Chapter 6

MODELING DOLORES AREA CULTURAL DYNAMICS

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INTRODUCTION

This chapter is devoted to the development of a general model of sociocultural change and to the identification of some implications of this model that can be tested against archaeological data from the Dolores area. After introductory comments about the nature of building and testing theoretical models, a major section is devoted to presenting a general model of a regional sociocultural system. This model is not specific to the Dolores area or to Anasazi culture, but is derived from theoretical considerations and substantive generalizations about how “Formative” level (Willey and Phillips 1958) sociocultural systems work. This general model is presented and discussed to identify variables and relationships potentially important in bringing about sociocultural change. Thus, it is intended as a survey of variables and relationships that might be considered in investigating specific instances of sociocultural change.

The next section of the chapter briefly discusses possible approaches to developing testable expectations from the general model. It is concluded that, short of a complex computer simulation beyond the capacity of the Dolores Archaeological Program, only selected expectations can be tested.

In the final section, selected variables and relationships are used to construct 2 specific processual models of change for evaluation against the Dolores archaeological data. The first assumes as primary an economic system that has stable economic goals and articulates population, material needs, and resources in a cost-efficient way. Sociopolitical development is seen as a necessary accompaniment to increased population density or to economic intensification brought about by resource supply/demand imbalances. The second model assumes that under any of a broad range of economic conditions, social variables can become primary, with status differentiation and competition promoting economic intensification, population growth, and sociopolitical development. Contrasting expectations are developed for these alternative specific models of systemic change. These expectations are examined, in light of several categories of data, in chapters 7 through 15. In some of these chapters, additional evaluations of relationships among variables taken from the general model are also attempted. Chapter 16 presents a synthesis of results. A number of the supporting studies that contributed data used in chapters 7 through 16 are published in Petersen and Orcutt (1985) and in Blinman et al. (1985).

Definition and General Requirements of Modeling

A model is a simplified or abstract representation of a real system, incorporating only the few variables and relationships believed to be most important in accounting for the variability in the real system (cf. Clarke 1968:32). Since a system is being modeled, relationships among the variables must be stated; i.e., how change in 1 variable is likely to result in change in others. If this change is repetitive and is maintained within a steady range of values, the relationships among these variables can be viewed as maintenance processes regulating the operation of the system. To the extent that the system as a whole or major subsystems within it undergo nonrepetitive or structural change, the relationships linking the sequent states may be viewed as evolutionary or change processes.

The model must be relevant to the system, i.e., the modeled variables must be thought to be present, important, and measurable (or at least capable of being estimated) in the real system. On the other hand, the variables and relationships chosen should be derivable from general sociocultural theory, and the results of testing propositions derived from the model against data should be able to contribute to general theory. Thus, the model will be powerful to the extent that it can both account for a variety of characteristics of the real system data and can also be related to general theory about the operation of systems of the kind under study.

Archaeological modeling operates under the burden of having to work with data derived from the archaeological record and hence somewhat removed from the sociocultural phenomena being modeled. The model must
not only incorporate theory about how sociocultural systems work, but must also use "middle-range theory" (Binford 1977) about how the sociocultural phenomena of interest are expressed in the archaeological record. These links are discussed in chapters 7 through 15 and in numerous supporting studies (Petersen and Orcutt [1983]; Blinman et al. [1985]).

Testing a model requires that researchers be able to develop from the model predictions or expectations about archaeological data that did not enter into the construction of the model itself, i.e., did not provide the basis for delineating the variables and their relationships. This is not a difficult constraint because the model presented is based on generalizations about sociocultural continuity and change and because expectations about the Dolores case are derivable from these general considerations, rather than from examination of specific Dolores archaeological data.

For the same reasons, however, the model itself is testable only in 2 rather indirect ways. In the first, and more direct way, propositions can be drawn from the model and compared to the Dolores area data. For example, we might posit that increased population density should be followed by increased social differentiation and by increased agricultural intensification. Should we find these expectations are not supported by the Dolores data, it would show that the posited relationships did not hold in this particular test, but would not demonstrate they were not generally present. These relationships have been found in numerous other cases, or at least it has been so argued (e.g., Plog 1974; Boserup 1965), and we would have added only one counterexample. The finding would, however, contribute to the literature on these propositions and might to some extent modify our evaluation of their worth as generalizations.

In the second, and less direct sense, the overall usefulness of the general model can be evaluated by asking "Did the general model assist in isolating variables and relationships that could be shown to account for aspects of Dolores area sociocultural continuity and change?" To the extent that this question can be answered affirmatively, the general model can be considered to have been supported by this application or "test." This does not mean, however, that some other general model might not have served better.

The view of testing presented here emphasizes the role of the general model in the DAP approach to Problem Domain 5 (Cultural Process) in the DAP general research design (Kane et al. 1983). The model serves to generate propositions whose applicability to Dolores prehistory can be tested. Thus, the focus is on determining what variables and relationships account for Dolores area continuity and change; the general considerations are useful and relevant to the extent they contribute to that goal.

Testing propositions derived from the model also requires that the tests be capable of being falsified; that is, some states of the variables could conceivably occur that would deny the predictions of the model. And, the archaeological data used in testing must be linked by credible warranting arguments to the variables employed in the propositions that are being tested.

A GENERAL MODEL OF SOCIOCULTURAL STABILITY AND CHANGE

This general model provides a selection of variables for examination, and a justification as to why these variables are potentially important in accounting for stability and change in regional sociocultural systems. It also indicates general directions of influence or effect among variables, what co-variance is to be expected and which variables are likely to change in response to change in others. The model is to be used as a framework for abstractly describing the state of a regional sociocultural system and for comparing the system at different points in time. It can also serve for describing and comparing different regional systems at the same or different times.

In figure 6.1, a number of variables are named and relationships among them shown by connecting arrows. The directions of the arrows indicate the direction of influence or effect. The variables and relationships are those thought to have the potential to affect sociocultural stability and change in a system of the kind found in the Dolores area during the period of interest. The individual variables and their probable relationships are discussed later.

Figure 6.1 and the discussions that follow present a very general model of a regional sociocultural system. The model also incorporates aspects of the natural environment and of adjacent sociocultural systems to the extent these may have had an effect on the regional system under study. Although most variables (e.g., population, resource demand) will play a part in the functioning of the system in any state it might assume, some of the variables (e.g., immigration, intersystem exchange) may not. All variables have the potential to change through time, but some may not in a particular case. For example, in the Dolores area, the supply of most raw materials for lithic tools appears inexhaustible and was probably not measurably depleted by use. On the other hand, the Dolores area population changed greatly through time. The strength of the relationships among variables may not vary through time. In the Dolores
case, it seems likely that the technology of tool manufac-ture and use exerted a fairly constant effect on resource procurement and processing costs throughout the time period of interest (cf. chap. II). On the other hand, immigration was probably a strong contributor to population size in some periods and not in others.

**Some Basic Considerations**

**Homeostasis and Open Versus Closed Models**

The system modeled here is assumed to have a tendency towards homeostasis, in that mechanisms exist to con-strain variability within certain limits so that the states of a given variable oscillate around a (statistical) norm. Some of this variability may be viewed as stochastic, and some as a result of directional change processes interrupted by a cultural response that restores a previous state. Thus the progressive deterioration of facilities may be halted by repair or by the construction of new facilities, disparities in rates of accumulation of goods may be reduced by ritual distribution, and so forth. The degree to which the system's components are functionally interrelated can be seen as leading to homeostasis, if one assumes a certain amount of inertia or resistance to change within each of the components. The existence of homeostatic or deviation-damping (Flannery 1968) mechanisms does not imply the system cannot change or that it is always, or ever, in perfect equilibrium. Nonetheless, homeostatic mechanisms must operate to some extent if the system is to maintain an adequate amount of functional integration and coherence.

The system should not be viewed, however, as so success-fully and thoroughly homeostatic that it remains in a state of equilibrium until a forceful enough disruption sends it oscillating toward a new equilibrium state. This view implies a kind of all-pervasive, well-oiled functional integration is the normal state, and further, that disruptions must come from outside the system. They could not come from inside if complete functional har-mony is the rule (Jarvie 1965). An undue emphasis on homeostasis and integration leads us to view the system as closed and directs the search for change agents to the larger social or natural environment outside the system.

Wood and Matson (1973) have properly criticized this view and have proposed that, following Buckley (1968), sociocultural systems be viewed as open. The system is defined as a nexus of interacting variables; to the extent that variables affect one another, they are part of the system. This is very close to the view adopted; in this
proposed model, certain sociocultural and environmental forms (variable states) are seen as the product of a balance among interacting forces; a change in any or all of these forces may cause a change in the balance so that a new set of forms emerges. Rapidity of change is constrained by the effectiveness of functional integration and deviation-damping mechanisms. Change is also assumed to be constrained by a certain inertia, resulting from attachment to particular cultural solutions to the problems of life, due probably to the intellectual, affective, and neuromuscular investments required to learn particular patterns of behavioral response (Jochim 1981:27-28).

In keeping with the open system concept, the model presented (fig. 6.1) includes aspects of the local environment as well as variables that are sociocultural and demographic. The key element in the treatment of the environment is resource supply, which is considered to be those aspects of the environment recognized by the area's population as actual or potential resources. Although climate is likely to have affected resource supply both directly (e.g., by early killing frosts) and indirectly (e.g., by causing long-term shifts in vegetation community distributions), socioeconomic factors must have had substantial effects on resources as well. These would have included, for example, the results of land clearing and cultivation and of collecting wild plant and abiotic materials and animals. From this perspective, treating resource supply as a product of a coupled, but separate, environmental system would be unnecessarily awkward.

**Geographic Boundaries of the Dolores Area**

The Dolores area is coextensive with the Escalante Sector in the DAP spatial systematics (Kane 1983). The Escalante Sector was established to encompass the central impact area and project takeline and is based on the extent of the Anasazi settlement system centered on the Dolores River canyon. In the model diagram (fig. 6.1), the Dolores area is distinguished from adjacent areas, some of which were inhabited by other Anasazi populations. This spatial boundary is not necessarily (though at some times it has been) a "natural" one, i.e., one that represents a fall-off in population density or in amount of social interaction between settlements. It is a heuristic bounding that facilitates consistent investigation of the prehistory of the Dolores area; it is the area from which most of our available data come; it is large enough to include several Anasazi communities and their primary economic catchments during the time period of interest; and it has environmental variety, but not so much that it cannot be summarized by a small set of physiographic, biotic, climatic, and edaphic patterns. In keeping with the open systems assumption, relationships with sociocultural systems outside the Dolores area are included in the model because they have the potential to affect variable states within the region of primary interest.

During the A.D. 600-950 period, Anasazi populations were present at least part of the time in areas immediately south, west, and northwest of the Dolores area. To the east and northeast, the higher, forested areas seem not to have supported Anasazi settlements, at least not on a year-round basis, nor does any evidence show they were occupied at this time by non-Anasazi hunters and gatherers. Further afield, Anasazi populations in the Durango and Animas-La Plata areas, the San Juan Valley near Farmington, the Mesa Verde proper, the Montezuma Valley and McElmo drainage, and the Blanding-Bluff region of southeastern Utah may have had interactions with and effects on the Dolores area Anasazi.

It is assumed the non-Dolores systems can also be characterized by the general model -- that all things being equal, they would respond to change in a given variable in much the same way as would the Dolores system. The credibility of this assumption may be increased by the fact that the populations likely to have been interacting with the Dolores Anasazi all participated in the Mesa Verde Anasazi Cultural Tradition, and thus probably had similar sets of cultural expectations and norms, had a generally similar level of sociopolitical complexity, and depended on generally similar economic resources. Of course, not all things were equal across southwestern Colorado and adjacent areas -- population density, costs and risks of obtaining necessary resources, and degree of agricultural intensification -- varied through both time and space, providing much of the impetus for economic, social, and demographic interactions among regions (cf. Braun and Plog 1982; Judge et al. 1981, Plog 1984).

The bounding of the Dolores area appears to be least arbitrary, in a demographic and sociological sense, during the A.D. 800's, when the Dolores River valley and some of the adjacent uplands were more heavily populated than were surrounding regions. The boundaries of the Escalante Sector probably passed through areas of relatively low population density and social interaction. Earlier, however, the small dispersed homesteads and hamlets that characterized the Dolores area in the A.D. 600's and 700's may well have been part of a larger distribution of such settlements that extended outside the area to the south and west. Their community boundaries may not necessarily have coincided with the edge of Escalante Sector.
Sources of Systemic Change in the General Model

In the following paragraphs, several groups of variables and relationships are described; each can be considered as a major component of the system and as a potential source of change.

Because the modeling studies are focused on the Dolores area, which has geographic boundaries, the first group of variables and relationships are referred to as "interareal," as extending outside the Dolores area. That is not meant to contradict the "open system" assumption described earlier but is the result of the adoption of a geographic focus. Social, economic, and demographic relationships that extend outside the Dolores area are not necessarily more or less important in determining sociocultural responses within the Dolores-based system than are its own economic, social, or demographic subsystems.

Interareal Relationships

In the model, the factors that extend beyond the Dolores area and that can bring about responses leading to change within the Dolores area are regional climate and relationships between the local system and adjacent sociocultural systems. Regional climatic variability can affect local climate, which in turn affects the supply of basic resources - in particular, the capability of Dolores area lands to yield agricultural products. The regional climate's effects on surrounding areas can also alter the relative attractiveness of the Dolores area vis-a-vis surrounding areas and hence can affect the attractiveness of emigration or immigration as solutions to economic or social problems in any of these areas.

Turning to sociocultural relationships, immigration to and emigration from the Dolores area are thought to have affected local population size and density, at least at times, although internal rates of growth and decline must also be considered. Population movement into and out of the Dolores area may have been strongly influenced by its economic costs, risks, and productivity relative to neighboring locales. Such movements may also have been constrained by the type and degree of leadership and social integration within each area and by the kinds of social interaction (including, for example, intermarriage and warfare) between groups in the different areas. Furthermore, though emigration might have solved economic or social problems for the individuals or group that moved, it might have caused other problems (e.g., a change in the ratio of food producers to consumers or a disruption of established cooperative hunting relationships) for the population that remained. Problems of social integration and access to resources and settlement space might also have been present in the area receiving the migrants.

An additional external relationship that may have affected the states of variables within the Dolores system was interareal exchange (cf. Braun and Plog 1982; Judge et al. 1981; Upham 1982; Plog 1983). Incoming items would have supplemented the inventory of resource raw materials or of finished cultural materials available locally. This could have served to compensate for temporary insufficiencies (e.g., due to crop failure) in local supplies of resources and material. The movement out of the area of exchanged items would have increased demand for resources needed to furnish these items.

Movement of goods between areas can be accomplished by exchange or by one-way transfers (Pryor 1977). Of the 2 mechanisms, exchange seems the more likely for interareal relationships. Such external exchange may have effects on social and socioeconomic systems. Because the distances involved are relatively great and because social relationships must be established with members of "foreign" groups, external exchange probably takes a greater investment of time by the participants than does local exchange. Perhaps for this reason, external trade appears to have a greater potential for social manipulation, e.g., by restricting participation to only certain groups (Upham [1982]). To the extent that foreign products are widely desired or admired, the group in control of their acquisition through exchange can obtain an economic advantage and can use the products to display and validate its special status. I am not asserting that in the Dolores case mechanisms for external trade or transfer of goods went beyond trading partnerships among individuals (Snow 1981, Ellis 1981), but merely raising this possibility.

Resource Supply

Within the Dolores area, the local environment is considered to be part of the system under study because it furnishes resources of value to the local population. One of the most likely sources of variability that could have affected other components in the system is resource supply. The agricultural potential of soils in this area can be greatly affected by even small variations in local climate, notably in length of growing season (Shuster 1981; Petersen and Clay 1983); it is also affected to a lesser extent by amount and seasonal distribution of precipitation. Climatic variability could also have affected the area's vegetation types and distribution (Petersen 1981, 1985), with possible effects on wild plant and animal resources.

Furthermore, the effects of resource use on the environment must have had effects on resource supply by
decreasing the availability of some items (e.g., pinyon pine \[Pinus edulis\]) as a result of land clearing for agriculture and by increasing the supply of others (e.g., edible pioneer plants such as goosefoot \[Chenopodium sp.\], which thrive in disturbed areas, such as cleared fields) (Bye and Shuster 1984; Petersen et al. 1985). Such environmental effects would include those resulting from land clearing and cultivation, harvesting timber for building materials and fuels (Kohler et al. 1984; Kohler and Matthews 1984), hunting, exploiting clay and lithic resources, and so forth.

Population

Another powerful source of systemic response and, potentially, of structural change, is variability in population. In some theories of sociocultural change this is considered a prime mover (e.g., Boserup 1965), although in others it is considered as one of several factors that might place stress on the system and hence eventually promote structural change (e.g., Flannery 1972, Hassan 1981; Lightfoot 1984). This latter perspective is adopted here. In this model, it is assumed population change is likely to have had important effects on other aspects of the Dolores system in 2 main ways: first, through its effects on resource demand; and second, through its effects on population density with consequent effects on the social system.

In societies in which most economic activity is focused on providing small and relatively equal amounts of basic cultural materiel – food, shelter, clothing, fuel, and tools – for all members of the population, a major component of resource demand will vary directly with population. The demand for food – in terms of calories and basic nutrients – is likely to be most closely tied to population size. Demand for fuel and for material culture and facilities (and hence for the resources necessary to provide them) will also vary more or less directly with population, but will be conditioned as well by demands stemming from the character of the socioeconomic system and technology (e.g., degree of sedentism, importance of storage) and of the social system (e.g., the need for group assembly facilities, the need for imported goods to validate social status). If interreal exchange is substantial, this will also of course affect the directness of the relationship between change in population and change in resource supply and demand.

Change in population size within a given area of course changes population density, which likely affects the social system by changing the number and frequency of interactions among individuals and groups, and thus increasing the opportunities for conflict, including those arising from overlaps in role definition. Numerous studies have cited increasing population density as one of the preconditions for increasing social differentiation and for the development of sociocultural complexity in general (cf. Plog 1974; Blau 1975; Carneiro 1967). If density is the aspect of population size with the strongest effects on social relationships, these effects might be achieved by aggregation of a dispersed population into larger, high-density settlements, even in the absence of change in regional population size. The effects of increased density should be most pronounced when both regional population size and aggregation are increasing, as was true for the Dolores area in the A.D. 800's. If average community size stays the same, population growth in an area would then increase the density of communities (i.e., number of communities in a given area). Situations in which resources are localized or are scarce overall may lead to territorial conflicts among communities, which may have an effect on sociopolitical relationships between communities or on sociopolitical institutions within communities.

Some of the possible effects of population change on the social and economic subsystems have been discussed. But what brings about population change? The balance of births and deaths is controlled by factors intrinsic to the population (Palkovich [1980]; Wetterstrom [1976]), and population size may also be affected by immigration and emigration.

In the model presented, one of the most powerful determinants of immigration and emigration is assumed to be the difference in economic costs and risks among areas close to one another. This differential is likely to result from the effects of climatic conditions on areas having differences in factors such as elevation, physiography, and soils, as well as from differences among areas in population densities. For example, immigration into the Dolores area would occur when conditions for agriculture were substantially more favorable than in nearby areas, and emigration out of the Dolores area would be most common when other areas had become relatively more favorable.

Economic differentials should be most effective in triggering population movement when the receiving area has low population density. As population density increases, rates of immigration should increasingly be affected by social factors such as marriage and land tenure patterns, including the development of land ownership by kin or other corporate groups that regulate access to land (Hunter-Anderson 1980; Hayden and Cannon 1982). Also, a history of social relationships (e.g., trade, intermarriage) among adjacent areas would enhance the possibilities for population movement between them. Responses to immigration may vary, depending on the character and history of the social and economic systems. When economic integration is low, when small
groups are essentially independent economically, immigration should slow gradually as population increases and arable land becomes more scarce. With greater economic integration in the recipient area, one might also envision a scenario in which the adoption of labor-intensive forms of agriculture or the growing importance of local economic differentiation and exchange would favor some amount of immigration (Lightfoot 1984).

Lightfoot (1984) argues that even in relatively simple societies, the development of institutionalized leadership groups and the competition among leaders and their communities for followers may promote immigration to particular settlements or localities. He also notes that competition among leaders to achieve and maintain status may promote other developments, such as agricultural intensification, warfare, or increased trade, which may then attract population to an area. Braun and Plog (1982) discuss interregional economic intensification and integration through the development of exchange networks, and note that population may be attracted to the major nodes in such systems.

Factors likely to have affected intrinsic rates of population change include the general state of the population's nutrition and health (Frisch 1978; Wetterstrom 1976). The occurrence of nutritional and disease stresses can be inferred from skeletal material (Palkovich 1980). The relatively small number of burials from the Dolores area makes this approach of secondary usefulness, even though the existing materials do yield valuable information (Wiener 1984; Stodder 1985). Modeling of variation in food resource supply (primarily of agricultural yields) will have to be relied on for estimates of whether food shortages that could not be buffered by storage or other mechanisms are likely to have occurred.

Because most preindustrial societies have been characterized by very low rates of population increase (Cowgill 1975a, 1975b), and Malthusian controls appear seldom to have operated, it can be inferred that most prehistoric populations had some kind of cultural patterns resulting in population regulation, well below the carrying capacity of their sustaining area and technology. This seems especially clear for hunter-gatherer societies (Hassan 1981:160). The adoption of an agriculture-based system, and particularly the development of attempts to intensify agriculture, apparently created in some times and places a demand for additional unskilled labor of the sort that could be provided by children. In such circumstances, larger families and population growth would be expected (Nardi 1981; Hassan 1981:223-224; Stuart and Gauthier 1981:23-24; Lightfoot 1984). This might lead to a positive feedback relationship in which population growth raised costs of meeting resource demand, which favored further intensification, and so forth.

In our situation, increases in population associated with agricultural intensification might be expected, provided it was of the type that would have made children's labor more valuable. It can also be argued that increasing social differentiation may create more statuses, or "niches," which then create a demand for a larger local population so these positions can be kept filled. Reference has already been made to situations in which competing leaders seek by various means to increase the population of their own faction, community, or tribe (Lightfoot 1984). Likewise, a decrease in population may make it difficult for a group to maintain complex kinship or ritual organization, or for leaders to retain political power, which would promote change in these aspects of culture.

Economic Subsystem

This subsystem, which plays a central role in the model, consists of the economic decision structure and the variables associated with it (resource supply, resource demand, resource costs and risks, technology, socioeconomic organization, exchange, resource acquisition/production, and resource processing). Resource supply has already been treated as part of a separate nexus of variables, but it is also considered as participating in the economic subsystem as well. The interaction of resource supply and resource demand is the most powerful determinant of resource costs, although technology, task group organization, and settlement size and location also affect costs directly.

In developing this aspect of the model, several assumptions were made about: (1) economic goals; and (2) economic decision criteria. Because of the importance of these assumptions, they are discussed in detail in the following paragraphs. These assumptions properly apply to individuals, but, as is commonly done, are generalized to the whole system. In other words, economic goals are held by individuals, and decisions about how to allocate available means to meet these ends are also made by individuals. However, in the modeled system, we assume these goals and decision criteria are widely enough held as shared cultural norms that they can be considered in aggregate as properties of the system. This can be a dangerous assumption, because even in a relatively egalitarian, undifferentiated social and economic system, it is probably unlikely that individuals, roles, groups, and communities had identical economic norms. With the development of economic or political status differentiation, almost certainly differences among statuses or groups in economic goals and in access to economic resources, goods, or services would exist. In any case, the assumption of
identity can allow us to model responses expected under such a condition; disparities seen in actual findings may allow us to identify differences in economic behavior that may reflect different economic norms among communities or other social segments.

The goals of the economic subsystem are assumed to be the provision of enough cultural material (i.e., food, fuel, clothing, tools, and shelter) to meet predetermined needs. It is assumed land is not a commodity; hence, access to land is subsumed under settlement pattern as a component of the socioeconomic organization.

This assumption of a "satisficer" criterion in the decision-making process (Jochim 1976:6-7; Earle 1980:16) seems appropriate for a relatively undifferentiated society. Maximization as a goal appears to be likely only where economic differentiation and exchange are highly enough developed so that individuals or groups can turn surpluses into goods they did not themselves produce, and hence can raise their standard of living significantly. Upham et al. (1981) and Lightfoot and Feinman (1982) argue from several Southwestern cases that certain individuals or groups were involved in the differential accumulation of wealth as a means of enhancing status, political power, and undoubtedly, economic security. In their example, however, differentials seem quite small, and certainly are so by comparison with truly complex societies. In modeling, the satisficing assumption is used to develop expectations; its adoption does not preclude our finding evidence for economic maximization at some times or in some areas of Dolores Anasazi economics.

Under the satisficing assumption, then, demand for cultural material and hence for resources from the environment is presumed to spring from: (1) population size – the needs of the populace for adequate food, fuel, clothing, and shelter; (2) technology – the needs for tools and facilities to obtain and process food and fuel, and to make other material culture items; and (3) social organization – the requirements of the social and ideological systems for items associated with differentiation, for ritual paraphernalia, and for facilities used for ritual or sociopolitical activities (above and beyond those used for basic housing and storage needs).

Demand can be estimated with aid from the archaeological record, population estimates, environmental reconstructions, and ethnographic analogy. The satisficing assumption implies the general level of use should indicate the general level of demand.

The archaeological record can often provide us with a relatively good list of what resource materials were actually used for food, fuel, material culture, and facilities by the prehistoric inhabitants. Environmental reconstructions and specific ethnographic analogy (from groups occupying closely similar environments) can help fill out the list of what resources were probably used. Estimation of amounts of resources used is more difficult. For imperishable materials (e.g., stone for building and for tools), the archaeological record may provide fairly direct measurements of total actual amounts used (though in calculating demand at any particular time for a given population size, allowance needs to be made for longevity of use and for reuse). For other materials, relative frequencies of use can sometimes be estimated for a series of resources having similar contexts of discard and deposition (e.g., animal bones in trash, charcoal in firepits). For broad classes of resources (e.g., plant foods, animal foods, fuel, wood for building), level of demand can be estimated from ethnographic analogy and from clues in the archaeological record. Proportional demand or desired resource mix can be estimated with the aid of uniform marginal cost analysis (refer to following discussion and to Earle 1980; Christenson 1980, 1981; Hastorf 1980), using the aforementioned list of "culturally acceptable" resources in conjunction with estimates of level of supply (from environmental reconstructions) and level of demand (from estimates of per capita demand and of population size).

The satisficing assumption does not mean that per capita demand for cultural materiel cannot change from time to time or differ from place to place. Rather, it implies that change does not come from a goal of economic maximization per se, but must be explained in a larger systemic context. For example, additional demand for raw materials for manufacture of tools or storage facilities might be engendered by intensification of agriculture in response to increasing costs or risks of farming. Additional demand for ritual paraphernalia or facilities might be generated by increased ceremonial activities, in turn related to agricultural intensification, to resolving stresses generated by higher population density, or to the use of ritual to validate increased status for powerful individuals or groups. Competition among individuals, groups, or societies for status and influence might also generate increased demand for goods to be used in "conspicuous consumption" or to be distributed at festivals designated to recruit supporters. General increases in standard of living and hence demand for resources might also follow technological changes resulting in either increased efficiency in production of food or material culture, or in increased productive capacity per capita or per unit of land.

Decisions about how to apply available means to meet economic goals are assumed to have generally followed a least cost or minimization of effort course (Earle 1980:14; Athens 1977:362) consistent with fulfilling
predetermined demand for resources and material. This strategy is characterized by Christenson (1982:424) as “minimization of input, with a constraint on output.” In our model, cost is equated with labor, which is measured or estimated as time expended (Earle 1980:6). Actual energy expenditure would be more appropriate but much more difficult to measure or estimate, except as a conversion from time. Like the others, the least cost assumption is admittedly unrealistic, because the embedding of economic activities in larger social patterns in simple societies is well documented (Polanyi 1957). Nevertheless, the assumption can provide the basis for developing some expectations as to economic behavior, and other possible assumptions are equally if not more unrealistic.

It is also assumed culturally defined economic goals are general enough that several resources can potentially be substituted for one another in meeting these goals. Within a category such as subsistence, the goal will be to obtain adequate calories and nutrients, and a range of food resources will be considered culturally acceptable for meeting the goal. Consequently, different combinations of resources can potentially be used to satisfy the need. What foods were actually on the “culturally approved” list can be estimated from archaeological remains, and reconstructions of past environments can provide information on what was likely to have been available for selection.

The substitutability of resources within general domains (e.g., subsistence, fuel and building timbers, raw materials for stone tools, raw materials for ceramics) makes possible the further assumption that within a general class of resources, least cost decisions as to desired resource mixes can be modeled with the aid of marginal cost theory (Earle 1980; Christenson 1980, 1981). It can be assumed that a mix of resources was chosen so as to obtain the lowest possible uniform marginal cost of exploitation for the aggregate of resources. Marginal cost is the cost of obtaining the last unit of a resource, “the increase in total production cost (input) when output is increased by one unit” (Christenson 1982:421). Under this assumption, low cost resources are exploited until their marginal cost rises to equal the initial cost of exploiting the next most expensive resource, at which time the latter is added to the resource mix. The result is a resource mix in which the marginal costs of each resource used will be more or less equal or uniform across the aggregate of resources exploited to meet the demand for calories, building material, and so forth.

This set of assumptions places emphasis on estimating, in at least a rough way, the costs of obtaining resources from the environment to provide sufficient cultural material to meet economic demands, as set by predetermined economic goals. Changes in resource costs can have important effects on the whole sociocultural system through the effects they exert on the socioeconomic subsystem. As demand for resources rises in a given area, the per unit costs of obtaining them can be expected to increase, leading ultimately to the adoption of intensified strategies of resource procurement or production to satisfy demand. This may promote the development or adoption of new technology or new forms of social organization (cf. Earle 1980; Christenson 1980; Athens 1977).

Related to the least cost assumption is the assumption that, to the extent feasible, risk is also to be minimized in meeting economic goals. Risk can be defined as the probability that output from a given economic strategy will be insufficient (Christenson 1982:422-423). Risk derives from variability in the supply of natural resources and in the reliability of various techniques for obtaining these resources. In the Dolores case, the risks most important to the economic system were probably those associated with variability in farming success related to variability in local climate. In these terms, risk can be considered the probability that the caloric needs of a given group of people (ranging from a household to the population of the Dolores area, depending on the level of analysis being undertaken) will not be met by a given agricultural strategy.

As risks rise, farmers can be expected increasingly to employ buffering responses, such as planting increased acreage, diversifying field locations, intensifying their use of the least risky parcels of land, building more storage facilities, increasing their dependence on wild foods, increasing their involvement in exchange networks, or moving to a different but lower risk area. Most of these alternatives would appear to increase subsistence costs. Furthermore, the magnitude of risk (probability of not being able to satisfy basic demand) and the effects of risk on the economic system may increase with increasing resource costs. When costs (labor inputs) are already high, the individual farmer or aggregate of farmers may simply be unable to marshal the time, technology, or organizational arrangements to respond effectively to a change in risk, particularly if this has been brought about by a rapid change in the magnitude or frequency (Jorde 1977) of the resource fluctuations. Consequently, the level of demand relative to supply has an effect on risks because of its effect on costs, and vice versa. A given climatic fluctuation may introduce greater risks if demand for agricultural or other products relative to supply is high than if demand is low.

As Christenson (1982) notes, the complexity of the relationships among risks, costs, and subsistence strategies make the concept of risk a difficult one to isolate.
and define operationally, and hence a difficult one to apply in economic modeling. He apparently prefers to treat assessment of risks as one of the factors contributing to determination of the target minimum (satisficing) level of resource output.

For example, if variability in yields per acre are high, more land will have to be planted to avoid risk than if variability is low. Also, higher cost resources may be substituted for lower cost ones if dependence on the former involves greater risk.

Our concern with risk is thus founded on the effects of resource supply fluctuation on basic subsistence demand. This also leads us to expect that the economic strategies for meeting a given level of demand might vary under differing conditions of fluctuation in resource supply. Under a high risk (high fluctuation) scenario, strategies incorporating storage, exchange, or diversification of field locations might be favored. Occasional surpluses would also be generated, which the system would have to discard.

Use of a feast cost and low risk assumption in the model does not imply that the actual costs of obtaining resources will always be low or that risks will never be high in a given sociocultural system. When a subsistence economy is intensified, when more resource units are extracted per unit of space (Turner and Doolittle 1978:297), the labor costs per unit of resource are likely to rise (Earle 1980), and to the extent that intensification requires concentration on one or a few of the most productive resources (Christenson 1980, 1981), the system may be placed in greater risk from environmental fluctuation. That is not to say, however, that the resource mix chosen and the technology and organization used will not be the lowest cost, lowest risk ones possible consonant with obtaining or producing the amount of food required to meet demand. Athens (1977) and Stuart and Gauthier (1981) show how attempts to reduce risk in seasonally variable environments by generating food surpluses for storage can lead to demand for more labor to increase production, which in turn can cause population to increase, resulting in a need for more intensification and a trajectory of growth in system size and complexity at the same time the subsistence resource mix is being simplified or niche width (Christenson 1980) reduced. Even in low risk environments, population growth due to other factors (e.g., immigration) could set in motion the same trajectory of intensification and system differentiation; so could other processes that strongly increase resource demand in the face of constraints on supply.

Modeling economic decisions in the fashion just described also provides a way to view economic intensification (or lack of it) as the product of rational and situationally expedient decision making over time, rather than as a long-range system goal, or as the inevitable result of improvements in tools, or of the introduction of cultigens. It also provides a mechanism to account for socioeconomic change without invoking Malthusian scenarios; the perception that resource costs are increasing or decreasing can be seen as the proximate cause of change; this avoids the unrealistic and mechanistic assumption that malnutrition, starvation, or the complete exhaustion of nonsubsistence resources had to occur before change would be forced to take place. This modeling perspective also avoids assuming fuzzily defined “insight” or “foresight” as mechanisms for triggering change and instead provides a clear, if idealized, model of change as a rational response to tangible factors in the economy.

The discussion of the economic subsystem so far has emphasized how the assumed decision structure can produce change in resource mixes and associated acquisition and processing behavior by differential allocation of means to ends in response to cost factors, but it has not considered other ways in which change could originate in or be affected by the economic subsystem. In addition to attempting to achieve least costs in the use of available means, the economic decision structure should favor the invention or adoption (i.e., through cultural borrowing) of means that: (1) decrease costs at a given level of output; or (2) that enable output to be increased beyond levels achievable through existing means; or (3) that enable output to be increased at a rate of cost increase slower than if existing means were used. Christenson (1981) suggests the first type of change, which increases overall efficiency in the system, may occur whether or not change in resource supply/demand relationships occurs. On the other hand, his discussion implies the second and third types of change may only be likely to occur when increasing demand requires increased output. In this type of situation, a change that enables output to increase may be developed or adopted, even if it results in some decrease in total efficiency (i.e., results in an increase in costs per unit output). Changes that can have these effects can be made either in technology or in socioeconomic arrangements.

Turning first to technology, this is a variable in which innovation or borrowing can clearly affect costs in the economic subsystem. As defined here, technology includes: (1) tools and facilities; (2) techniques for acquiring resource materials; (3) techniques for transforming them into cultural material; and (4) the technical information required to successfully use tools, facilities, and techniques to satisfy demand for cultural material. Some resource acquisition and processing (e.g., picking and eating raw fruit) does not require tools or facilities, but all resource acquisition and processing requires techniques and knowledge.
All 4 of these components of technology may be a source of technical change through innovation or borrowing. All 4 components of technology may have somewhat different functional interrelationships within the system and these differences may constrain the acceptance or integration of either a diffused or innovated technology. For example, the adoption of a storage technology may be affected if the new kinds of facilities required come into conflict with the existing allocation of space in a household cluster, this allocation being a function of social as well as economic factors. However, the degree to which a technological innovation or borrowing would help solve problems of economic costs or security would affect the likelihood of its overcoming resistance based on conflicts with existing functional relationships. It follows that if economic costs or risks are rising, the rate of trial and acceptance or the rate of technological borrowings or innovations should increase.

With respect to the socioeconomic area, the relationships of supply, demand, and costs can be profoundly affected by the structure of economic task groups, by settlement location, by settlement size, and by intrasystem exchange, both reciprocal and redistributive. Changes in any of these components may provide an effective response to economic needs to increase efficiency or to increase output. Furthermore, because these socioeconomic arrangements usually serve to solve social as well as economic problems, a change in response to social needs may have substantial effects on the economic system. For example, an increase in settlement size, if accomplished by aggregating small dispersed settlements, may substantially affect travel time to various resource loci and at the same time provide new opportunities for intracommunity exchange and for different structuring of task groups. Yet, the proximate cause of the aggregation may not have been these intended economic effects but may instead have been a response to intraregional and interregional hostilities or to problems of the social integration of the community. It is best to view the socioeconomic subsystem from the perspective of both the social and economic problems of the system as a whole.

**Social Subsystem**

The social subsystem of the model has at its core social organization; it also includes, and shares with the economic subsystem, the components that make up socioeconomic organization. The distinction between social organization on the one hand and socioeconomic organization on the other is heuristic rather than reflective of any "natural" separation. Because socioeconomic organization plays such an important role in this model and because the components included in this construct are likely to have relatively clear archaeological expression, this element of the model has received more detailed treatment than has social organization per se. Social organization as a whole is treated in terms of the abstract variables differentiation and integration. One of its parts — socioeconomic organization — is drawn out for treatment at a more concrete level of analysis.

Social organization is characterized along the dimensions of social differentiation and integration (Blau 1975). This conceptual structure is flexible enough to serve as framework for a number of kinds of measures of social complexity, and it is also compatible with a number of general theories of sociocultural change.

Differentiation, as the name implies, has to do with the division of society into differing parts — in this case, into roles and subgroups. These divisions have 2 main dimensions — horizontal and vertical (Tainter 1977:331). Horizontal differentiation refers to the numbers of roles and subgroups within a community or society. Proliferation of such divisions may be related to economic division of labor, to ethnic or associational memberships, to kinships or ceremonial structure, or to sociopolitical structures. Vertical differentiation has to do with the extent to which roles and subgroups can be ranked or arranged hierarchically in terms of their access to economic goods, to influence over individuals and groups, to ceremonial power or prerogatives, or to political authority. There is general agreement that change in social differentiation is one of the major processes of sociocultural change (Plog and Bates 1980:389-390). Aspects of social differentiation may be detected and measured with data from the archaeological record of a society in a number of ways; in particular, archaeologists have had success in recognizing differential status, as well as craft specialization and other forms of economic division of labor.

Integration has to do with mechanisms by which social cohesion is maintained, at whatever level, ranging from household through total society. To the extent that differentiation results in the appearance of roles and subgroups having goals different from one another, a potential is created for conflict or confusion. If a society, or a component social group within it, is to maintain a reasonable amount of internal order, or to take collective action, or to defend itself from outside threats, some mechanisms must exist to reinforce common concerns and values, to disseminate the information essential to the successful interaction of different social components, and to resolve conflicts. Such integrating mechanisms can range from informal methods for achieving consensus in small groups, to ceremonies that promulgate and reinforce integrative values and behavior, to formal political structures that allocate group decision-making authority and provide
for centralized conflict resolution and punishment of disruptive behavior.

Changes in social differentiation and integration can occur in response to changes in the economic sector, either because they affect socioeconomic arrangements such as settlement pattern or because of changes in economic security for particular groups or the society as a whole. In the latter case, if the economic system does not adequately buffer the effects of variability in resource supply, the decline in economic security may engender a number of stresses because of increased frequency of physical deprivation, uncertainty over future economic well-being, and trials of new behavior patterns. Such a situation should promote the development of more effective integrative mechanisms, as well as select for successful responses to these problems in the strictly economic sphere.

Another major source of change in social organization is change in population density, especially as it is expressed in the number and size of settlements in the region. As population density increases, the potential for role and intergroup conflict increases, leading to a need for stronger integrative structures; to the extent that these employ ceremonial or political specialists, this process also can contribute to further differentiation, as can the failure of integration and the onset of intergroup feuding or warfare.

Interregional relationships, including warfare, intermarriage, alliances, and external trade, can also affect the complexity of the social organization. Warfare may lead to the development of warrior and war chief roles, or the promotion of these roles to higher levels of status or authority. External trade may provide individuals or groups with a route by which they may escape economic insecurity, and in so doing become differentiated from the food-producing, essentially self-sufficient majority.

Whether change in social differentiation and integration can occur as independent developments (from causes lying within the social organization itself) is an open question; this possibility is certainly not ruled out in the model. The more complex the society becomes, the more likely contradictions in the goals of component roles and subgroups will be a source of stresses that can lead to the development of new integrative forms or to further social differentiation. Furthermore, as Flannery (1972) has pointed out, if a role or subgroup is promoted in status to solve a problem, that component will tend to attempt to maintain its status even when the problem has been solved.

Lightfoot (1984) argues that a simple leadership/management hierarchy can develop even in very simple societies as a response to any of a variety of factors that increase the amount of information that must be processed in the society and that create conditions where the adoption of a reliable decision-making mechanism gives the society a selective advantage. These triggering or forcing factors can include population increase, sedentarism, localized highly productive subsistence resources, warfare, social or environmental circumstance, or dependence on exchange. Once leadership is established, a tendency for vertical status differentiation to increase will be promoted by a feedback cycle based on differential advantages that accrue to leaders. In an attempt to maintain or increase their standard of living, access to ceremonial and social perquisites, and so forth, leaders may accumulate and distribute economic surpluses, increase local population by recruiting followers, and initiate interregional exchange to acquire valued goods for redistribution. These processes themselves, in addition to competition engendered among aspiring leaders or between communities, create demands for additional centralized decision making and management and hence promote increased further vertical differentiation. To the extent that communities or societies having greater sociopolitical development can grow at the expense of less-developed societies, or are more effective at meeting external or internal threats to their continued integration, sociopolitical development has a selective advantage. Lightfoot (1984) points out, however, that operation of this developmental cycle often runs counter to "leveling devices" designed to counter status differentiation, and that it may create societal instability by overburdening some subgroups or by promoting overexploitation of resources. Consequently, sociopolitical development is often truncated before it results in major structural transformations of society.

Whatever their source, changes in social organization can result in additional constraints or demands being placed on other aspects of the system. For example, if defensive needs or the formation of larger cooperative work groups or increased intracommunity exchange lead to the formation of larger settlements, some of the costs of resource acquisition may increase because individuals will be residing farther from resource loci. This may have an effect on factors such as resource mix and storage technology which, in turn, might have still other effects on the organization of economic task groups.

In another familiar example, intensification of the subsistence economy, particularly if accomplished by higher labor inputs, may promote an increased or increasingly clear cut division of labor and the development of essential managerial roles even in the presence of strong social or cultural constraints on the development of vertical differentiation. These changes may generate demands for additional cultural materiel to be
used in signifying or validating new statuses, in providing facilities, equipment, or goods to be used by integrative activities or institutions needed to counter the effects of increased differentiation; and in providing goods and equipment for managerial or other integrative specialists no longer producing these items themselves. In addition, as specialization increases, and acquisition of cultural material no longer depends largely on one’s own household production, a situation is created in which individuals or groups may improve their standard of living either by producing more of their particular speciality for exchange for a variety of other desired items or by gaining influence or control over the surplus production of others. All of these results lead to increased demands on the economy for the production of cultural material, which in turn may lead to further differentiation of society.

Summary of Variables

In the following section, each of the terms used in figure 6.1 is defined and its role in the model briefly indicated. These definitions and relationships are discussed more fully in the preceding text; this section is intended as a compact reference aid. The model’s variables, or factors, are grouped in several categories, in accord with the relationships discussed under “Sources of Systemic Change in the General Model.” The interareal relationships previously discussed are presented here along with the group of variables with which each is most closely related. An attempt is made to relate these general variables to the Dolores area, the subject of this investigation.

Resource Supply Variables

Resource supply. – Resource supply is determined by the quantities and kinds of resource materials obtainable from the environment. Resource supply is affected by the rates at which supply decreases with use and by the edaphic, biologic, and geological properties of the area, which may vary with climate and the effects of resource use. Resource supply and demand are the major variables affecting resource costs.

Regional climate. – Factors such as temperature and precipitation in the region, including seasonal, interannual, and long-term variability. In the Four Corners region of the Southwest, these types of variability affect the relative attractiveness of various areas, e.g., the Dolores area versus the Montezuma Valley versus the Durango area, for settlement or resource acquisition.

Local climate. – In the Dolores area, the most important components of local climate are temperature, precipitation, and patterns of cold air pooling and drainage. Diurnal, seasonal, interannual, and longterm variability of these factors must all be considered. In conjunction with other local environmental factors (e.g., geological properties such as elevation, exposure, slope; edaphic properties such as soil type), local climate affects relative resource potentials of loci within the Dolores area.

Edaphic/biologic properties of area. – Types and distributions of soils, plants, and animals within the Dolores area, with emphasis on the resource potential of these for farming, subsistence hunting and gathering, and acquisition of fuel and resources for material culture and facilities. Edaphic/biologic properties are affected by changes in local climate, by geologic variables including rates of geomorphic processes, and by the direct and indirect effects of human resource use (e.g., depletion, succession initiated by land clearing).

Geologic properties of area. – Bedrock and surficial deposits, physiography, ongoing geomorphic processes—principally erosion and sediment deposition. These properties directly determine supply of resources such as stone for tools and building, and clay and temper for pottery. They indirectly affect edaphic/biologic properties through relationships of the latter to factors such as elevation, slope, exposure, and substrate. In theory, geologic resource materials are subject to depletion; in actuality, most of the geologic raw materials used by prehistoric Dolores area inhabitants occur in quantities large enough so as to be inexhaustible.

Environmental effects of resource use. – Response of the edaphic, biologic, and geologic properties of the area to the direct and indirect effects of growing and collecting plants, hunting animals, and collecting geologic materials. The results of these activities may consist not only of depletion, but of changes in biotic communities or in soil characteristics in the wake of land clearance and timber harvesting.

Population Factors

Population size. – The number of people in the Dolores area at any given time. Changes in population size are determined by intrinsic rates of increase or decrease, as well as by rates of immigration and emigration. Affecting intrinsic rates is the population’s state of nutrition and health, which is related to the ability of the economy to provide adequate food, fuel, material culture, and facilities. The economic system’s demand for labor, especially for child labor, may also affect rates of population growth. Social differentiation may also have an effect on population size by providing additional roles; increased differentiation may create demands for more people to keep these roles filled. Development of leadership statuses having prospects for upward mobility may promote population growth
through recruitment of followers, especially if competition develops among factions, communities, or societies. Recruitment may include promoting intrinsic increase for a group, as well as encouraging immigration. Population size is an important determinant of demand for cultural materiel, which determines demand for resources.

Population density. Population size is related, by definition, to population density; density affects the frequency of interpersonal and intergroup contacts and hence affects social organization. By ordering social relations, social organization also affects the population density that can be sustained in an area. Because agriculturalists spend most of their time in settlements, size and number of settlements in a region are important aspects of population density with respect to social organization. As population density increases, patterns of land tenure and access may also have major effects on social organization.

Immigration and emigration. These factors are defined as the rates of movement into and out of the Dolores area. These rates are affected by conditions in the Dolores area relative to those in adjacent and nearby areas. Conditions thought to be relevant to decisions to emigrate/immigrate include relative economic potential, relative population size, and relative degree of social integration and differentiation in the current versus the considered area. Previous interareal social relationships (or lack of same) established through trade, intermarriage, and ceremonial affiliations, are probably also relevant.

Nutrition and health. These factors determine the state of physical well-being of the population and are affected by the ability of the economy to provide adequate food, fuel, tools, clothing, and shelter. If nutrition and health fall below minimal levels, it will cause the population to decline, may contribute to the level of stress in society and hence affect social organization, and may contribute to decisions to move to another area, as well as to intrasystem economic change.

Economic Variables

Resource supply. (Refer to discussion of resource supply variables).

Resource demand. System requirements for raw materials from the environment are generated by demand for cultural materiel. Resource demand is one of the factors contributing to the determination of economic costs.

Economic costs. This variable is determined by the costs (in person-days or person-hours, as a substitute for actual energy expenditures) of obtaining resource materials and producing cultural materiel. It includes not only the direct costs of acquiring resources, but the costs of making and maintaining tools and facilities needed to obtain and store resources; costs of learning and transmitting economic and technical information and techniques; and costs of organizing and maintaining economic task groups and managerial personnel. Consequently, the main contributors to economic costs, in addition to resource supply and demand, are technology and socioeconomic organization.

Resource risks. Risk can be defined as the probability that output from a given resource acquisition/production strategy will be insufficient to meet basic demand. Risk derives from variability through time and space in the supply of resources and, to a lesser extent, from variability in various techniques for obtaining these resources. Risk is related to costs in that the ability to meet demand in the face of a drop in supply may be more difficult if costs of obtaining needed resources are high than if they are low. The necessity to buffer risks may also require use of higher cost resources or organization than if average resource yields could always be relied upon.

Economic decisions. This variable includes decisions about how much of what resources to acquire and process into cultural materiel, with what technology and what economic task groups. The model assumes decisions are made to select least cost alternatives after considering marginal costs of required acquisition or production and that, for a given producing unit, the goals of production are sufficient supplies of desired cultural material, rather than maximal production of goods to provide "buying power." Underlying these assumptions about economic goals are the expectations that aspirations for a rising standard of living are limited to a considerable degree by weakly developed social differentiation and convertibility of goods and services, and hence by the absence of pervasive use of markets or barter.

Resource acquisition/production. These variables involve the total amounts of resources acquired (as in hunting and gathering) or produced (as in agriculture or husbandry), as well as the proportional mix of these resources. It is assumed economic decision making of the sort just described will cause the proportional mix of resources chosen to vary in response to variation in resource costs. In the absence of extensive exchange, substitution of resources can occur only within resource categories (e.g., plant foods, animal foods, fuels and building timbers, source materials for stone tools) that permit functional needs to be satisfied in a variety of ways (e.g., corn [Zeae may] to take the place of wild seeds as a nutrient source, juniper [Juniperus sp.] to
take the place of Douglas-fir \([\text{Pseudotsuga menziesii}]\) as building material.

**Resource processing.** - Processing activities are needed to transform acquired or produced resource materials into cultural materiel. Some resource processing will require the organization of economic task groups, and much of it will require the use of tools or facilities, as well as techniques. Some resource material (e.g., fuel wood, some foods) may receive little or no processing before use; the act of producing or acquiring is sufficient to transform it into cultural materiel.

**Technology.** - This variable is represented by the tools, facilities, and techniques used to acquire and process resource materials into cultural materiel. Not all resource acquisition, production, and processing requires tools or facilities, but all require techniques. The costs of technology include the costs of obtaining materials for tools and facilities, making and maintaining these, and learning techniques. Technological costs are considered part of the resource costs of the system.

**Socioeconomic organization.** - Those aspects of social organization most directly related to the economy comprise this variable. For the purpose of this model, the components of socioeconomic organization are considered to be economic task group organization, intrasystem exchange, settlement size, and settlement location. The specific form of all these components is constrained by the organizational requirements of resolving social as well as economic problems. Settlement location is a function of social needs to facilitate interaction among social groups, as well as of the need to minimize costs of acquiring resources and of distributing cultural materiel. Socioeconomic organization is affected by economic decisions, and contributes to economic decisions through its effects on resource costs. As part of the total social organization, socioeconomic organization helps generate demands for cultural materiel that go beyond the amounts needed to maintain the population’s minimum biological wellbeing.

**Cultural materiel.** - Food, fuel, material culture (e.g., clothing, containers, tools, ornaments), and facilities (e.g., houses, storage structures, community assembly structures) comprise the cultural materiel required by the system. The demand for cultural materiel generates demand for resources from the environment; the economy obtains resources and converts them into cultural materiel. In any adapted system, enough food, fuel, equipment, and facilities must be provided to ensure the population’s biological survival and continuance; consequently, population size can be seen as setting a minimum level of demand for cultural materiel.

In all human societies, however, some demands that go beyond this abstract minimum are satisfied, and in some, the demand for and supply of cultural materiel goes far beyond the minimum. This permits an increased standard of living for some groups in the society, the support of an “overhead” level of personnel not involved with producing basic items such as food and fuel, and the widespread use of cultural materiel to signify social and ideological arrangements.

The evolution of rising demand for and supply of cultural materiel appears to involve complex relationships among adaptive success, social differentiation and integration, and exchange. For example, economic differentiation and the development of exchange in widely substitutable goods and services (with money providing the extreme example of a substitutable item) permits individuals and groups to increase their standard and security of living by producing more of particular goods and services and then exchanging them for a variety of other goods and services. Without specialization and exchange, their ability to increase their own standard of living would be less because they would have to satisfy their full range of demands by their own production.

**Social Variables**

**Social organization.** - Although socioeconomic organization is treated in more detail elsewhere in the model, social organization as a whole can be viewed abstractly along the dimensions of differentiation and integration. Horizontal differentiation refers to the numbers and kinds of social roles and groups present in the society; vertical differentiation refers to the extent to which these components can be ranked in terms of social privilege or access to economic, political, or ceremonial power. Integration refers to mechanisms by which interpersonal or intergroup conflicts are avoided or resolved, by which collective action is achieved, and by which a generally orderly working of social relations is maintained. Increased differentiation (and hence increased demand for integration) is thought to be promoted by economic intensification, including increased division of labor and the rise of economic managers; by increased population density, which increases opportunities for interrole and intergroup conflict and hence favors the emergence of integrative specialists; by increased immigration or exogamy, if this increases ethnic diversity within the society; by increased exchange, to the extent that this favors the emergence of specialists and the signification of social differences; and by some kinds of intersystem relationships, especially warfare. Any of these stresses may also trigger a feedback cycle by promoting establishment of leadership statuses. An emerging leader, in seeking to maintain or promote a privileged status, may engage in
activities that favor further status differentiation. Socioeconomic organization is, of course, a part of social organization but has been distinguished as a separate component in the model because of its role in the economy, its importance in the model, and the likelihood that it will have a greater archaeological expression than will some other aspects of social organization.

Intersystem exchange. – This factor is related to the economic system as well as to the social system because it involves the acquisition or disposition of cultural material. In systems of the sort modeled here, foreign exchange may in part or even largely result from demand for items used ceremonially (a probable relationship with social integration) or for use in symbolically validating ceremonial, economic, or political status or influence (a relationship with differentiation). Intersystem exchange may also serve more directly adaptive functions if it involves goods such as foods, tools, or raw materials (e.g., hides) that have clear economic as well as social significance. Intersystem exchange is likely also to function as a mediator and maintainer of intersystem social relationships such as trading partnerships, which can be called on for other purposes, e.g., when individuals or groups desire to travel outside their own territory, are seeking mates, wish to emigrate to a new area, or need food or other basic economic goods in times of adaptive stress. To the extent that the Dolores system was not a political entity and its boundaries were not clearly defined in prehistoric times, external trade is not likely to be sharply distinguished from internal exchange.

In any case, the greater the distances involved, the greater the cost of the exchange and the more likely it is that social rather than utilitarian economic relationships are emphasized in or signified by the exchange. The effect of external trade on social organization is probably proportional to its frequency and the amounts of goods involved. Because it involves more time per unit of goods moved, and has more logistic requirements than does most intrasystem exchange, foreign trade would appear to lend itself to being run by specialists if the amount and frequency of this exchange is high. On the other hand, low volumes of external exchange certainly would not require specialists; the extent to which exchange served to mediate other relationships would also militate against the development of specialization.

Intersystem interaction and warfare. – Movement to new areas by individuals, groups, or populations is a strategy often used to resolve adaptive or social problems. Individual and group travel outside home territories is also documented ethnographically for many groups, as is occasional recourse to neighboring villages or even other ethnic groups for provisions in times of adaptive stress. For these reasons, it is advantageous for individuals and communities to maintain knowledge of adjacent areas and relationships with their inhabitants. The role of exchange in such relationships has been discussed with the preceding variable; archaeological identification of external exchange may provide clues to these relationships, though not all are likely to have had exchange as a component. It also seems likely that feuding or warfare was a possible type of relationship among communities in adjacent areas, especially if population density was high over the whole region and resource supply was fluctuating. In the absence of well-developed polities, hostilities may have been most likely among adjacent settlements, whether or not they were inside or across area boundaries. In any case, warfare, if frequent, destructive, or sustained, is likely to have promoted differentiation of the role of warrior, and probably the aggregation of population. If defensive facilities were constructed, this would have placed additional demands on the economy. If war parties were large enough, or the threat to the whole group great enough, the status of war leaders would probably have increased, thereby amplifying the level of political integration during times of hostility and raising the possibility that such leaders would attempt to maintain their authority after the cessation of hostilities. Warfare may also have contributed to the elaboration of ritual and religious ideology, both because this could contribute to greater group integration and because hostilities would raise psychological stresses that ritual might be able to reduce.

OPERATIONALIZING THE MODEL: GENERAL CONSIDERATIONS

Two main problems, or groups of problems, occur with operationalizing any model of a sociocultural system. The first is how hypotheses or expectations about change and continuity are to be derived, given the multivariate, multirelational nature of the model. The second problem is how the model is to be linked with the archaeological record. What properties of the archaeological record represent the abstract variables modeled? What kinds of variation and covariation in the archaeological phenomena indicate significant variation and covariation in and among modeled variables?

The first problem is concerned with the ways in which expectations can be derived from the general model. How can we credibly predict the effects of changes in 1 variable on the states of other related variables? Even though the model is drastically simplified as compared with a real sociocultural system and its environmental context, the model nonetheless has many variables and many possible interrelationships. Therefore, the problem of equifinality (i.e., that the same result can be
produced in several ways, depending on complex chainings of interaction among the variables involved) is a large one. This obviously complicates the task of making predictions.

At least 4 ways of approaching the problem of deriving expectations are considered here. The first is the standard "linear" hypothesis—the "if...then" statement linking 2 or at least a few variables in an independent-dependent relationship. An example drawn from the model is "If resource demand increases, resource costs will rise." The model also tells us, however, that this should more properly be stated "If resource demand increases while resource supply, technology, and socioeconomic organization are held constant, resource costs will rise (provided supply is depleted under the level of increased demand that is anticipated)." Most, if not all, other examples that can be drawn from the model show the same characteristics—an any given variable can be affected by, and can affect, several others.

This suggests that testing a large number of simple, univariate hypotheses will be very cumbersome and may not provide satisfactory results. This leads us to a second alternative for deriving expectations for testing against the Dolores area data—a computer simulation that could incorporate all or at least many of the model's variables. Although in theory this appears to be the most appropriate way to approach the problem, in practice it poses a number of problems. The first is the lack of other comparable large simulations of whole sociocultural systems, using archaeological data to investigate continuity and change. Examples of this kind of project that could be fairly readily adapted to our needs are lacking; consequently, we would have to pioneer such a large-scale simulation. Furthermore, the immense demands on staff and computer time that this project would entail proved to be beyond the resources of the DAP, given the many other contractually required analyses and reports that had to be produced.

A third alternative is to investigate relationships among domains of related variables. At a DAP modeling seminar held in 1982 (Dean 1983; Lipe et al. 1983) change in 7 major domains of variables was targeted for explanation, and each was assigned to a working group. The variable domains chosen were population size and growth, settlement behavior, exchange, resource mix, technology, resource costs, and social organization viewed as social differentiation and integration. Each of the target groups of variables was to be considered as a dependent variable, and effects on it of the other variables (at least, those indicated by the general model as affecting the target variable) were to be examined. The intent, then, was to use the Dolores area data to arrive at conclusions about the directionality of causation, or at least, influence, among a set of variables considered in highly abstract form. Although some progress was made toward this goal, and these efforts are reflected in some of the presentations in chapters 7 through 15, the time and data demands of this project also proved too great in relation to the many other obligations of the DAP staff. Furthermore, some of the DAP staff involved in this work became concerned that the focus was on the variables, rather than on the Dolores case itself. In other words, the Dolores data was to be disarticulated to better understand the relationships among the variables specific in the general model. The alternative was to focus on the specific trajectory of the Dolores Anasazi sociocultural system through time, and to concentrate work on those variables and relationships that seemed most promising for providing a processual understanding of the systemic changes reflected in the Dolores archaeological record.

Consequently, a fourth approach was considered and eventually adopted. This was to select 2 contrastive weightings of key variables and relationships, and to incorporate these into 2 alternative processual models, each of which might account for the observed trajectory of the Dolores system. Then, the archaeological data could be used to evaluate the 2 specific (as opposed to general) models. The first model assumes as primary an economic system that has stable economic goals, and that articulates population, demand for material, and resources in a cost-efficient way. Sociopolitical development is seen as a necessary accompaniment to increased population density and to economic intensification brought about by resource supply-demand imbalances. Climatic variation is seen as creating interregional variations in agricultural productivity and risk that lead to immigration into the Dolores area at certain times, and emigration at others. The second model assumes that under any of a broad range of climatic, economic, and demographic conditions, social variables can become primary in bringing about change. Hence, even low initial levels of status differentiation may bring about competition among individuals or groups, and promote economic intensification, population growth, and sociopolitical development. These models are more fully described in the following section of this chapter, and contrastive expectations are developed for evaluation in chapters 7 through 15.

This fourth approach does not fully resolve the problem of equifinality, but does so better than the first approach suggested—that of attempting to test a large number of specific hypotheses, considered one at a time. This approach is feasible under the time and funding available, which the second, or simulation, approach was not, and it places the emphasis on explaining the Dolores system trajectory in terms of the...
interaction of selected variables, rather than the reverse, which characterized the third approach.

The second major problem of operationalization has to do with the relationships between the model, which is an abstract, simplified version of how a kind of sociocultural system is thought to work in general, and the archaeological record, which is composed of the debris and traces of specific acts of human behavior that took place in a specific sociocultural system. Most of this record has to do with the production, use, and discard of cultural material, including facilities; cultural material, of course, is only one of the many components of the model. The behaviors that produced the archaeological record can be linked to the abstract factors in the model only by chains of inference of varying lengths, but all of them long.

Furthermore, although the archaeological record was created in large part by past sociocultural behavior, it has been subject to geologic and other processes (including both prehistoric and recent human disturbance in some cases) that have removed portions of what was once there and that have altered spatial and quantitative relationships among what remains. We also know this record only from a sample of observations and collections, most of which have been made acquired with methods of field recording, specimen collection, and specimen analysis that represent our best guess in 1978-1979 as to what data would be most generally useful.

These problems appear large because our modeling effort is ambitious, but they are not different in kind from the problems faced by any archaeologist who wishes to make statements about past culture from the evidence he has obtained from the ground and from the objects he has collected. Yet an increasingly explicit awareness of these problems appears to have stimulated, rather than crushed, the efforts of archaeologists to make sense of the past.

To investigate some of the variables and relationships outlined in the general model, a number of studies of aspects of the Dolores area archaeological record were undertaken in 1982 through 1984. These supporting studies are reported in Petersen and Orcutt (1985) and Blinman et al. (1985). The studies attempted (with varying success) to take into consideration the problems of relevance of the archaeological data to the abstract variables, the problems of sampling and variance introduced by modes of data collection, as well as problems of loss and locational change from postdepositional transformations. More abstract consideration of problems of data relevancy and linking arguments are provided in chapters 7 through 15.

TWO SPECIFIC MODELS OF SOCIOCULTURAL CHANGE IN THE DOLORES AREA, A.D. 600-980

As described in the previous section, 2 narrower, more focused models of change have been developed from the general model. One views economic responses to population and resource imbalances as the driving force in change, and the other sees sociopolitical development as predominant. For convenience of reference, the 2 models are labeled “the economic model” and “the social model.” Of course, both areas are functionally interrelated; both economic and social factors are important in each model. The goal, however, is to construct the alternative models in such a way that the relative strength of the contrastive assumptions can be assessed. The approach is designed, therefore, to be a heuristic one that will help sort out the web of cause and effect present in an actual prehistoric sociocultural system.

Below, the basic assumptions and characteristics of each model are briefly described. Following this, some of the contrastive implications of each model that can potentially be examined in the archaeological record are discussed.

The Economic Model

The first model can be characterized as a least cost economic response model, hereafter referred to as the economic model (fig. 6.2). Its basic assumptions are that subsistence intensification and the development of leadership and management hierarchies are responses to economic stress brought on by imbalances between resource supply and population demand. The model also implies that if economic stress lessens or if constraints on lower cost options weaken, then the lower cost options will be pursued. These might include dispersal, subsistence “deintensification,” abandonment of expensive facilities, or rejection of managerial superstructures. The subsistence response portion of the model derives largely from work by Earle (1980) and Christenson (1980), while the assumptions about organizational responses overlap somewhat with Stuart and Gauthier’s (1981) notion of an “efficient” adaptation.

In this model, systemic change is promoted by population/resource imbalances brought on by an increase in population relative to population size. (Actually, resource demand is the critical factor, but because population is the primary source of resource demand in societies of the type treated here, population can be used directly.) Population increase may result from the movement of people into an area because of its low relative costs or risks, or it may occur as a result of in
Population Increase Or Resource Decrease → Stress From Rising Costs → Least Cost Response

1. Emigrate To Low Cost Area
2. If (1) Infeasible, Intensify Economy

Figure 6.2 - Economic model, part 1.

Situ population growth, which presumably would be enhanced by a period of low economic stress. A decrease in resource supply can be brought about by climatic change or by human activities that deplete resources and alter habitats. Increased risk due to greater variability in resource supply may have effects similar, though not identical, to those of decreased resource supply. The system will have to adapt to a greater frequency or magnitude of "bad years" and will have to increase buffering of seasonal or interannual shortfalls.

Given a relative increase in demand due to population increase, or to a decrease in resource supply, the economic model assumes that the population in question will seek a least cost solution to the imbalance. If adjacent areas have more favorable population/resource relationships, i.e., lower resources costs, then the favored or "least cost" solution may be movement. If movement is not economically attractive, or is constrained for sociopolitical reasons, the solution will be to intensify the local economy - to meet increased demand by extracting more resources from the local area. For the subsistence economy, this can be modeled with the aid of uniform marginal cost theory, as described by Earle and Christenson (1980).

In the Dolores area, and probably for the Four Corners area in general, subsistence intensification by Anasazi groups will ordinarily mean increased dependence on cultigens, often in combination with pioneer plants that grow in cultivated or abandoned fields (Shuster 1981). The marginal costs for increasing the output of such resources will ordinarily rise much more gradually than will costs for increased harvests of wild plants or animals from the same area.

Agricultural intensification promotes a number of other changes in the sociocultural system (fig. 6.3). Technological responses include greater investment in processing of subsistence resources for cooking and storage, as well as in construction of storage facilities. The tool and container assemblage therefore can be expected to show increased emphasis on production or on processing of cultigens, and on construction of storage and other facilities. Organizational responses to agricultural intensification include decreased mobility, increased interareal exchange, and greater scheduling and management of economic task groups. Assuming that population density also has increased, greater number of people in combination with agricultural intensification will promote greater regulation of access to land and perhaps to other key resources. This may contribute to community aggregation, which reduces conflicts due to overlapping of small catchments and facilitates land use regulation at a community or large kin group level.

These responses create conditions favorable for the growth of more effective leadership and management roles. In this situation, statuses are likely to be reinforced by increased ceremonial validation and by interregional trade in valuable items that serve as status indicators. These processes create an "overhead" cost that might seem incompatible with a "least cost" model. For example, aggregation increases costs by increasing travel time to fields and other resource locations, while the activities associated with maintaining leadership statuses also add costs. On the other hand, the alternatives are presumably even more costly crop failures due to poor scheduling or social conflicts due to increased population density and competition for land or other resources. The model does predict, however, that status elaboration will be minimal and will decline if economic stress and agricultural intensification decline. Even though sociopolitical development is promoted by ecological stress, the relatively low level of investment in this area may make the society vulnerable to adaptive failure in the face of major environmental problems or of competition from a more highly organized society.

The Social Model

The second model can be characterized as a sociopolitical development model, hereafter referred to as the social model (fig. 6.4). It proceeds from different assumptions and implies a different trajectory of change.
This model is derived largely from recent work by Lightfoot (1984) and has similarities to the "power" model proposed by Stuart and Gauthier (1981).

Lightfoot offers a model of sociopolitical development that has at its core a feedback cycle that can be initiated in even very simple societies once a simple decision-making hierarchy has emerged. Several conditions can select for such leadership development. These include population increase, sedentarism, warfare, and others. What these conditions have in common is that they increase the density of activities and information in the society and hence select for effective decision making as an alternative to inaction, confusion, or conflict.

Once a simple decision hierarchy appears, a feedback cycle is set in motion (fig. 6.5). To maintain or enhance their positions, leaders recruit followers, and as part of this effort may foster subsistence intensification and the amassing and distribution of surplus foodstuffs. Leadership statuses can also be validated by interregional trade in valuable items and by hosting or promoting certain ceremonies. Competition among potential leaders may intensify these developments. Overall, they lead to higher levels of population density, activity, and information flow, which in turn select for additional management and leadership. Furthermore, groups that successfully attract population and that have the organizational capacity to respond effectively to problems are likely to expand at the expense of neighboring groups. As regional population density increases, this is likely to promote intergroup competition that selects for further sociopolitical development within specific groups.

The model does not assume that societies exist in an economic vacuum, but that one of the results of leadership development is to create surpluses and to increase the flow of energy through the system. Consequently, these groups tend to be fairly well buffered against environmental variability. Nevertheless, because resources play an important role at several points in the feedback cycle (e.g., support of increased populations), the development process should be most
Development of Leadership/Management Hierarchy → Intercommunity Competition

Increased Selection For Leadership/Management

Feedback Cycle:
- Population Recruitment
- Surplus Accumulation
- Subsistence Intensification
- Regional Status Exchange
- Ceremonial Elaboration
- Intercommunity Competition

Figure 6.5 - Social model, part 2.

successful in times and places of relative resource abundance and stability. Groups with well-developed managerial hierarchies should also be able to respond effectively to environmental problems. Because of intragroup competition for leadership statuses, however, the hierarchy may be inherently unstable, and prolonged or severe economic problems may exacerbate weaknesses and lead to collapse of the relatively "expensive" superstructure.

Summary

In sum, both the economic and social models account for the development of agricultural intensification and managerial hierarchies, but to different degrees and by different pathways. In the following section, some of the contrasting implications of the 2 models are discussed. A number of these contrasts are only partial; for example, if aggregation precedes area-wide population increase and agricultural intensification, this lends support to the social model, but if aggregation accompanies population growth and intensification, it could result from either social or economic factors. The set of implications discussed in the following section should provide a basis for assessing the differential success of the models in accounting for Dolores Anasazi sociocultural change.

Implications of the Models

Population Distribution

The economic model implies that population should be distributed so that subsistence costs are similar over both the Dolores area and the larger Mesa Verde area of which it is a part. Population density should be higher in the more productive parts of the area and lower in the more marginal parts (figs. 6.6). Because agriculture appears to have been quantitatively the most important contributor to subsistence during the period of interest, it is assumed that relative agricultural productivity and costs will be a good predictor of relative population density across the area.

The social model implies that sociopolitical mechanisms are strong enough to generate surpluses and foster subsistence intensification within broad ranges of resource productivity. Within the zone of agricultural feasibility (referred to as "the dry-farming belt" by Peters in the environmental studies chapter of this volume [chap. 4]), relative population densities should have more to do with the success of communities in attracting followers and in absorbing competing settlements than with variations in the agricultural productivity of their catchments (fig. 6.6). For the region as a whole, there should be a great variability in economic costs, with the sociopolitically more developed centers having substantially higher subsistence costs because of their higher population densities, greater degree of aggregation, and higher rates of surplus accumulation and conversion.

Population Movement

Under both models, population movement should conform to the general principles of population distribution (fig. 6.7). The economic model predicts that
Population Distribution

<table>
<thead>
<tr>
<th>Economic Model</th>
<th>Social Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlates With Agricultural Productivity and Cost Variation</td>
<td>Within Agricultural Zone, Little Correlation With Agricultural Productivity Or Cost Variation</td>
</tr>
</tbody>
</table>

Figure 6.6 - Population distribution.

Population Movement

<table>
<thead>
<tr>
<th>Economic Model</th>
<th>Social Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immigration When Dolores Area Has Lower Costs Than Adjacent Areas</td>
<td>Immigration When Dolores Area Has Greater Sociopolitical Development Than Adjacent Areas</td>
</tr>
<tr>
<td>Emigration When Dolores Area Has Higher Costs/Risks Than Adjacent Areas</td>
<td>Emigration With Adaptive Or Sociopolitical Failure In Dolores Area, Or With Greater Sociopolitical Development In Adjacent Area</td>
</tr>
</tbody>
</table>

Figure 6.7 - Population movement.

Population movement should equalize the cost and risk differentials among areas - people should move from high cost or high risk areas to lower cost or lower risk areas - although some constraint on movement will be due to investment in facilities and in social relationships. The social model, on the other hand, indicates that within the general zone of adaptive feasibility, population movement should be from areas or communities having a lower degree of sociopolitical development to those having a higher degree. Because larger settlements ordinarily will have higher subsistence costs, this implies that movement will often be from low cost to high cost situations.

Settlement Pattern

Within a given area, the general characteristics of settlement pattern are predicted by the previously discussed principles. Under the economic model, community size should vary with catchment productivity, as should community spacing (fig. 6.8). Settlements and communities will be distributed so as to at least roughly even out subsistence costs over the area, with larger and more closely spaced communities in the more productive areas and smaller, less closely spaced communities in the more marginal areas. The social model, on the other hand, implies that within the zone suitable for agriculture, relative community sizes should fit a hierarchy determined by degree of sociopolitical development and that there should be regular spacing among communities that occupy central roles in competing sociopolitical systems (fig. 6.8).

Aggregation

Because aggregation generally increases the costs of subsistence by increasing travel time to fields and other resource locations, the economic model predicts the system will “attempt” to maintain a dispersed settlement pattern under most conditions of low population density (fig. 6.9). Exceptions might occur if several critical resources have spatially uncorrelated locations. With increasing population density, aggregation may be favored as a solution to conflicts created by catchment overlap and access to resources distant from the settlement. Aggregation may also be a component in systems of increased social control, and hence may be favored...
by the need for greater organization and conflict resolution fostered by increased population density, agricultural intensification, and high subsistence costs or risks. In the Dolores area, where both land and water are relatively abundant and widely distributed, we would expect the system to aggregate “reluctantly” and only in association with or following substantial increases in population, agricultural intensification, and economic costs and risks.

Under the social model, aggregation is an aspect of the successful development of leadership and recruitment of followers (fig. 6.9). Consequently, it may precede, or at least be uncorrelated with, the rate of population increase and the degree of agricultural intensification.

**Sociopolitical Development**

In both models, sociopolitical development should be expressed archaeologically by the development of settlement size hierarchies within the sphere of influence of a particular sociopolitical unit (fig. 6.10). Architectural differentiation should also demarcate ceremonial, administrative, or residential locations associated with leadership and management functions. Under the economic model, the expression of settlement hierarchies should be more influenced by local resource relationships than under the social model.

The economic model would also lead us to expect an ethic of egalitarianism would be maintained as long as possible even when some form of greater managerial control was adopted. This would be consistent with keeping “overhead” costs low and probably with maintenance of individual options to solve economic or social problems by relocating. Consequently, both settlement and architectural expressions of hierarchy should be more weakly expressed if the assumptions of the economic model apply rather than those of the social model. The economic model therefore implies that leaders would be likely to exercise control indirectly, perhaps through manipulating ceremonial sanctions, and that leaders might be expected to eschew higher standards of living and visible trappings of status.

The social model, on the other hand, implies the development of more direct and overt forms of leadership. If the assumptions of this model apply, administrative facilities are more likely to appear, and leaders would be more likely to possess large residences and to control exotic manufactured or imported goods. Another contrasting implication of the 2 models is that under the
Sociopolitical Development

<table>
<thead>
<tr>
<th>Economic Model</th>
<th>Social Model</th>
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<tbody>
<tr>
<td>Expressed In Community Size</td>
<td>Expressed In Community Size</td>
</tr>
<tr>
<td>Hierarchy And Intracommunity Architectural Differentiation</td>
<td>Hierarchy And Intracommunity Architectural Differentiation</td>
</tr>
<tr>
<td>Leadership Status Poorly Marked; Few Status Indicators</td>
<td>Leadership Status Well Marked; Abundant Status Indicators</td>
</tr>
<tr>
<td>Accompanies Or Follows Increased Population Density, Aggregation, Agricultural Intensification</td>
<td>Precedes Or Accompanies Increased Population Density, Aggregation, Agricultural Intensification</td>
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</table>

Figure 6.10 – Sociopolitical development.

economic model, archaeological expression of increased managerial hierarchy should accompany or follow increases in population density, aggregation, agricultural intensification, and economic costs and risks. However, the social model implies these expressions of sociopolitical development should precede or accompany the appearance of some of these factors. They might also be more strongly expressed in the absence of severe economic uncertainty or risk.

Agricultural Intensification

This refers to the use of agriculture to increase the output of food from a given area. Above rather low levels of demand, the costs of increasing food output by agriculture can be expected to rise less rapidly than the costs of increasing the exploitation of wild plants and animals. Consequently, as output continues to increase, agriculture should contribute an increasingly larger proportion of the diet. As the subsistence system’s marginal costs rise, however, additional types of wild plants and animals heretofore too “expensive” to exploit may be added to the subsistence mix. Therefore, the number of food sources used may increase, even though non-agricultural elements comprise an increasingly small proportion of the diet. Provision of essential nutrients and a desire for taste variety may also contribute to the maintenance of subsistence variety.

The economic model implies that agricultural intensification will correlate closely with both population change and with the costs of exploiting wild food sources (fig. 6.11). Agricultural intensification should also increase with aggregation because wild plant and animal sources should be rapidly depleted in the vicinity of large settlements. Intensified agriculture will ordinarily require increased management and scheduling and it may also promote aggregation to the extent that this is associated with development of a higher order of social control.

The social model implies that agricultural intensification will be undertaken as a way of developing a reliable surplus that can be controlled by leaders and as a way of supporting community growth (fig. 6.11). It should thus correlate with aggregation and with evidence of growth in leadership hierarchies. It will not necessarily correlate with regional population density or with the costs of wild foods.

Storage

Under the economic model, increased storage is to be expected as agriculture is intensified, so that the seasonal surplus can be distributed across other seasons (fig. 6.12). Increased storage can also serve to buffer climatic variability that affects crop production. Consequently, storage should increase in times or places of high agricultural risk or when costs vary substantially from one year to the next. Storage should be managed by agricultural production units (ordinarily households or small groups of households) and little variability in storage within or between communities should occur, except as predicted by the distribution of agricultural intensification and subsistence risk.

The social model implies that storage increase is associated with the creation of food surpluses for disposition by leaders (fig. 6.12). This can serve to increase buffering of climatic variability, but also plays a role in competition for followers among emerging leaders.
within a community or between communities. Consequently, storage volume should be greatest at the leading settlements within a sociopolitical sphere and should also be highest within the communities at residences, administrative facilities, or ceremonial facilities associated with leaders. Storage volume should not vary directly with the level of agricultural intensification and risks, and storage volume may actually be greatest in times of low costs and risks when abundant crops facilitate surplus accumulation.

Exchange

The economic model implies that exchange serves to even out variability in the distribution of useful commodities within and between regions (fig. 6.13). Furthermore, it functions to establish and maintain networks of social relationships adaptive because they play a role in providing mates and may furnish individuals or groups with economic support or even a place to resettle during times of hardship. If we also assume that egalitarian organization, or at least the appearance of egalitarianism, is low cost, then the economic model implies that exchange needs will be met largely by a network of trading partnerships manned by individuals at the same status or sociopolitical level. This should result in a relatively uniform distribution of exchanged goods within and among communities. It also implies that there will be relatively little traffic in exotic items for use as status markers and that these will be rare and not differentially distributed in the archaeological record.

The social model implies that exchange will be used as a path to leadership, so that both commodity and status exchange will tend to come under control of a leadership hierarchy or will be used by competing leaders (fig. 6.13). The model also implies that overt status differentiation is likely to emerge early in the process of sociopolitical development and hence that exotic items will be relatively abundant. It also implies that these should be differentially distributed in the archaeological record, possibly in high-status residences or in ceremonial contexts that function to enhance leadership. Such goods should certainly demarcate the burials of high-status individuals.
### Exchange

<table>
<thead>
<tr>
<th>Economic Model</th>
<th>Social Model</th>
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<tbody>
<tr>
<td>Varies With Agricultural Intensification And Sub-</td>
<td>Varies With Sociopolitical Development</td>
</tr>
<tr>
<td>subsistence Risks</td>
<td></td>
</tr>
<tr>
<td>Relatively Uniform Distribution Of Trade Items</td>
<td>Relatively Nonuniform Distribution Of Trade Items</td>
</tr>
<tr>
<td>Within and Among Communities</td>
<td>Within And Among Communities</td>
</tr>
<tr>
<td>Exotic Items Rare:</td>
<td>Exotic Items Abundant In Leadership Burials/Residences</td>
</tr>
<tr>
<td>Randomly Distributed</td>
<td>Or Ceremonial Contexts</td>
</tr>
<tr>
<td>Or Associated With</td>
<td></td>
</tr>
<tr>
<td>Ceremonial Contexts</td>
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Figure 6.13 – Exchange.

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