INTRODUCTION

I'll begin this essay with a question: What is space and how do we relate to it as humans and, in turn, how does space influence our lives? I'm not sure I can answer these questions but they should be considered by archaeologists in more detail. E.T. Hall (1966, 1968) has addressed these questions about space concerning modern culture and it is in the writings of Hall that archaeologists concerned with space should pay close attention. The use of space is, in fact, influenced a great deal by cultural values. Hall suggests that space and the use of space is incorporated in different manners in different cultures. We need to be especially relativistic as anthropologists when we are dealing with questions about space. For example, crowded situations in terms of our own cultural concepts may not be considered as crowded to people of another cultural background (Hall 1968). Of course this point is obvious, but I do feel that anthropologists and archaeologists dealing with both modern and prehistoric settlements or communities tend to forget this basic rule. In the archaeological literature, we are at times exposed to concepts such as "small rooms," or "small habitation units." Although these terms may in fact describe a room or unit that is smaller than most, we should not classify these units as such unless we understand the total spatial structure or spatial variability of a culture (Clarke 1977b).

Before we go any farther with this discussion of space and its associations with anthropology, archaeology, and geography let us turn for a moment to some early examples of the philosophy of space and spatial classifications. James (1972:35-36) points out that the concept of space was pondered by the ancient Greeks. Aristotle and other Greek philosophers of his time recognized two kinds or types of space. These were celestial space and earth space. In addition, James suggests that there was also some speculation about the space within the interior of the earth. This probably represents the first known classification of space into general categories. Aristotle believed that space is the logical condition for the existence of things. Sir Isaac Newton saw space as an absolute reality,
but void. George Berkely (1685-1753) thought of space as a "Mental construct based on the coordination of sight and sound (James 1972:459)." Immanuel Kant (1724-1804) described space as an a priori form into which sensuous experience necessarily falls, providing therefore, for the physical classification of knowledge (James 1972:459-450).

In the latter part of the 1800's, Tonnies (1887 pub. in English 1957) made the all important distinctions between natural forms of spatial interaction and "deliberately constructed social conventions (Tonnies 1887:43)." The importance of this classification into the concepts of natural and man-made social or spatial units is very important and it is the basis of modern spatial theories.

Buttimer (1969) writing on the interdisciplinary perspective of social space states that it was Emil Durkheim in the 1890's who first "articulated and applied" the concept of social space. The French geographer, Chambart deLauwe (1952,1966) then expanded the general theme of social space into a hierarchy of social spaces. First there is family space-relationships at the domestic level of interaction. Next, neighborhood space - daily and local movements. Economic space further embraces employment centers, and finally, urban space (Buttimer 1969).

ETHOLOGY AND ITS CONTRIBUTIONS TO THE SOCIAL SCIENCES CONCERNING SPACE:

Man is not the only animal that classifies and defines his spatial units. Territory marking has long been understood in animals, especially in canids. A recent volume by Esser (1971) and works by Kummer (1969), Wilson (1969), Leyhausen (1965), and DeVore (1963) are excellent examples of how non-human animals utilize, organize, and mark spatial or territorial units.

Studies on animal spatial behavior can be used to explain Homo sapiens spatial organization. Wilmsen (1973) has used the spatial organization of the Brewer's Blackbird to help explain possible spatial arrangements in hunter-gatherer situations or settlements. Briefly, Wilmsen's study is an ecological one. The Blackbird model describes social spacing with regard to food resource availability. The Blackbird model is one of optimal user location, relative to food resources. Here the distinction has to be made between mobil and stable food resources. The former describes animal species with large home ranges while the latter denotes plant and animal species with a small or stable home territory. The Brewer's Blackbird, in
response to these different types of food resources utilizes two types of procurement strategies which optimize the bird’s return on investment. A central location, that is in the middle of the resource area is optimal for the procurement of mobile food sources. On the other hand, a dispersed procurement situation would be optimal in the exploitation of a stable food resource. Collecting stable food resources has better return when one's group is spread out over a wider area within the resource unit (Wilmsen 1973:6). One can easily see the applicability of the Blackbird model to ethnographic examples.

Wilmsen takes the ethological analogy even further and I feel that his approach is justified. He states,

A fundamental fact of animal spatial organization is that no individual or group uses all of the space that might be available to it. Groups allot spatial units among themselves if for no other reason than to cope with administrative and communicative problems which would rapidly become insoluble if distances were not constrained (Wilmsen 1973:3).

However, the distinctions between spatial units, boundaries, or territories are often not sharply defined by either physiographic or cultural boundaries. In many instances, these so-called boundaries tend to overlap considerably (Leyhausen 1965, Wilmsen 1973). It is within this interface zone that considerable, intensive territory marking activity takes place. This type of activity may involve aggressive behavior but it is often characterized by advertisements; visual displays, vocalization, scent marking, landscape alterations, or by the identification of the inhabitants with some characteristic of the territory (Wilmsen 1973, Leyhausen 1965).

Fredrik Barth (1969) concludes that boundaries exist in spite of a flow of people from one territory to another. Barth feels that the main reason for this is the fact that people show identity through overt signals or signs and by value orientation. Both Ortiz (1969) and Rappaport (1968) describe advertising behavior to delineate social boundaries (Wilmsen 1973). Unfortunately, this type of information can never be recovered from the archaeological record.
SOME ETHNOGRAPHIC EXAMPLES OF SPACE UTILIZATION AND THEIR APPLICATION TO ARCHAEOLOGY:

Archaeologists, as a whole, can and do make considerable use of ethnographic material, and spatial concerns along these lines are no exception (see Fletcher 1977). Brown (1974) using census data, informants and archaeology, reconstructed the settlement pattern of Picuris Pueblo at around 1900. His results could be of use to archaeologists working in the region of Picuris. For example, Brown concluded that during the early 1900's a nuclear family actually occupied two distinct household units at different times of the year. A family would occupy a house within the Pueblo during the winter and during the summer, a house near the families farming plot would be utilized. Brown states that these summer field houses were often occupied for extended periods of time (Brown 1974), perhaps during the entire growing season. Brown's work at Picuris also provides the archaeologists with some additional information pertaining to secular and non-secular uses of space. He concludes that secular architecture is, as a general rule rectangular, while religious architecture tends to be circular. He was also able to make distinctions between architectural units associated with certain ceremonial groups within the Pueblo.

In a paper entitled "Adaptations to crowded space: The case of Taos Pueblo" Katz (1974) discusses the cultural responses by the Taos Indians to crowded conditions. Katz points out that Taos has the most compact living arrangement of all the eastern Pueblos. Her analysis and results have a direct importance to archaeologists concerned with the questions of space especially in the prehistoric southwest.

The social responses to crowded conditions at Taos are exactly what we might expect. (1) The maintenance of social distance through idealizing restraint, moderation and non-competitiveness; (2) displays of aggressiveness, hostility, suspicion, and factionalism; (3) mechanisms to maintain solitude and privacy by withdrawing from social (not visual) contact, keeping secrets, and when needed, traveling long distances from the Pueblo (Katz 1974:300-301). Of these responses, the archaeologist can perhaps recognize an attribute such as factionalism through architectural remains.

Draper's (1973) work on the !Kung suggests that residential crowding does not produce symptoms of pathological stress (Draper 1973:302). His study adds further weight to Hall's ideas that spatial concepts are culturally determined. Draper's analysis should be especially interesting to the archaeologists...
interested in estimating population from settlement size. Draper points out that !Kung camps have a high person density but they lack rooms, walls, or other architectural features that might limit access (Draper 1973:302). These types of features, or lack of, should be evident in the archaeological record and the archaeologists should be aware of the spatial interpretations possible.

Steward (1938:50-54) describes the way in which band territories among the Paiute were oriented across the valley so that each spatial unit had access to portions of different botanical zones. Price (1962:57-58) describes a similar situation concerning family owned pine nut gathering plots among the Washo. These plots were arranged to include both early and late spring ripening stands to ensure that all families had equal access to pine nuts (Wilmsen 1973, Price 1962). The importance of Steward's and Price's work is crucial to the archaeologists dealing with settlement patterns.

Binford's (1978) ethnographic work can shed light on archaeological spatial distributions of small hunting camps, or perhaps seasonal campsites. Studies by Jet (1978), Swan (1980) and Nespore (1980) are useful in reconstructing the dynamic nature of settlement patterns and tribal origins. The historical archaeologists can also make use of ethnographic data pertaining to spatial organization. For example, Gilmore's (1977) work in Spain describing how a "class model operates reciprocally with spatial orientations to intensify cultural opposition in a Spanish town (Gilmore 1977:437)."

SPATIAL ANALYSIS IN ARCHAEOLOGY:

The analysis of man's use of space is directly linked to the discipline of economic geography since most of the common approaches to the analysis of space were developed in that field. These approaches, or spatial theories and their archaeological applications will be discussed in some detail below. First, we must outline the historical developments leading to the present applications or new directions in spatial archaeology.

Clarke (1977) provides an excellent summary of these historical developments and much of what appears below has been derived from Chapter 1 of Clarke's book Spatial Archaeology.

The analysis of space, as it pertains to archaeology had it's beginnings in Europe. In Europe, the Austro-German school of Anthropogeographers developed the mapping of
attributes and artifacts to define culture complexes and their relationships to the environment. Clarke (1977b:2) cites Gradmann (1898), Ratzel (1896), and Probenius (1898) as examples. The interesting concept to be emphasized is that what the anthropogeographers developed is what we now call point pattern analysis. Hodder and Orton (1976:30) state that point pattern analysis deals with the distribution of points whether they are artifacts within a site or scattered archaeological sites. Statistical quantification of point pattern analysis was developed in plant ecology (Clark and Evans 1954) and this type of analysis is still quite popular with British archaeologists, especially Ian Hodder (Hodder and Orton 1976, Hodder and Hassall 1971, Hodder 1974a, 1974b, 1975).

Present use of point pattern analysis (sometimes called locational analysis) owes it's diachronic perspective to C. Fox who in 1922 developed a methodology or technique using archaeological and environmental distribution maps to cover a region over thousands of years. His technique was used to a great extent during the 1930's, especially by V. Gordon Childe (Clarke 1977b:2).

Clarke (1977b:2-3) maintains that during the later part of the 1940's economic interest tended to dominate European prehistory and the spatial approach lost ground. It was not until the 1960's, perhaps from influence from the United States (Steward 1938, Willey 1953, Phillips et al, 1951), that spatial archaeology regained popularity. Clarke points out that the Cambridge School of New Geography and the School of Architecture also influenced the regained popularity of spatial archaeology.

It was at this point that "spatial archaeology" diverged into two directions of methodologies. There was the theoretical development of models (Clarke 1968, 1972, 1977) and the articulation and employment of the catchment area concept (Chisholm 1968, Vita-Finzi and Higgs 1970). The catchment area concept caught on almost immediately in archaeology and has been used and misused since it inception.

In the United States the approach to the study of spatial relationships followed a slightly different line than did that of the Europeans. Although the Americans were influenced by the anthropogeographers, they seemed to be more interested in social organization and settlement pattern studies as opposed to artifact distributions maps that covered a large area. Clarke points out that the "anthropological dimension became stronger and the geographical aspect diminished (Clarke 1977b:3)."
During this same time period in the United States (1930-1960) Roper (1979) points out that there were three basic ways in which archaeologists ordered space. There was the culture area concept as described by Kroeber (1939), the horizon (Willey and Phillips 1958), and by settlement pattern studies (Willey 1953).

These approaches to spatial analysis, as Clarke points out, tended to limit spatial studies to settlement analysis in the United States. The "new archaeologists" of the 1960's came close to what Clarke would probably have called real spatial studies but they too, fell short. These "new" archaeologists who were concerned with the advancement of archaeological science still emphasized sociological, economic, and ecological objectives when dealing with spatial problems. Real spatial studies, if I may use that term, the role of spatial structure, or spatial variability were still a minor consideration. "Spatial archaeology remained a secondary consideration" (Clarke 1977b:4).

SPATIAL THEORIES AND SOME ARCHAEOLOGICAL APPLICATIONS:

There are, according to Clarke (1977b) four general spatial theories which underline most, if not all, spatial theories dealing with anthropology. These are; (1) anthropological spatial theories; (2) economic spatial theories; (3) social physics theory; and (4) statistical mechanics theory (Clarke 1977b:18). All of these spatial theories have roots in economic geography, and therefore in economic spatial theories as well.

Anthropological Spatial Theories.

The main essence of anthropological spatial theory is that archaeological remains are spatially patterned. Thus, the patterned distributions of archaeological materials provides the archaeologists with data pertaining to the social organization of a particular society. What archaeologists are interested in is the non-random distributions of artifacts, houses, or settlements. This assumption, and it is just that, is perhaps the most important one made by archaeologists (Schiffer 1972:156).

More recently, archaeologists and cultural anthropologists have turned to behavioral and structural approaches to the study of space (Levi-Strauss 1953, Binford 1962, Clarke 1977b:18). Clarke states that,
The first step is usually to define the spatial patterning of the archeological remains by quantitative methods and then to offer testable hypotheses based on anthropological or mathematical analogy as to the organization of the society and the associated patterns of individual behavior behind the spatial patterning observed (Clarke 1977b:18-19).

Economic Spatial Theory.

This approach is analogous to the well known "principle of least effort (Zipf 1965)." The theory makes the assumption that man is a rational animal and that man will make choices and decisions which minimize cost and maximize profits. Clarke (1977b:19) points out that it is the economic spatial theory that serves as the stem for later spatial theories such as central place, catchment, and locational analysis.

Social Physics Theory.

In this case, large numbers of people are thought to act in a similar manner as large numbers of physical particles. Gravity models are probably the most common forms of social physical theory.

Statistical Mechanics Theory.

The approach of statistical mechanics linked social physics with mechanical statistics and stochastic background (Clark 1977b:20).

I feel that it is probably safe to say that it was Von Thuen in 1826 who "invented" a most important concept with regard to spatial data. His locational theory, which noted the land use pattern and activity distribution around a central location plus the law of diminishing returns, is at the root of all later spatial theories. (Figure 1).

Site Catchment Analysis.

This approach to the study of spatial relationships has probably been used and abused in archaeology more than any other spatial theory. The theory was first developed by Chisholm (1968), but later expanded upon and elaborated to fit archaeological situations by Vita-Finzi and Higgs in 1970. In their often cited paper, they state that the catchment area
concept was employed to make a "comparative analysis of hunting-gathering and agricultural economics (Vita-Finzi and Higgs 1970:1)." The basic thrust of site catchment analysis makes the,

... modest assumption that a human group will in the long run make use of those resources within its territory that are economic for it to exploit and that are within reach of available technology. On this assumption, a site placed in a territory largely composed of grazing country would have been inhabited by human groups intent on the exploitation of grazing animals (Vita-Finzi and Higgs 1970:2).

This assumption can easily be tested by archaeology, but only in areas with good preservation of floral and faunal remains. Far too often, archaeological results have been overlooked when catchment analysis has been attempted. Flannery (1976) and Whallon (1974) are two notable exceptions and more will be said about these below.

Site catchment studies, as proposed by Vita-Finzi and Higgs (1970) is what they would call the study of the relationships between technology and those natural resources lying within the economic range of individual sites (Vita-Finzi and Higgs 1970:5). Roper (1979) expanded their definition by suggesting that site catchment analysis,

... emphasizes such considerations as the availability, abundance, spacing, and seasonality of plant, animal, and mineral resources as important in determining site location. However, it is distinguished from other man-land approaches by the assessment of those resources within a demarcated area surrounding a site. That is, sites are conceived of as points at the focus of an area throughout which economic activities were performed (Roper 1979:120).

On can easily see that the distance of a resource area in relation to the site has a direct bearing on how the area will be exploited. In other words, "the further the area from a site, the less likely it is to be exploited (Vita-
In their original use of the catchment area concept, Vita-Finzi and Higgs describe a four part methodology concerning their approach to catchment analysis. The first two variables describe actual site locations or situations while the latter describe the somewhat more abstract notion of exploited land. These are:

1. Home Base
2. Transit Site
3. Site Exploitation Territory
4. Annual Territory

A home base is a "site which is primarily concerned with the exploitation of a site territory (Vita-Finzi and Higgs 1970:6)." How can a "site exploit a site territory?" Of course they mean the site inhabitants, but their analysis in the final form may in fact forget about the actual people at the sites and what they were doing.

The concept of a transit site describes a site located along a probable migration route. This brings up the problem of site function in catchment studies. A site exploitation territory refers to the area around a site which is exploited by the inhabitants. The last variable, described as the "annual territory" denotes the "total area exploited by a human group throughout the year. It may contain one or more site exploitation territories (Vita-Finzi and Higgs 1970:7)."

Basic problems associated with site catchment analysis become obvious. In the first place, catchment studies in their original form may tend to overlook the fact that they are dealing with people and distinct cultures. If we know where a site is located, perhaps even the reason why it is located at that particular point but know nothing of the actual subsistence or economic activity practiced by the people who occupied the site, how can we simply draw a circle around the site and call it a catchment area. My basic argument is in the use of arbitrary 1km or 10km or 2 hour or 10 hour distances to serve as the cut off points for catchment analysis! Vita-Finzi and Higgs, along with Jarman (1972) soon realized this problem and attempted to rectify the situation. They state that "in a flat or relatively uniform environment, territories will tend to be circular; where relief is pronounced, they will be distorted (Jarman, Vita-Finzi and Higgs 1972:62)."
They further conclude that we can no longer get away with drawing circles around sites, but they still follow the time factor (2 hours walking distance) to serve as the cut off point for the catchment area. This is taking Von Thuen's law of diminishing return to an extreme and in addition it is rather ethnocentric to impose a 2 hour walking limit on prehistoric cultures. Time and distance are determined to some extent by culture, thus I can easily dismiss any type of limit of time or distance as a cut off point in catchment analysis.

Dennell (1980) points out some additional problems with the original application of catchment analysis and he offers two suggestions. He concludes that catchment studies, in their original form, can lead to unreliable mapping of catchment areas and often does not take into consideration environmental changes that have occurred through time. He also suggests that since catchment studies are still in the very early stages of development, the present methods are not really suitable for application to animal based economies and those with complex social and economic relationships. Dennell offers two suggestions for the improvement of catchment studies. First of all, catchment studies can be used in a way to obtain data on the physical settings of prehistoric settlements, which can supplement botanical and faunal data from excavations. Second, catchment studies can be used as a way to model the most plausible type of subsistence economy (Dennell 1980). This is an improvement but I would make one additional modification following the work of Flannery (1976). Flannery begins with the actual archaeological data, mainly floral and faunal remains. Then, on the basis of the ecological zones represented by the plant and animal remains, he constructs the catchment area or as in most cases, catchment areas. This approach takes into full consideration the cultural aspect and, therefore, only those materials preserved in the archaeological record are used to reconstruct the catchment areas. Of course, only archaeological sites with good preservation of floral and faunal remains can be used in this approach to catchment studies.

Flannery (1976) also addresses another basic problem dealing with site catchment studies which is site typology and site classification. He uses the example of high mountain deer hunting camps established well away from the valley floor villages. Are these hunting camps distinct and different sites or, as Flannery argues, "temporary
annexes to the village (Flannery 1976:94)." Puebloan field houses are another example of this type of situation. If we accept Flannery's concept of village annexes with regard to these remote sites, which I do, then these remote sites are in fact catchment areas since they were used in the procurement of economic goods.

This idea adds further support, in my opinion, to the abandonment of the time/distance factor to delineate the boundaries of the catchment area. Settlement, artifactual, and cultural data should be utilized to a greater extent in the determination of the catchment areas. Archaeologists can no longer get away with simply drawing circles around archaeological sites and calling it the catchment area.

Central Place Theory.

Central place theory is, and has been another important theoretical approach to the study of space. As with catchment analysis, the approach has been misused when applied to archaeological data. First developed by Christaller (1936, 1966), the central place model is based upon the centralistic principal which we have seen expressed by Von Thuen and Chisholm. In fact, when one reads the writings of Christaller it is clear that a great deal of his theoretical approach stems from the realms of social physics. He states,

The crystallization of mass around a nucleus is, inorganic as well as organic nature, an elementary form of order of things which belong together - a centralistic order. This order is not only a human mode of thinking, existing in the human world of imagination and developed because people demanded order; in fact it existed out of the inherent pattern of matter (Christaller 1966:14).

Of course centralistic order is obvious in human community life. The church, plaza, square, and park are all examples of central places within community situations. Therefore, central place theory has applications to within-site analysis as well as to inter-site considerations.

Christaller was influenced by Von Thuen but his approach was also shaped by other German geographers of the 19th and early 20th centuries. Kohl (1850) sought laws that determined the distributions and size of towns. Grademann also had an
important influence on Christaller. In 1926 he made the geographical distinction between rural and urban settlements. Grademann's work (1926,1931) suggested that particular types of settlements are predominant within certain regions (Christaller 1966:1).

Perhaps the most influential aspect of Grademann upon Christaller was his concept of the "chief profession of a town." Christaller modified Grademann's original concept to mean "to be the center of its rural surroundings and mediator of local commerce with the outside world (Christaller 1966:16)."

Central place theory is a common approach to archaeological problems. But as Clarke (1977b) points out, these uses of central place theory have generally been limited to sites in an urban context, with elaborate economic systems. The ancient civilizations of Mexico, Central and South American have been analyzed through the use of central place theory.

Before I discuss a few of the examples of central place studies in archaeology, let me expound a bit on the theoretical orientation of this important analytical tool. Morrill (1970) points out two important concepts about central place theory. First, service centers are necessary for the distribution of goods and services. In addition, specialized goods, military protection or control are all organized from a central location. Second, the principle of least effort (Zipf 1965) is in effect. If all of the above mentioned services are available at one center which is centrally located, effort in obtaining the goods and services is minimized. Christaller's central place model combines these aspects with lattice theory, thus suggesting the "ideal pattern of settlement (Hodder 1972: )." Of course, what is "ideal" may not even exist in the real world and this becomes a fundamental problem with central place theory.

Wilmsen (1973) brings out two additional points that deserve mention here. First, there is a functional relationship between a network of localities and the territory in which these occur. Second, the sites of functionally similar territories and locations tend to be regular (Wilmsen 1973:10). In other words, Wilmsen realizes the importance of environmental considerations which also play a part in the distribution of settlements. Christaller's model is a purely economic one and it tends to neglect
environmental considerations. Cultural considerations are also neglected in the original use of the theory.

The most basic assumption of Christaller's central place model is that settlements occur in an unbound featureless plain, and that they are in a closed economic system as Von Thuen described.

Another problem with central place theory is discussed by Parr and Denike (1970). Their approach to central place analysis is with a diachronic outlook. They conclude that,

... systems were based on cost and demand conditions as they existed for the various goods at a particular point in time. In the real world it is highly unlikely that the composition of the hierarchy would remain stable through time. (Parr and Denike 1970:574).

This aspect is especially important and in my opinion is one of the major shortcomings of central place analysis as Christaller describes it.

These problems have been considered by archaeologists, and a number of important modifications have been made to Christaller's original theory. These modifications include an inclusion of the dominance of economic factors in the settlement and growth of centers. The rational behavior of consumers, and the congruence of spatial distributions of retail market centers with that of non-economic factors effecting settlements (Crumley 1979:151, Hodder and Orton 1976, Olsson 1966). Religious factors and central place theory have been neglected in archaeological applications. This is unfortunate since religious remains from archaeological sites in the form of architectural remains are commonly discovered, especially in the American southwest. For instance, do Anasazi sites with Great Kivas represent central places? I think that a strong case can be made in favor of such an analysis (Rohn 1982 class lecture).

Let us now discuss a few of the applications of central place theory to archaeological data. Hodder (1972) uses central place theory in his analysis of Roman-British towns. He also employed the concept of ranking, describing a hierarchy of sites.
Pollard (1980) discusses the protohistoric Tarascan state and suggests that human settlements vary in two ways. First, they differ in the functions they perform themselves and for other settlements. Second, they differ in population size. She maintains that these variations do reflect differences in centrality and importance. She suggests that a large dense population is a measure of site importance. However, this equates site with settlement and we know this not always true. A very important site to the prehistoric inhabitants of a region may in fact be a site where no people live at all, such as a shrine or other religious structures.

The latter part of Pollard's analysis is more informative. In complex societies, she points out, there are several ways communities interrelate with each other.

A. As central places

B. As noncentral generalized places being served by central places commonly called hamlets of mall villages.

C. As specialized places performing functions for nonlocal communities (Pollard 1980:78).

Pollard goes on to argue that these are hierarchically related and spatially distributed in predictable patterns.

Evans (1980) questions the use of central place theory or marketplace exchange as used by Smith (1980) in the southeastern basin of Mexico. Smith's argument, that the central place model was an important factor in the placement of Aztec towns is a purely economic one. Christaller would have been proud. Evans (1980) on the other hand, feels that environmental and political factors were far more important in the shaping of settlement patterns within the region. Both are probably correct, however, the importance of this exchange between Smith and Evans denotes how central place theory has been used in archeological situations. As Clarke (1977b) points out and stresses, the spatial models that were developed in geography were conceived in purely economic terms. In addition, most if not all of them were developed as tools to analyze post-industrial society. In their pure economic sense, they cannot be applied to prehistory. One cannot overlook the importance of market systems since it is market systems that provide us with the best examples
of central places (not considering religious features). However, market systems must not be analyzed at the exclusion of political environmental, or diachronic variables. With all of these aspects in mind, central place analysis can be a very important archaeological tool.

Let me suggest some possible archaeological situations close to home where central place analysis may be applicable. Do the large Puebloan towns in the Montezuma Valley of Colorado represent central places? As stated earlier, I feel that a strong case can be made for central places when one considers the religious features present in the form of Great Kivas at a number of these sites (Rohn 1982 class lecture). There may be additional information to support a central place analysis but this data is still buried beneath the ground. For instance, does the overall settlement pattern of these towns and their outliers suggest a central place type of situation. I feel that it does based upon the small amount of information that is known from the region. What we see are large towns like Goodman Point, perhaps surrounded by smaller pueblos similar to the Mustoe site. The interesting aspect here, as Rohn (1982 class lecture) has discussed, is the distinct and real possibility that the clay source for the Mustoe site is the Goodman Point ruin. If this is so, and the two sites are contemporaneous, can a case be made for a central place on the basis of raw materials for ceramics? Before such conclusions are drawn, data concerning the clay sources for the other pueblos around the Goodman Point ruin will have to be investigated. If all of the clay used in ceramics for all of the outlying sites around the Goodman Point ruin originated from the source at the Goodman Point ruin, a strong case can be made for central place status for the Goodman Point pueblo. Of course, other material, and social/cultural factors will need to be considered as well.

The Gravity Model.

A brief discussion of the gravity mode is in order since it has been applied to archaeological data (Plog 1976, Earle and Erickson 1977). The gravity model, first proposed by Olsson (1965, 1970) suggests that,

The amount of interaction between two cities is directly proportional to the numbers of people living in those cities, and inversely proportional to the intervening distance (Crumley 1979:146).
The first problem with the gravity model concerns demographic archaeology. How do we determine how many people lived in prehistoric sites. Only relative population estimates would need to be utilized however, Crumly further states,

The model nonetheless has severe practical limitations in its applicability for archaeological problems; minimally one must have either artifacts that are sensitive economic indicators (solving the equation for populations) or considerable historical evidence of interaction between one center of known and one of unknown location (solving the equation for distance). Such requirements necessitates well-dated sites distributed over a large area (Crumley 1979:49).

THE LEVELS OF SPATIAL ANALYSIS WITH SOME ARCHAEOLOGICAL EXAMPLES:

Clark (1977b:11-14) discusses the four levels of spatial analysis. He defines these as, (1) the micro level, (2) the semi micro level, and (3) the macro level. I will briefly discuss each of these, following Clarke's conclusions, and offer a few archaeological examples of each level.

The micro level of analysis is mainly concerned with the proxemic and social factors which describe spatial activity. Clarke (1977b) maintains that individual and cultural factors, at this level of social space, are more important than economic factors. The micro level of analysis is concerned with the spatial activity within structures.

At this level of analysis, a number of important contributions can be offered about how people organized and utilized their personal space. Flannery and Winter (1976:34) have suggested that the smallest spatial unit of archaeological analysis is the activity area. They define an activity as a spatially restricted area where specific or related tasks were carried out (Flannery and Winter 1976:35). The micro level of analysis has been used with some success to define male and female work areas (Flannery and Winter 1976, Hill 1966) and household specialization (Flannery and Winter 1976).

Lyman (1980) used the micro level of analysis to make inferences about kill distributions in prehistoric Nez Perce
villages. He was able to read bone distribution patterns on house floors which denoted kill distributions between family groups. Lyman states that;

> Whatever the case, the distinct patterned sharing of the deer suggests a social or kinship regulation requiring one family to receive the anterior half while the other family receives the posterior (including the sirloin half (Lyman 1980:119).

Lyman also uses ethnographic data on the Nez Perce to further substantiate his conclusions.

Spatial analysis at the semi micro level is concerned with the spatial relationships within sites. Clark (1977b) maintains that at this level, social and architectural concerns are greater than personal requirements but economic interests are also important.

In their analysis of household activities at Oxacca, Flannery and Winter (1976) describe four types of activities evident at the within site or semi micro level of analysis. First, they describe a universal activity that is carried out by every household. This is food procurement and storage. Second, there is possible household specialization. This activity may in fact be discovered at the micro level of analysis but a large number of houses would need to be fully excavated prior to this type interpretation. Third, they describe possible regional specializations, such as shell working. Interestingly, this activity as well as the fourth specialization, what they call unique specializations could perhaps be recognized at the micro, semi micro, or macro level of analysis. Flannery and Winter (1976) use magnetite mirror production as an example of a unique specialization.

Winter's (1976) concept of the household cluster has become a popular tool in spatial archaeology at the semi micro level. Winter suggests,

> a typical household cluster might consist of one house, two to six large storage pits, one to three graves, and various additional features, separated from the nearest contemporary cluster by an open area of 20-40 meters (Winter 1976:25).

Bogucki and Ryszard (1991) use Winter's concept to study the spatial layout of small habitation sites in Poland. They
conclude that it is a valid methodology for the analysis of small site situations.

In an interesting but somewhat inconclusive paper Stacy (1977) discusses hill sites with rock wall features or low rock walls located on hills adjacent to Sells phase prehistoric sites. Stacy falls back on the use of the ethno­graphic analogy, which in this case is rather difficult to make. Although Stacy can make no real functional interpre­tation of these features, she does recognize their importance as spatial units associated with the village sites.

Since the hill sites are contemporary with and adjacent to these Sells phase village sites, they must have provided additional space for the performance of specialized seasonal or intermittent activities by the village inhabitants (Stacy 1977:15).

Perhaps the most important questions that archaeologists can ask about prehistoric societies with regard to space can be derived from spatial studies at the semi micro level of analysis. For example, Hill (1970), Longacre (1970), Dean (1970) and Rohn (1965, 1971) have addressed the problems associated with the analysis of prehistoric social organization. (see Rohn 1965, 1971).

Saile (1977) also discusses architecture and how it relates to prehistoric social organization and spatial concerns in Chaco Canyon, New Mexico. More will be said about Saile's work below.

The entire area of structural archaeology, which I will discuss below, relies on the semi micro level of analysis to make inferences about how prehistoric or historic cultures conceived of their spatial surroundings (see Fletcher 1977).

The macro level of analysis is concerned with the spatial relationships between sites. Clarke (1977b) concludes that geographic and economic models are most important at this level. However, Kay's (1975) analysis of Hopewell projectile points demonstrates that social distance can be measured between archaeological sites on the basis of tool manufacture. For the most part, geographical and economic factors are largely dominant at this level of analysis. Zipf's (1965) principle of least effort seems to be a common theme at the macro level of analysis. However the over use of this concept
can lead to very ethnocentric statements (Rohn 1982 class lecture).

Despite the problems of ethnocentrism, Zipf's concept has been used with some success concerning archaeological data. Green (1973) and Wood (1978) both use the principle of least effort to discover site settlement patterns in relation to utilized resource areas.

Clarke's levels of spatial resolution are not clear cut nor are they exclusive to one another. The results of Flannery and Winter bear this out. The important contribution is that these levels provide the archaeologist with a set of bounds to work with and they make up the basic elements for the matrix of spatial relationships (Clarke 1977b:12-17).

THE NEAREST NEIGHBOR STATISTIC AND ITS APPLICATION TO ARCHAEOLOGICAL SPATIAL ANALYSIS:

One of the most common tools available to the archaeologists concerned with spatial questions is the nearest neighbor statistic. We owe this statistic to P.J. Clark and F.C. Evans who in 1954 first used this method to measure spatial relationships in plant populations. In addition, Clarke and Evans' use of this statistic was used to describe plant distributions objectively by assessing contrast between actual patterns and their theoretical counterparts (Pinder et al 1979:430). Hodder and Orton (1976) state that the nearest neighbor statistic permits one to describe a settlement pattern as regular, random, or clustered. The important assumptions to the use of this method is that only settlements which were occupied at the same time can be used in the analysis.
THE NEAREST NEIGHBOR STATISTIC

\[ \bar{d} = \frac{2n}{a} \]

\( \bar{d} \) = mean distance between a point and its nearest neighbor.

\( a \) = area concerned.

\( n \) = number of points

\( R = 0 \) which is a maximum cluster.

\( = 1 \) which is a random distribution

\( = 2.15 \) which is a maximum dispersion

From Clark and Evans (1954), Noisat (1978:112)

An additional consideration needs to be taken when the nearest neighbor statistic is used. The universe needs to be known, that is all of the sites within the area under consideration need to be identified (Noisat 1978, Clark and Evans 1954). Furthermore, the points which are compared by the use of this statistic need to be roughly equal. In other words, one cannot use this method to compare large towns with farming hamlets (Rohn 1982 class lecture).

Noisat's (1978) use of the nearest neighbor statistic in his study of Navajo settlement patterns is interesting since his post World War II to present winter-spring camps in the Sage Plain area show a random distribution around hogan clusters. Noisat concludes that winter activities require the Navajo herder to range farther from the hogan than do summer activities. It thus appears that winter-spring camps are the most sensitive indicators of the extent of the traditional use area of the Bisti-Star Lake homesteads (Noisat 1978:114).
Whallon (1974) concludes that the nearest neighbor statistic has advantages over other statistical methods, namely dimensional analysis of variance, because it is free from problems of grid size, shape, and orientation.

Washburn (1974) used the nearest neighbor statistic to interpret Pueblo I - III settlement patterns along the Rio Puerco river in eastern New Mexico. She was able to show clusters of Pueblo I - III house locations with area suitable for field agriculture. Stark and Young (1981) have modified the nearest neighbor statistic for use on linear settlement patterns.

The nearest neighbor statistic can be quite useful to archaeologists dealing with spatial information. The important fact to remember is that this approach can be used at the micro, semi micro, or macro level of analysis.

STRUCTURAL ARCHAEOLOGY: SPATIAL ARCHAEOLOGY AND HARMONIC ORDER

Structural archaeology, if I may use that term, may represent another direction towards the analysis of how space was used by prehistoric and historic populations. This direction is concerned with how the population under study conceptualized space, and furthermore how their conceptualization is obtainable from archaeological remains, mainly architecture. The important features of human locational behavior were defined in Hall's (1966) work The Hidden Dimension. Space, whether it is architectural, personal, or conversational, is regulated by cultural preference.

They are plainly capable of estimating distances without being deliberately aware of the actual distance used and without the aid of any concrete measuring standard (Fletcher 1977:49).

Before we go on with this discussion of structural archaeology, let us first take a brief look at some of the historical background material.

Chang (1962) following the work of Sears (1961) made the distinction between "settlement pattern" and "community pattern" with regard to archaeological data. Chang argues that "settlement "pattern" served as a "catch all" term which needed to be defined in each particular case. Chang's solution to this dilemma would be to distinguish "settlement archaeology," that is the spatial aspects of prehistoric settlements which
includes ecological and cultural factors from "community patterns" or those aspects of settlement related to social psychology or sociology.

West (1970) following Sears (1961), Chang (1962) and Sanders (1967) describes the differences between "settlement patterns" and "community settlement patterns" for the site of Chan Chan in Peru. Sanders (1967) defined settlement patterns as "the distribution of human populations in a geographical region and the analysis of the factors responsible for the distributions (Sanders 1967:53)." Sears (1961) concludes that community settlement patterns are "strictly the social aspects of settlement patterning, including site community pattern-internal patterning of single communities (Sears 1961:226)."

Layton (1972) suggests that when the nature of social relations within settlements are investigated, two approaches may be used. First, one may attempt to learn how far social relations tend to have any constant features. Second, one should attempt to show how these relations within a particular settlement are restricted by rules more or less unique to that particular social setting (Layton 1972). Archaeologically these "constant features" should show up as part of the spatial arrangement of a culture. Draper (1973) suggests that it is the complete lack of space regulating features that is constant in !Kung camps. The spatial arrangement will include house plans, spacing between features, activity areas, and areas of trash disposal. Thus, these arrangements are restricted by cultural values and therefore should appear in the archaeological record as a type of "signature" for the particular culture. These arrangements of space need to be discovered, analyzed and tested cross culturally to get at the mental image of the use of space by the aboriginal occupants (Layton, 1972).

Architecture is probably the best way to understand archaeologically the aboriginal concept of space, and it is architecture which is the main feature of Fletcher's (1977) approach. Saile (1977) who is an architect, suggests that there are two concerns in architectural studies. First, architecture deals with place, and place implies spatial organization. Second, spatial qualities may be ordered in a diffused manner or by sharp breaks separating private and public space. Saile further suggests the two major aspects of spatial organization with regard to prehistoric sites in Chaco Canyon. First, it is possible to compare different
sites, or different developmental stages at one site by out-
lining the spatial organization as indicated through archi-
tectural remains. Second, considerations of the manners in
which the physical space - defining how elements can function -
may give clues to the manner in which space was used by the
prehistoric builders (Saile 1977:64).

Fletcher (1977:53) cites such examples as Eliade (1954),
Moholy-Nagy (1969), and Rapoport (1969) as examples of ethnog-
graphic works dealing with cosmology and settlement form.

The basic theme of all of these studies is that settlement and house form are closely
connected to the internally consistent cate-
gories and rules used by human communities.

Structures are in effect standing represen-
tations for the consistent classification
of other categories in the same cultural
milieu (Fletcher 1977:53).

In addition,

structures are important not only for their
materials function in providing shelter and
storage but also because they form the
coherent fram for community life and
reflect its regularities (Fletcher 1977:55,
emphasis mine).

The underlying assumption to Fletcher's brand of spatial
analysis is "formal order of design based on consistent
spacings (Fletcher 1977:57)." He points out that variation
cannot be regarded as an inconvenience in the search for formal
order. Variation, he states "may be an integral element of
that order since variation in the dimensions of a structure is
as much part of the visual contact of the community as any
regularities (Fletcher 1977:61)."

CONCLUSIONS

In this paper I have discussed a number of topics dealing
with the analysis of spatial data from archeological sites.
As with most methodological approaches in archaeology, the
historical development of some of our common spatial theories
can be traced to the later part of the 1800's. The influence
of Von Thuen cannot be overlooked in any of the "modern"
spatial theories practiced today.
Spatial archaeology has its roots in the field of geography especially economic geography. This has been the source of many of the problems archaeologists have tried to deal with when applying these approaches to archaeological data. Most, if not all, of the spatial theories employed by archaeologists today; site catchment central place theory, gravity models, all stem from economic geography. In addition, these theories were developed in response to post-industrial society and therefore in their original state, have little use to archeologists. Much further work is needed in the development of catchment analysis, and central place theory before they can be applied to most archaeological situations. The concepts are valid, the mechanisms need some modifications.

The work of Fletcher and others doing spatial analysis at the semi micro and micro levels are, in my opinion, exciting and long overdue. Only when this type of analysis is performed, over a wide range of cultural settings, will we begin to understand the spatial structure and spatial variability of prehistoric societies.
FOOTNOTES

1. I am limiting myself to a discussion of archaeological patterning in this instance. However, cultural anthropologists as well as archaeologists need to be more concerned with the detailed recording of spatial features in ethnographic works.
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