Contrast (C) scale. The first
societies as systems requires a shift to a higher level of abstraction. A system simply cannot be characterized merely by describing the attributes of its parts. A system is a holistic entity the characteristics of which are not equivalent to the summed characteristics of its individual parts (von Bertalanffy 1968:55). To characterize a social system we must isolate and measure social dimensions that reflect the constituent parts of a system, as well as the patterned relationships among these parts. Such abstract, composite dimensions are the structure and the organization of social systems. The structure of a system is meant to indicate the number, nature, and arrangement of its articulated components and subsystems (Miller 1965:209, 218), whereas organization is most basically defined as the constraints imposed on the ranges of behavior which may possibly be pursued by the elements of a system (Rothstein 1958:34–36).

This perspective suggests four social dimensions for which information is to be sought. These are the degree of structural differentiation, the nature of structural differentiation, the amount or degree of organization, and the nature of organization. The degree of structural differentiation and of organization are quantitative variables, and must be modeled as such.

For archaeological analysis, we can isolate two dimensions of structural differentiation that are of general significance. These might be termed the vertical and the horizontal dimensions. The first refers to the structure of rank grading in a society. The horizontal dimension encompasses structural components that equate on identical hierarchical levels. Examples of the latter might include sodalities, certain types of coresident descent units, task groups, territorial bands, and the like.

In terms of structural differentiation along the horizontal dimension, we have seen how the spatial organization of mortuary remains can reveal the existence of corporate descent groups. Yet there are many components of the horizontal dimension for which such universal criteria for analysis have not been developed. The study of the vertical dimension presents fewer ambiguities. Levels of ranking may be confidently isolated as distinctive levels of energy expenditure (Tainter 1975b; cf. Randsborg 1974). As Blau (1970:203–204) has noted, such levels of ranking may be viewed as structural components of a social system. The number of such rank levels will mark the degree of structural differentiation along the vertical dimension.

The analysis of vertical differentiation allows the indirect measurement of the total structural complexity of a social system. In an analysis of structural differentiation on contemporary organizations Blau (1970) found that the size of an organization correlated strongly with both its degree of vertical differentiation and its degree of horizontal differentia-
tion. Blau noted that this finding is not limited by the function of an organization. Hence, the observation can be considered applicable to prehistoric as well as to contemporary social systems. This finding is significant for archaeological research. The strength of the observed correlations (see Blau 1970) suggests that any one of these characteristics of a social system may be used to monitor not only itself, but the state of the other two as well. Structural differentiation along the vertical dimension can thus serve as an index of the total structural complexity of past social systems.

The measurement of organization is a more complex matter. Organization has been defined as constraint on behavior (Rothstein 1958:34–36). Thus, the measurement of organization must be approached through the measurement of behavioral constraint. The field that provides techniques for the measurement of organization is information theory.

The central concepts of information theory that are of use to us are entropy (disorder, disorganization, randomness), and its converse, organization. An additional concept is statistical equilibrium. In communication theory this would refer to a situation where, in a set of messages, all messages have an equal probability of transmission. A situation of statistical equilibrium corresponds to a condition of entropy. In statistical equilibrium the occurrence of any specific message is unpredictable, and thus the maximum information may be obtained when a particular message is sent. Hence, information and entropy are quantities that covary (Weaver 1949; Goldman 1953; Theil 1967; Young 1971).

To illustrate the archaeological use of these concepts, consider some hypothetical social system structurally differentiated into a number of components. In the total absence of any organizational constraints the process by which individuals acquire membership in the components would be purely random. Such a random process will ultimately result in a situation where the proportion of the population selecting affiliation with each component would be a fraction equal to 1/N, where N is the number of components. Such a proportional distribution corresponds to a situation of statistical equilibrium, and so to a condition of entropy.

But of course no social situation lacks constraints of one form or another. To the extent that either social or demographic pressures limit freedom to acquire membership in certain components (such as those of high status), there is constraint and thus organization. In the presence of such constraints, the proportion of the population affiliating with certain components will depart from a condition of statistical equilibrium. It is precisely such departures from equilibrium that the mathematical techniques of information theory may be used to measure (Tainter 1975b, 1977a, b; Tainter and Cordy 1977).

Shannon’s (1949:50–51) formula for measuring information may be transformed in a number of ways. For our purposes the formula may be given as

$$H = \sum_{i=1}^{N} p_i \log_2 \frac{1}{p_i}$$

where $H$ is the entropy (information) of a set of probabilities, and $p_i$ is the probability of occurrence of the $i$th message (or the $i$th structural component). This information measure ranges from 0.0 (no entropy) to $\log_2 N$ when all messages or components are equally probable (maximum entropy, referred to as $H_{\text{max}}$).

Rothstein (1958:36) has suggested that organization be measured as the excess of the entropy a system may potentially exhibit ($H_{\text{max}}$), less the entropy it actually does exhibit ($H$). Gatlin (1972:35–36) refers to this measure as the Divergence from Equiprobability, symbolized as $D_1$. The formula for organization ($D_1 = H_{\text{max}} - H$) can range from 0.0 (maximum entropy) to a value that converges on $H_{\text{max}}$ (maximum organization).

It is apparent in the calculation of the $D_1$ measure that the amount of organization a system may potentially exhibit increases with its degree of structural complexity. $D_1$ is a measure of amount of organization. Since the maximum $D_1$ value may increase with increases in $H_{\text{max}}$, it is useful to calculate the ratio $RD_1 = D_1 / H_{\text{max}}$ as a measure of degree of organization. Where $D_1$ assesses the amount of constraint on a population’s access to membership in structural components, $RD_1$ measures how much constraint is imposed relative to the amount that might be imposed. The ratio $RD_1$ will range between 0.0 (maximum relative entropy) and a value that approaches 1.0 (maximum relative organization).

Within the perspective being discussed, the final variable to be measured is rank differentiation. Rank differentiation is considered an important variable to measure because it includes elements of both structure and organization. Levels of ranking may be viewed as structural components of a system, while organization (behavioral constraint) is clearly an element of rank differentiation.

A measure for rank differentiation proposed by Harary (1959:23–25) is useful for mortuary studies. In this measure the status of an individual is based on two interacting factors: the number of persons subordinate to the individual, and the number of rank grades that separate these subordinates from the person of higher status. In a ranked hierarchy, any person $P$ will have $n_s$ subordinates in rank level $k$ (rank levels are numbered downward from any given level, so that the first lower level is 1, the second is 2, etc.). If $M$ is the number of rank levels below $P$, the status $s(P)$ of person $P$ can be measured by the formula
\[ s(P) = \sum_{k=1}^{N} k(n_k) \]

Expressed verbally, the status measure of a person is the number of the individual’s immediate subordinates, plus twice the number of their immediate subordinates, plus three times the number of their immediate subordinates, and so forth. Hence, persons at the top of a hierarchy will have a higher status measure if they have a greater number of subordinates and/or if their subordinates are heavily distributed in the bottom-most rank levels. The rationale behind this measure is discussed in more detail by Harary (1959) and Tainter (1975b, 1977a, b).

In archaeological analysis it is impossible to determine the precise number of individuals subordinate to a person of paramount rank at any point in time. But it should be possible to determine the number of levels of ranking in a past social system, and to ascertain the number of persons from a total mortuary population who were members of each rank grade. To compute the \( s(P) \) measure it is necessary to consider the population of subordinate rank levels as multiples (or fractions) of the number of persons in the paramount rank grade. The formula used for this purpose in \( N_K/N_1 \), where \( N_K \) refers to the number of persons in rank level \( k \), and \( N_1 \) indicates the number in the highest rank level. With this transformation the paramount rank grade is always associated with the value 1.0, and subordinate levels become appropriate multiples (or fractions) of 1.0. The degree of rank differentiation in a hierarchy can then be expressed as the difference between the highest and lowest levels. Since the status of the lowest level is always zero, the degree of rank differentiation can be expressed as \( s(1) \), the status measure of the highest level.

It should be clear that the archaeological application of these measures requires complete sets of mortuary data. The use of the measures may be illustrated by reference to a set of Middle Woodland (ca. 150 B.C.—A.D. 400) burials from mounds situated on the western bluffs of the Illinois Valley. In a set of 512 interments, the following levels of energy expenditure and ranking were observed (Tainter 1975b, 1977a, b).

**Level 1:** Individuals interred in, or processed through, large, log-roofed tombs, which served as the central feature of most mounds

**Level 2:** Peripheral burials in smaller, log-covered graves

**Level 3:** Burials with limestone slab inclusions

**Level 4:** Individuals buried with locally produced sociotechnic items, most often Hopewell series pottery vessels

**Level 5:** Interments in simple subfloor graves

**Level 6:** Individuals placed on accretional mound surfaces.

The distribution of the population among these rank levels is shown in Table 4.1. This table also illustrates the calculation of the entropy measure for this system. The Middle Woodland rank system displays an entropy of 1.8354 bits. \( H_{\text{max}} \) for six rank levels is 2.8496 bits, and so the measure of amount of organization (\( D_s \)) is (2.8496 - 1.8354) .7496. The degree of organization (\( RD_s \)) amounts to (.7496/2.8496) .29. The measure of rank differentiation is shown in Table 4.2. For this Middle Woodland system, \( s(1) \) amounts to 13.671.

Such quantitative measures are most meaningful when used for the assessment of variation and change. In two such applications these measures have yielded excellent results. In a study of Woodland social change in west-central Illinois during the period A.D. 200–800 there appeared a general decrease in the structural complexity of social systems between the Middle and Late Woodland (A.D. 400–900) periods. Also evident are two contrasting quantitative trends: (a) a decrease in both organization (amount and degree) and rank differentiation in the *early* Late Woodland period; and (b) a corresponding increase in these variables during *later* Late Woodland, just prior to the emergence of the truly complex social systems characteristic of the Mississippian period. The pattern of social change evidenced by the quantitative measures is significant, not only for the information it discloses, but also because it parallels and is confirmed by nonquantitative assessments (Tainter 1975b, 1977a, b). It might be added at this point that, if evolutionary typologies had been used in this study, both Middle and Late Woodland systems would have been characterized as ranked societies (in Fried’s terminology). Thus, no social change between the Middle and Late Woodland periods would have been evident. The pattern of social change that was observed was evident only because of the use of quantitative measures.

In a second study these measures have been applied to two contem-
TABLE 4.2

Middle Woodland Rank Differentiation

<table>
<thead>
<tr>
<th>Rank level</th>
<th>N</th>
<th>N4/N1</th>
<th>3(N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>91</td>
<td>1.000</td>
<td>13.671</td>
</tr>
<tr>
<td>2</td>
<td>56</td>
<td>.637</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>.121</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>.055</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>241</td>
<td>2.648</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>37</td>
<td>.407</td>
<td></td>
</tr>
</tbody>
</table>

poraneous prehistoric social systems from the Island of Hawaii. One of these (Kaloko) displays a complex rank hierarchy evidenced by both mortuary data and settlement patterns. The other (Anaehoomalu) displays a very truncated rank hierarchy with no persons of the highest rank grades. Quantitative analysis corroborates these qualitative conclusions, and indicates that Kaloko was characterized by greater structural complexity, organization, and rank differentiation (Tainter and Cordy 1977).

A comparative study that applies the quantitative methods developed by Saxe (1970) and Tainter (1975b) to the same data sets would be a useful step in furthering mortuary studies.

MORTUARY PRACTICES: CONCLUDING EVALUATIONS

This discussion of the social dimensions of mortuary practices leads to a set of conclusions and recommendations for future archaeological research. Perhaps most basic is the recommendation that investigators be explicit about which dimensions of a social system are to be monitored in a given study. (It does not need to be emphasized that this suggestion applies to all studies of past societies, whether dependent on mortuary data or not.) Along with the recognition that social dimensions of interest should be explicitly stated goes the responsibility to model these dimensions in a manner that will allow the study of social variation and change. The minimum requirement entailed by this consideration is that social dimensions be modeled by criteria that are objective and cross-culturally valid. For mortuary practices two analytical criteria have been developed that fulfill these requirements. These are the spatial distribution of mortuary remains, a variable that contains information relating to corporate group differentiation, and energy expenditure, an indicator of rank grading. A second consideration in the study of variation and change is that social dimensions be measured on true interval or ratio scales. The nominal categories that are characteristic of evolutionary typologies are simply not sensitive enough to yield the kinds of information we need for the study of social change. Two approaches to quantitative modeling of past social systems have been developed (Saxe 1970; Tainter 1975b). Such quantitative measurement of social variables must become a central goal in the study of mortuary practices.

REFERENCES


Rothstein, J. 1958 *Communication, organization, and science*. Indian Hills, Colo.: Falcon’s Wing Press.


1974 Analytical approaches to the archaeological study of social change. Department of Anthropology, Northwestern University, Evanston, Illinois (Xerox).


Ubelaker, D. H. 1974 Reconstruction of demographic profiles from ossuary skeletal samples: A case study from the tidewater Potomac. *Smithsonian Contributions to Anthropology* No. 18.


