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THE STRUCTURE OF ARCHAEOLOGICAL THEORY

Michael B. Schiffer

Contradictory programmatic statements have increased uncertainty about the nature and roles of theory in archaeology. However, a framework can be constructed that ties together diverse kinds of theory that archaeologists use—and often create. Three overarching realms of theory can be recognized, each consisting of one or more functionally defined domains: social theory, reconstruction theory (the domains are material-culture dynamics and cultural and noncultural formation processes of the archaeological record), and methodological theory (the domains are recovery, analysis, and inference). Within each domain are high-level, mid-level, and low-level theories. Previous investigators often have overlooked the richness and complexity of archaeological theory, sometimes generalizing from a very narrow perspective.

Perhaps stimulated by Taylor's (1948) strident critique and building on the sporadic efforts of earlier decades (e.g., Steward and Setzler 1938; Rouse 1939; Krieger 1944), American archaeologists began consistently in the 1950s to recognize, make explicit, and contribute to the growth of various bodies of theory (e.g., Chang 1958; Ehrich 1950; Rouse 1955; South 1955; Spaulding 1960; Wauchope 1955; Willey and Phillips 1958). This heightened concern with theory, which had parallels abroad (e.g., Childe 1951, 1956; Clark 1952), became a preoccupation with the "new" archaeology of the 1960s and 1970s. By 1973 David Clarke could note the passing of the discipline's innocence, for it was becoming clear that everything archaeologists do is infused by theory (much of it, regrettably, still implicit). Interest in theory continues to this day but, along with concrete contributions, the recent literature is marked by programmatic statements, some seeking to establish new theory-based variants of archaeology (e.g., Hodder 1982a). These apparently contradictory pronouncements have raised doubts about the nature and roles of theory in archaeology. Indeed, if the discipline were to be assessed on the basis of these statements, the inescapable conclusion would be that its theoretical structure is in disarray (cf. Dunnell 1986a). In order to promote integration, the present paper fashions a framework for tying together the diverse kinds of theory that archaeologists use—and often create.

A paper that grapples with the overall structure of theory inevitably must take stands on certain contentious issues in the philosophy of archaeology (cf. Salmon 1982). It is doubtful that such issues can ever be resolved to everyone's satisfaction; I treat them here only to expose my biases, to present basic definitions used below, and to lay a foundation for this paper's treatment of theory in archaeology.

THEORY IN ARCHAEOLOGY: LEVELS AND HIERARCHIES

Definitions of Theory

"Theory" is used in several different senses in archaeology, and so must be carefully defined. In its least precise usage, theory is applied to a specific explanation of a particular past phenomenon. Although such explanations employ general principles, being tied to a given time and place they

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are not themselves nomothetic statements. Theories in this sense should be regarded as explanations, explanatory sketches, models, or hypotheses—not theories at all.

Theory also sometimes denotes an investigator's fundamental assumptions about the nature of human societies and culture. Assumptions at this level, which are very abstract, deeply held, and stubbornly incapable of empirical disproof, are also termed "paradigms" (as in Kuhn 1962; cf. Leone 1972; Martin 1971), "theoretical frameworks" (Binford 1965; Hill 1977:60), and "conceptual schemes" (Kluckhohn 1940; Taylor 1972). I prefer the latter term. Because they are so abstract, conceptual schemes cannot explain specific empirical phenomena (cf. Schiffer 1983a); explanations of the latter require theories (as defined below) and experimental laws.

I now turn to a final definition of theory, which is adopted here. Theory, according to many philosophers of science (e.g., Nagel 1961:85–98), consists of a series of basic premises, postulates, or assumptions that specify certain fundamental entities, processes, or mechanisms, often implicating phenomena that themselves are unobservable (at the time of theory formulation). For example, "atoms" and "molecules," key entities in several theories, were postulated long before they could be observed. Many processes invoked by archaeologists such as agricultural intensification and political centralization also are unobservable, not simply because they must be inferred for past societies but because they often occur over a span of time so long or on a spatial scale so great that direct human monitoring is precluded. Even in the present, one can observe only *aspects* of these processes or some of their effects. Theories do not invariably invoke the unobservable, but this is a common pattern. The main function of theories is to explain less comprehensive theories and laws. (In the present paper "principles" and "nomothetic statements" refer collectively to theories and laws.)

In mature sciences nomothetic statements form hierarchical structures, with a small number of high-level principles logically subsuming more abundant principles at lower levels. As one moves down levels, principles become less abstract, less comprehensive, and more empirical in content, and consequently are more easily tested. Although the boundaries between levels are arbitrary, this idealized structure calls attention to the need for middle- and lower-level principles to mediate between the most abstract theories and empirical reality.

Middle-Range Theory

In recent years some archaeologists have advocated the development of middle-level or middle-range theory. As Raab and Goodyear (1984) recount, the concept of middle-range theory derives from sociology, where Robert Merton argued the need to create principles for linking high-level, unifying theories with the low-level, empirical relations produced by most sociological studies. Middle-range theories, then, logically would be subsumed by high-level theories and, in turn, would subsume empirical regularities. This concept of middle-range theory was introduced into archaeology by Raab and Goodyear, first in an unpublished but widely circulated paper and subsequently in several articles (Goodyear et al. 1978; Raab and Goodyear 1984). Regrettably, Raab and Goodyear's application of Merton's middle-range theory to archaeology is in some ways problematic, a point to which I shall return.

In 1977 Binford adopted the term middle-range theory and identified its alleged lack as one of archaeology's most pressing problems. As Raab and Goodyear (1984) pointed out, however, Binford did not use "middle-range theory" in the same way that they (and Merton) had. For Binford, apparently, middle-range theory is the entire suite of principles that archaeologists employ to transform the static facts of the archaeological record into statements about the dynamics of past sociocultural systems (Binford 1977:6). That is, Binford's middle-range theory facilitates certain operations, allowing archaeologists to transform evidence into inference. Although Binford shows little concern for the logical relations between middle-range theory and other conceptual or empirical entities, he does call attention to the important principles that underlie (i.e., make possible) the archaeological research process (Schiffer n.d.).

It is tempting to chastise Binford for misusing sociological concepts, but that would beg a larger question: Can Merton's middle-range theory be applied literally to archaeology? My answer is no.

Perhaps a single hierarchy of logically related principles can be contemplated in sociology, but in archaeology such a structure is difficult to envision. I maintain that the principles of archaeology are so diverse that they never could be forced into a single hierarchy. For example, principles describing the activity of wood-rotting fungi, relevant for understanding the deterioration of structures and for interpreting certain radiocarbon dates (Schiffer 1986, 1987), are not subsumed by high-level theories of social change but by theories from biology. Unlike sociology, archaeology is the quintessential interdisciplinary discipline, incorporating varied home-grown theories as well as theories from nearly all other social and natural sciences. Indeed, the basic structure of archaeological theory is that of multiple and loosely coupled hierarchies. Although principles within each hierarchy cohere substantively and may be related logically, such connections largely are lacking between hierarchies. However, principles in different hierarchies are linked procedurally in the archaeological research process. For example, principles of wood use and principles of wood decay together facilitate certain chronological inferences (cf. Dean 1969; Schiffer 1982, 1986). If archaeological theory consists of an aggregate of many autonomous hierarchies of principles, then Merton's concept of middle-range theory cannot be applied literally to archaeology.

Raab and Goodyear (1984) appreciate that high-level social theories cannot subsume all other archaeological principles. To resolve this dilemma, they make the remarkable claim that only principles capable of explaining cultural behavior are real theory; all else (i.e., Binford's middle-range theory) is methodology]:

> some may believe that pursuit of methodological problems alone necessarily constitutes an exercise in building "theory." That belief is unwarranted if we mean by theory the conceptual devices by which we seek explanations of cultural behavior [Raab and Goodyear 1984:258].

Thus, at the same time that Raab and Goodyear accuse Binford of having a narrow conception of middle-range theory, they themselves advance a restrictive and unacceptable view of theory. This they accomplish by confusing the structure and function of theory. It is true that a theory can function as method, but that use makes it no less theory. Indeed, as noted below, any theory can function as method, depending on context.

Though problematic, the concept of middle-range or middle-level theory is used here. The position adopted is that each hierarchy of archaeological principles contains high-, middle-, and low-level theories. In conformity with the spirit of Merton's formulation, principles within each hierarchy can be related logically. A level of theory (high, middle, low), then, denotes a particular degree of abstraction within one hierarchy of related principles *or* an analogous degree of abstraction that crosscuts different hierarchies. Thus, we may regard evolutionary theory as high level and the theory of pedestrian tactic survey as middle or low level without implying that the former subsumes the latter. Because the study of archaeological theory is still in its infancy, the level to which a given theory belongs and its relations to other theories may not be easy to determine.

Theories and Experimental Laws

Theories are linked to the empirical world by low-level principles, sometimes called experimental laws (Nagel 1961). For example, the kinetic theory subsumes the gas laws of Charles and Boyle, which explain the gross behavior of gases. In this paper an experimental law is defined as a true generalization, having substantial empirical content, about the relation between entities and/or variables, which lacks temporal or spatial qualifiers (based on Nagel 1961:47–105; Salmon 1982: 8–30). Experimental laws provide proximate explanations for empirical phenomena and so are indispensable in routine scientific activity. In practice, it is difficult to differentiate experimental laws from low-level theories. The difference, at best, is one of degree—in complexity of statements, generality, and empirical content. For purposes of this paper, then, low-level theory and experimental law are not distinguished rigorously.

Because they describe empirical regularities or patterns, experimental laws, which can be universal or statistical, encode a certain truth about the world that persists in the face of changing theories or even in the absence of theories. Kuhn (1962), for example, recounts how the Newtonian laws of

motion survived the demise of Newtonian theory. Indeed, experimental laws can arise before or after development of an overarching theory. Examples of experimental laws not subsumed by explicit theory abound in archaeology, a condition that probably indicates our science's immaturity. However, such experimental laws are without full explanatory power. Theories, then, back up experimental laws by incorporating them into more comprehensive systems of understanding. By the same token, a theory cannot be regarded as fruitful unless it subsumes (ultimately) a family of experimental laws that articulate it with the real world.

In archaeology, some investigators promote theory building (e.g., Binford 1977, 1986), whereas others call for the discovery of experimental laws (e.g., Reid et al. 1975; Schiffer 1972a, 1975, 1976, 1987). Despite the sometimes combative rhetoric used by their proponents, these strategies are complementary; indeed, individual investigators can originate both kinds of principles. For example, in addition to his theory building Binford has established countless experimental laws (e.g., Binford 1978, 1981); likewise, I have worked on both experimental laws and theories (e.g., McGuire and Schiffer 1983; Schiffer 1979, 1987; Schiffer and Skibo 1987; Schiffer et al. 1978). These controversies may reflect nothing more than inconsequential stylistic differences in the ways archaeologists describe the research process and exhort their colleagues. In any event, a science progresses to the extent that there is growth in its corpus of well-founded general principles—both theories and experimental laws.

ARCHAEOLOGICAL THEORY: THE DYNAMIC PERSPECTIVE

To this point archaeological theory has been treated statically, from a philosophic standpoint. Although the logical structure of archaeological theory is important, of even greater significance is what theory does as a part of the archaeological research process; that is, the functions that various bodies of theory carry out. A number of recent efforts to systematize archaeological theory have adopted this functional-processual stance (e.g., Clarke 1973; Rathje and Schiffer 1982; Schiffer 1975, 1978, 1985; South 1977; Sullivan 1978) and laid a foundation for the framework that follows.

Archaeological theory consists of three great realms, each of which is made up of one or more domains. The three realms are social theory, reconstruction theory, and methodological theory. Social theory, which contains only one domain (at present), consists of principles for explaining behavioral variability and change. Reconstruction theory permits human behavior and environmental conditions of the past to be ascertained. This realm is made up of three domains: material-culture dynamics (correlates), cultural formation processes of the archaeological record (c-transforms), and noncultural processes contributing to the formation of the archaeological and environmental records (n-transforms). Finally, methodological theory encompasses principles used for obtaining and validating archaeological evidence. Methodological principles channel the choice of techniques and methods as well as guide employment of reconstruction theory. The methodological realm contains three domains: recovery, analysis, and inference. Figure 1 shows the realms and domains of archaeological theory in relation to various conceptions of middle-range theory.

Each domain is composed of families or hierarchies of principles. The discussions below stress principles central to each domain, but some mention is made of principles that serve importantly in more than one domain. In most domains, some theories are derived from or are closely linked to theories in other disciplines. These principles tend to be introduced by archaeologists borrowing new ideas to try out. "External relations" also are formed by multidisciplinary collaboration, such as that typified by zooarchaeology, paleoethnobotany, and geoarchaeology. The general nature of each domain's external relations is outlined below.

The following sections provide support for the general claims made above about the structure of archaeological theory. Discussions emphasize how each domain contains theories at various levels as well as its own network of external relations. Obviously, I cannot furnish a comprehensive survey of all archaeological theories; particular principles have been selected for their illustrative value.

SOCIAL THEORY

Social theories function, in the archaeological research process, to explain variability and change in human behavior. By behavior is meant human activity at any scale or level of abstraction, from

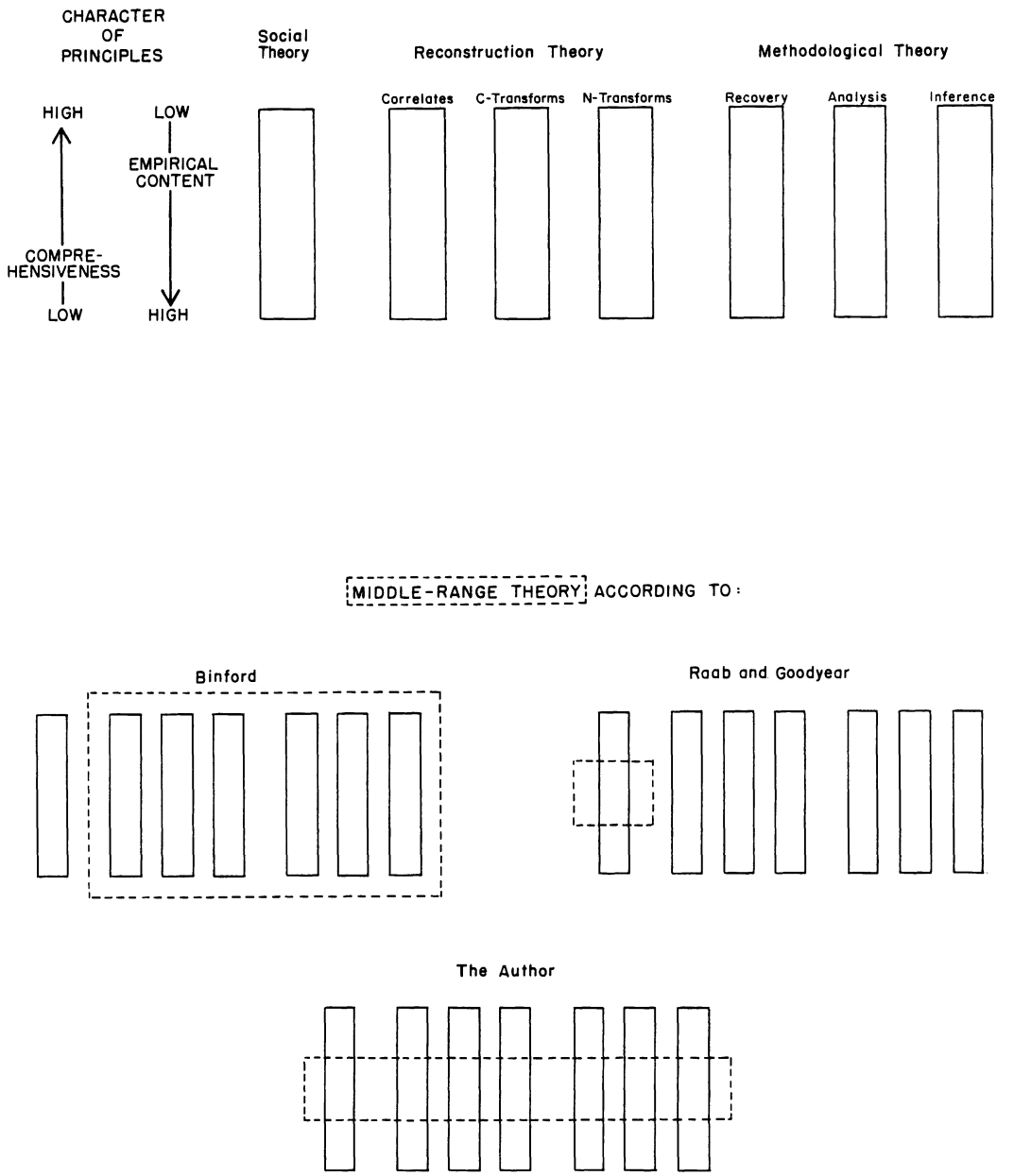

Figure 1. The realms and domains of archaeological theory in relation to various conceptions of middle-range theory.

the handiwork of a particular artisan to the rise and fall of complex societies. Except in experimental and ethnoarchaeological settings, social theory in archaeology mostly explains *reconstructed* behavior.

Lacking appropriate expertise, I have not formally divided social theory into domains. However, two domains are suggested tentatively: hunter–gatherers and complex societies (i.e., states). Both bodies of theory are studied intensively by specialists in archaeology and both have characteristic external relations. For example, insofar as settlement-subsistence behavior is concerned, hunter–

gatherer theory draws heavily on ecology whereas complex society theory derives among other sources from social history, information theory, and even anthropology. Theories applied to the many societies that fall between hunter–gatherers and states are quite diverse, ranging from cultural ecology (e.g., Braun and Plog 1982) to world systems theory (e.g., Upham 1982). The hope remains that the fragments of social theory we see today one day will be subsumed by a more comprehensive theory.

Between about 1920 and 1960, American archaeology did have one major social theory, diffusion theory, that encompassed all societies. Although now discredited, diffusion theory can illustrate the hierarchical structure of principles that once typified social theory. Basic principles of diffusion theory can be found in many works (e.g., Dixon 1928; Kroeber 1923).

Diffusion theory consists of three fundamental entities: culture, trait, and idea. A culture is the learned behavior of a group, and its characteristics (e.g., objects, belief system, marital-residence pattern) are traits. Each trait is the embodiment of a specific idea held by the culture-bearers. Cultures change (i.e., add or delete traits) in response to the flow of ideas. Three major mechanisms or processes—invention, diffusion, and migration—are responsible for originating and spreading ideas. Invention is the generation of a new idea; diffusion is the transfer of an idea from culture to culture; and migration is the transmission of an idea by the movement of its bearers.

Although diffusionists differed among themselves regarding inherent rates of invention, nearly all recognized vast differences in time and space in invention rates. Thus, a fundamental principle is that inventions tend to cluster in culture centers. Ideas originating in culture centers spread outward into surrounding areas, and so traits tend to exhibit contagious distributions. The age-area hypothesis postulates that ideas diffuse as a function of time: the longer the time elapsed since invention, the greater the spread.

Diffusionists tacked on to these basic entities and processes a number of low-level principles for interpreting specific trait distributions. For a diffusionist, explanation consisted of determining which mechanisms had been responsible for producing the traits encountered in a given archaeological culture. For example, some believed that simpler traits were more likely to be invented independently, and so diffusion or migration was not required to account for their distribution. The diffusion literature is filled with such low-level principles that, used as rules-of-thumb, permitted investigators to cope with trait variability. However, these "principles" have an ad hoc character and many were not widely shared—even by diffusionists. Failure to establish broadly acceptable middle- and low-level principles helped to undermine diffusion theory, as endless arguments proliferated over the mechanisms responsible for specific trait distributions (cf. Binford 1968).

A replacement for diffusion theory took shape in the 1950s and 1960s, based on the ecological and evolutionary ideas of Steward (1955) and White (1949), and still underlies most archaeological explanations. The fundamental principles can be found in many texts (e.g., Gibbon 1984; Thomas 1979; Willey and Sabloff 1980), and need not be repeated here.

The external relations of social theory are extensive and in constant flux as ideas are tried out from various sources. Archaeologists traditionally have borrowed social theory from other social and behavioral sciences. Although principles mostly came from anthropology, archaeologists began to obtain principles from other disciplines in the late 1960s, especially cultural geography (e.g., Clarke 1968); even the biological (e.g., Dunnell 1980; Keegan and Diamond 1987) and physical sciences now furnish principles. The episodic appearance of "new" social theories in the archaeological literature, often with poorly developed arguments for their applicability, gives the impression that archaeologists are prone to indulge in fads or jump on bandwagons. It could be argued that by flirting with foreign theories we avoid the arduous job of theory building at home. Although it is tempting to dismiss introductions of social theory on these grounds, the important point is that borrowings give us an opportunity to assess, firsthand, the fit between theories important in other disciplines and archaeological phenomena. Even if a theory fails miserably, the discussion and trials generated by its introduction leave archaeology intellectually enriched. I will examine a few recent introductions of social theory, laying stress on the attempt by some advocates to undermine the scientific basis of archaeology.

The newest major social theories in archaeology include symbolic structuralism and neo-Marxism.

The symbolic-structural program (Hodder 1982b, 1982c) mainly has focused on explaining stylistic (or purportedly stylistic) material culture phenomena. When symbolic-structural theory does venture into social theory, its positions mimic neo-Marxism. By neo-Marxist (see Renfrew 1982:11) is meant that congeries of Marxist ideas, filtered through French (and sometimes British) social anthropology and sociology, recently introduced into British and American archaeology (e.g., Friedman and Rowlands 1978; Miller and Tilley 1984a; Renfrew et al. 1982; Spriggs 1984). A more traditional Marxism also is found in archaeology, and has advocates in eastern Europe, China, and Latin America (e.g., Bate 1982; Lumbreras 1974), but I treat only neo-Marxism.

Although symbolic-structural archaeology and neo-Marxism (and the closely related critical theory—Leone et al. [1987]) have little influenced social theory in American archaeology thus far, these programs are of interest here because of the external relations that some adherents posit between social theory and the larger societal context of archaeology. I will examine critically one major claim, that society at large determines the substance of social theories. Indeed, some have proposed that social theory and its applications serve as ideology in the modern world: "history is always produced in the service of class interests" (Leone 1986:418). Patterson (1986), for one, has advanced a scenario of the recent history of American archaeology in which its practitioners respond to the interests of two power groups, the Eastern Establishment and the Core Culture. One need not accept Patterson's conspiratorial interpretations to appreciate that social theories are influenced by the society in which archaeologists work (Trigger 1986). Rathje and Schiffer (1982:302), for example, suggest that diffusionist theory became popular in archaeology at a time when evidence for the efficacy of its mechanisms was to be seen everywhere: the inventiveness of an industrial society providing a constant stream of new products, the spread of Western artifacts as colonial powers overwhelmed indigenous societies worldwide, and the reality of migration through the open gates at Ellis Island. In another example, Trigger (1981) argues that issues of concern to middle-class Americans during the 1970s were reflected in contemporaneous archaeological explanations, which often focused on population growth, environmental deterioration, and exhaustion of nonrenewable resources. Wilk (1985) explores such connections in the recent history of Maya archaeology.

In view of the linkages—ranging from tenuous to convincing—that can be established between a society and the explanations its archaeologists offer for behavioral variability and change, some investigators—mostly symbolic-structural archaeologists and neo-Marxists—have adopted positions that can only lead to an unproductive epistemological relativism (cf. Murray 1987:281). The extreme relativist argument reduces to the claim that because all theories and explanations are cultural products and there is no objective reality against which to test them, the precepts and procedures of science are inappropriate for archaeology. Miller and Tilley (1984b:151) have expressed this view:

> Both archaeological evidence and the theoretical statements made which attempt to give meaning to that evidence are social creations . . . the primary logical relationship between theory and data is a conceptual one. Statements about the past are not therefore ultimately to be judged by whether or not they can be tested, or by the outcomes of such tests, but in terms of . . . the internal coherence of any particular study, which can only be criticized in terms of internal conceptual relations and not in terms of externally imposed standards or criteria for "measuring" or "determining" truth or falsity.

However, in the absence of the ability to test or falsify knowledge claims, archaeologists would be reduced to creating interpretive scenarios of the past that would be equally worthwhile (or worthless). Worse still, investigators might consciously fashion stories to influence or constrain ideological applications of their works. The relativist position rests on a series of misunderstandings about how science functions and about the nature of the relations between science and society.

First of all, the relativists seem to believe that close relations between science and society are evil and inevitably produce bad theory. That society at large provides impetus to address certain explanatory issues rather than others is not unique to archaeology or even to the behavioral sciences. Scientific activity is inspired by intellectual curiosity, but just as often it is fostered—directly and indirectly—by technology or other practical concerns. The effects of navigation on astronomy, milk and fermented beverages on bacteriology, and aniline dyes on organic chemistry are well-worn examples. Should we throw out the germ theory of disease because its discovery and application

serve capitalist interests? Archaeology is no different in this respect than other sciences. When archaeologists examined ecological issues, beginning extensively in the 1960s—at a time when those issues had become important in American society—they simply were responding to the sorts of stimuli that always have motivated science. Put bluntly, society rewards those who address its significant problems with employment opportunities, grants, prizes, prestige, or merely publicity. Scientists do respond to these inducements and need not apologize for undertaking research of possible practical value. More importantly, the origin of a problem has no direct bearing on the scientific content or quality of research undertaken toward its solution.

A second questionable assumption implicit in relativist rhetoric is that the methods of science are incapable of producing progress in social theory. If one looks at social theory *over a long time frame,* however, it can be seen that archaeologists do reject theories. Traditional diffusion theory reigned during the first half of this century, but most archaeologists did dispense with it in the 1960s. Admittedly, the pace of fundamental change in social theory—especially at the highest levels—is slow. Nevertheless, archaeologists do winnow social theory over the long run, finding some ideas to be more or less productive than others. A cynic might suggest that the advocates of certain theories, which have not been adopted widely by archaeologists, are attempting—perhaps in frustration—to discredit the scientific process so trying their patience.

Another assumption at the core of relativist attacks is that the prehistoric world is seen only through cultural, theoretical filters; there is no objective reality (Shanks and Tilley 1987). In a trivial sense this assumption is true: Theory causes us to conceptualize the past in certain ways. Thus, we focus on some behavioral properties or variables and not on others. Once conceptualized, however, these variables take on a life of their own and can be combined with others in laws unanticipated by the framers of any social theory. For example, today it is ecological-evolutionary archaeologists who devote much effort to quantifying trade—a mechanism of diffusion.

There is no objective reality in another trivial sense: The past cannot be perceived directly at all, but is a product of the theory-laden operations of reconstruction. Fortunately, archaeologists holding different theories about social processes can apply the principles of reconstruction to arrive at some agreement on what happened in the past. Indeed, over the past century and a half, steady headway has been made in reconstructing the past and in discerning overarching patterns in prehistory. This network of inferences puts constraints—sometimes rigid ones—on theory building and is the constantly growing objective reality that theories must confront (cf. Harris 1968b). For example, hyperdiffusionist theories that posited the one-time origin of civilization could not be sustained in the face of accumulating inferences showing the independent development of complex societies in many places. Likewise, diffusionist theories for the advent of an agricultural lifeway, which assumed the inherent superiority of farming over hunting and gathering, have fallen into disfavor precisely because archaeologists have shown that many groups, including those in the American Southwest and Midwest, carried out only the most casual forms of agriculture, perhaps for millennia, before taking up the practice in earnest. In short, it sometimes is easy to forget that we do know a great deal about certain aspects of the past (though not as much as we would like). Thus, what we think we know at any one time serves as a touchstone for theory building in a way that the relativists cannot comprehend. To maintain a consistent stance, the extreme relativists would have to reject all purported knowledge of the past, and perhaps that will be their next ploy. The claim that there is no objective reality for testing theory in archaeology is nothing but pernicious dogma.

If all theories are equally valid by virtue of their creation, and if there is no objective reality for testing them, one might suppose that the extreme relativists would simply allow all theories to blossom and bear fruit. Yet, it is they who attempt most fervently to discredit other theories, using a variety of strategies including ponderous argument (e.g., Shanks and Tilley 1987). In the final analysis, however, theories might have to pass a litmus test: Good theory would be politically correct theory. No one has yet made this criterion explicit in archaeology—though Shanks and Tilley (1987) come close, but I suspect that it motivates arguments that ostensibly have other foci. For example, neo-Marxists are not noted advocates of middle-range theory building (e.g., see Braithwaite 1984: 94), perhaps because they do not wish to confront the inevitability of social stratification in complex societies. After all, that would undermine any program to build an egalitarian (and thus more "just")

society beyond capitalism. Ironically, without middle-range social theories, the societal engineering that some neo-Marxists would engage in is doomed to failure. More importantly, without such theories neo-Marxists can "explain" the events and processes of prehistory by establishing tenuous links between a small number of politically correct but ambiguous high-level principles and archaeological cases. This strategy is carried out in a hermetically sealed epistemology that avoids harsh confrontations with the real world. I am distressed by the prospect that some investigators, wishing to use archaeology as a means to further unspecified political ends, will subvert the scientific process.

Despite their epistemological flaws, symbolic-structural and neo-Marxist archaeologies offer many intriguing ideas that merit study and testing. For example, the multifarious functions of symbols and ideology—both advertising and concealing aspects of social reality—and the roles of conflict and competing interest groups in social change embody ideas essential for theory-building efforts.

This excursion into symbolic-structural, neo-Marxist, and critical archaeologies has helped to clarify the relations between social theory and the society within which archaeologists work. Some advocates of these archaeologies claim that other bodies of theory merely serve ideology in capitalist society, justifying the actions and furthering the interests of powerful groups. (Ironically, these investigators never examine critically the interests their own theories serve.) I suggest that the self-corrective action of the scientific process and the cumulative growth of sound inference will serve to check—in the long run—any insidious influences of society on the content of social theory and explanation (cf. Trigger 1978:95). In the short run, of course, archaeologists should question and test all potentially fruitful ideas, regardless of source; after all, theories used ideologically or yielding practical dividends still could be scientifically important.

RECONSTRUCTION THEORY

Reconstruction is the process of inferring aspects of the cultural and natural past by rigorously applying explicit principles to archaeological evidence. By reconstruction, I emphatically do not mean the creation of a complete "picture" of a past society at one point in time.

The term reconstruction is in many ways unfortunate, as Taylor (1948:35–36) noted long ago. But his objections to that term I regard as quibbling in semantic and philosophic contexts. A more profound challenge to reconstruction has come from Dunnell (1978) and Binford (1986) who claim that the reconstruction of past lifeways is neither a legitimate research process nor a worthy archaeological goal. As I noted elsewhere (Schiffer 1976), however, testing social theory against the archaeological record *presupposes the ability to infer behavioral phenomena of the past*; and that, unequivocally, is reconstruction.

Material-Culture Dynamics (Correlates)

Artifacts are the medium through which we come to know (through inference) the cultural past and they also furnish a unique focus for the discipline. Archaeology, for some, is the science of artifacts (Clarke 1968; Deetz 1970) or technology (Leone 1973). As the behavioral archaeologists put it, the irreducible core of archaeology is the effort to ascertain and explain the relations between human behavior and material culture in all times and all places (Berenguer 1985; Rathje and Schiffer 1982; Reid et al. 1975). The principles of material-culture dynamics are termed correlates (Binford 1968; Hill 1970; Schiffer 1975), and their discovery through ethnoarchaeology and comparative ethnography (and experimental archaeology) properly was given a high priority by the new archaeology.

For purposes of inference, material culture is regarded as reflexive: Artifacts, by virtue of their formal, spatial, quantitative, and relational properties, can serve as evidence for inferring particular past phenomena. On the other hand, because artifacts are an integral part of nearly every specific behavior and social process, an understanding of material culture can furnish significant insights into how and why societies operate and change. As such, the boundary between social theory and material-culture theory is fluid; some theories function in both domains.

Probably no domain has more explicit experimental laws than material-culture theory. For ex-

ample, virtually every inference about artifact manufacture and use involves material- and process-specific laws. The study of chipped stone provides examples.

The principles describing the conversion of lithic raw materials into usable tools comprise a fascinating corpus of experimental laws built up, primarily, by archaeologists. The basic principles are so well known that we take them for granted, scarcely appreciating their nomothetic basis (Schiffer 1974). For example, descriptions of the basic types of flaking (e.g., hard-hammer, soft-hammer, and indirect percussion; pressure flaking) call into play process-specific laws having much predictive and explanatory power. Let us examine one of these in more detail. Hard-hammer percussion involves, initially, two material elements—a hammerstone and a core—and a knapper. The hammer must be a hard, tough material—either stone or metal. The core should be a brittle material, such as glass or cryptocrystalline quartz. If the core already has a suitable striking platform—an edge with a platform angle of about 90° or less, then with a deft and energetic striking motion the knapper can knock off a flake. The shape of the core and platform as well as the placement, velocity, and angle of blow determine the shape and size of the resultant flake. The latter relations, which still are being investigated by experimenters (e.g., Speth 1974), are expressed as even lower-level experimental laws. (A more complete statement of such principles would require precise definitions of terms and variables.)

Another large family of lithic laws pertains to use wear. Using experimental methods, analysts have linked behaviors (e.g., material worked and mode of working) to the resultant traces on a stone tool. For example, Semenov (1964) called attention to the law that any repetitious motion, such as cutting, would produce striations oriented parallel to that motion on the tool's working edge. Probably the most dramatic breakthrough in laws of this kind was Keeley's (1980) demonstration that specific worked materials, such as dry bone or antler, create distinctive types of polish on flint tools. It should be noted that an essential component of many technological correlates, such as those of lithic use wear, is drawings and photographs, without which an independent observer would be unable to recognize specific effects (such as "dry-bone polish").

Understanding the functioning of every technology, from chipped stone to communications satellites, requires correlates (cf. Bunge 1974), many of which only now are being generated experimentally. In industrial technologies correlates usually are explicit; codified in handbooks they are used by engineers for artifact design. In principle, technological correlates should be subsumed by principles of physics and chemistry. In practice, engineers often had to develop their own theories, which later entered physics, such as those pertaining to hydraulics and hydrostatics. Indeed, recent studies in the history and philosophy of technology underscore that technologists frequently take the lead in developing new scientific principles (e.g., Aitken 1976). Archaeologists should expect that requisite middle- and high-level theories for explaining nonindustrial (and often extinct) technologies might not yet exist. For example, at the present time there are no generally accepted theories for explaining the correlates of polish formation on chipped-stone tools (cf. Vaughan 1985:13). In short, technological correlates will be explained, eventually, by middle- and high-level theories similar to those principles in other sciences but perhaps created by archaeologists (cf. Schiffer and Skibo 1987) or by collaboration between engineers and archaeologists (e.g., Cotterell and Kamminga 1987).

Because material culture intimately is involved in all aspects of societal functioning, one can expect that archaeologists have uncovered many correlates that link social and material phenomena. Indeed, archaeologists have used correlates of this sort, often implicitly, throughout the history of the discipline. Early on, investigators such as Lewis Henry Morgan (1877) identified societal types on the basis of organizational and technological traits. Such crude correlates were employed by archaeologists to make broad inferences about societal traits from artifacts. The formulation of such correlates continued in this century, for example, with the works of Childe (1950) on urbanism and civilization and Service (1962) on bands, tribes, chiefdoms, and states. Archaeologists have devoted appreciable effort to refining and applying such correlates, as in Renfrew's (1974) creation of varieties of chiefdom-type societies for use in European prehistory. Although this strategy of correlate building often is referred to pejoratively as "typological thinking," it could be much more than that if theoretical questions were raised about why traits often tend to cohere as groups. In any event,

archaeologists have begun to lose interest in these general correlates as more detailed inferences about social systems are sought.

One thrust toward more narrowly construed social inferences was made by new archaeologists of the 1960s and 1970s who set forth correlates linking marital-residence pattern to the distributions of stylistically defined male and female craft items. An example is that with uxorilocal residence (husband moves to vicinity of wife's family), there is a random distribution of male items and a patterned (i.e., clustered) distribution of female items. Many of the classic case studies of the new archaeology explicitly rested upon these correlates (e.g., Deetz 1965; Hill 1970; Longacre 1970), which had been creatively derived from anthropological theory (e.g., Murdock 1949) and coupled to theoretical assumptions about material culture. As such, these principles pertain to highly idealized situations (e.g., no trade or lateral cycling of goods—see Schiffer 1976:24), and with few exceptions (e.g., Graves 1981) they have not been tested ethnoarchaeologically.

Marital-residence correlates, too, are falling into disuse, not only because of the gaggle of auxiliary assumptions involved in their application to archaeological cases, but because many investigators have come to appreciate that doing anthropological archaeology need not involve mimicry of what sociocultural anthropologists do (Deetz 1970; Harris 1968a).

To the extent that it has made substantive contributions to theory as opposed to providing unbalanced critiques of other theoretical programs, symbolic-structural archaeology has expanded the corpus of correlates concerning the symbolic functioning of artifacts. Despite Hodder's (1982a) rejection of the "functionalist" elements that taint other programs (e.g., new archaeology, behavioral archaeology), symbolic-structural archaeology's principal accomplishment has been to show that archaeologists have not appreciated the full complexity of symbolic-artifact functions. For example, Hodder (1982a, 1982b, 1982c) has demonstrated that symbols can be used to protest or deny certain social realities, as in the wielding of particular symbols by relatively powerless groups. Hodder (1984) also has argued that the choice of specific items as symbols is rooted in a historical context, which establishes their saliency.

To this point, concepts such as "symbolic function" have been used in this essay much as they are used in the archaeological literature, without explicit definition. In fact, concepts of artifact function are elements of some of our highest-level theories of material-culture dynamics. The past two decades have seen much work in this area, and I can do little more here than call attention to a few sources (e.g., Binford 1962, 1965; Dunnell 1978; Jelinek 1976; McGuire 1981; McGuire and Schiffer 1983; Rathje and Schiffer 1982:63–103; Sackett 1977). Needless to say, such theories remain partial theories, each coping only with aspects of a complex reality; no unified theory of artifact function has yet emerged.

The preceding discussions scarcely scratch the surface of correlate theory. These principles comprise one of archaeology's long-standing concerns, one that remains central in theory building. Even so, many correlates remain implicit and poorly founded; there is much room for testing and synthesis.

Cultural Formation Processes (C-Transforms)

The cultural behaviors that occur during an artifact's life history after it has taken part in a particular activity are termed cultural formation processes (Schiffer 1972b, 1976, 1987). Archaeologists have had some interest in cultural formation processes throughout the history of the discipline. For example, the formulation of Worsaae's Law (Rowe 1962) was coeval with the establishment of a scientific archaeology in the early nineteenth century. Today, the nomothetic study of cultural formation processes is an active arena of research, stimulated in part by the theoretical formulations of Ascher (1968), Cowgill (1970), and Schiffer (1972b, 1976). Many new lower-level principles are emerging from experimental and, especially, ethnoarchaeological investigations. The building of mid- and high-level theories in this domain has begun (cf. Schiffer 1987), but most still are quite crude.

Discussions of cultural formation processes usually begin with the theoretical distinction between systemic context and archaeological context (the behavioral and nonbehavioral states of artifacts). The four principal types of cultural formation processes—reuse, cultural deposition, reclamation,

and disturbance—are defined in part by changes in state within and between contexts. Each family of processes is governed by its own experimental laws and theories, though development of these principles has proceeded unevenly. Principles of cultural deposition, which outnumber all others combined (Schiffer 1987), are used to exemplify the c-transform domain.

One active area of research has been treatment of the dead (e.g., O'Shea 1984). The most general principle, to which many archaeologists subscribe, is that people treated differently in life are treated differently in death (Tainter 1978). This is an example of a high-level principle, one allied closely to certain social theories. The generality of this principle is obvious; its great abstractness can be grasped readily if one tries to define, empirically, "treated" and "differently." Between this principle and the actual mortuary behavior of specific societies are several mid-level theories and experimental laws. For example, Binford (1971) furnishes some evidence in support of the principle that societies having greater social complexity (i.e., more social roles) should have a correspondingly larger number of modes for treating the dead. This principle is accepted widely, despite shortcomings in Binford's (1971) cross-cultural test, because it follows from the more general principle; that is, its prior probabilities (*sensu* Salmon 1982) are high.

Much work remains to be carried out on mortuary behavior, but the known principles cast doubt on the efficacy of procedures commonly used for drawing social inferences from mortuary evidence (Whittlesey 1978). For example, it is not unusual to find analyses in which burials have been arranged by quantity of grave goods, which is alleged to indicate past social ranks (e.g., Lightfoot 1984). However, grave goods alone tend not to be a reliable guide to social identities (cf. Rathje and Schiffer 1982; Tainter 1978). The slow diffusion of general principles into archaeological practice—in this case and many others as well—is lamentable.

Extant principles of refuse disposal and abandonment processes have an equally great potential to overturn specific inferences as well as to promote the creation of new analytic techniques. Although many studies are based on the assumption that the artifacts being analyzed were deposited as primary refuse, recent research has shown that primary refuse tends to be produced only under limited conditions (Schiffer 1972b, 1987). Some principles of refuse disposal have been formulated (e.g., Deal 1985; DeBoer 1983; Hayden and Cannon 1983; McKellar 1983; O'Connell 1987; Schiffer 1972b, 1987), and these can illustrate the levels of theory being developed.

Performance of activities in all settlements, usually in specific loci, generates broken and wornout artifacts subject to discard processes. (The quantities of items whose use lives end under given conditions of activity performance are described by the pathway model [Hildebrand 1978; Schiffer 1976, 1987].) Accumulations of refuse in activity areas are handled by maintenance processes, which vary in rate and thoroughness. At one extreme, activity areas may not be maintained at all, in which case discarded artifacts form deposits of primary refuse. At the other extreme, activity areas may be maintained often, and so most items are deposited elsewhere as secondary refuse. Any artifacts left behind in maintained activity areas are known as residual primary refuse (Schiffer 1987). In general, small items have a higher probability of becoming residual primary refuse; this effect is described by the experimental law known as the McKellar Principle (McKellar 1983; Schiffer 1983b, 1987). The size threshold of residual primary refuse varies directly with the rate and thoroughness of the maintenance process which, in turn, are thought to be a function of variables such as rates of refuse generation and diversity of activities (Kent 1984; O'Connell 1987; Schiffer 1987).

Flows of refuse from activity areas to dumps are termed waste streams; they consist of a series of storage and transport activities. Waste streams can terminate in few or many refuse areas, and can be short or long; Hayden and Cannon (1983) identify several factors leading to multiple waste streams. Ratios of secondary to primary refuse produced by a settlement's waste streams vary directly with intensity of occupation and population size or density (cf. Murray 1980).

The key theoretical entity of waste stream, which permits one to visualize (and so model) relations of activity areas to refuse areas, was not made explicit in archaeology until the 1980s (e.g., Hayden and Cannon 1983), long after the establishment of several low-level principles. Now that waste-stream theory is explicit (see Schiffer 1987), however, one can tease from it additional implications that could become new experimental laws. For example, in a settlement with many long and converging waste streams, artifact richness (Kintigh 1984) increases as one moves toward the ter-

minus of any given stream. In addition, the artifact contents of such waste streams become more distinctive as their sources are approached. These principles are implicit in a number of works (e.g., Boone 1980, 1987; Schiffer 1976), but waste-stream theory has helped to crystallize them.

Waste stream theory provides an excellent example of a mid-level theory, one that helps to explain a number of experimental laws. So far, however, no high-level theory has been proposed to account for the patterned flows of refuse specified by waste-stream theory. Perhaps an overarching theory can be based on the idea that discarded items are peculiar (culturally created) resources that need management. In this way, reuse and reclamation processes, as well as other behaviors, eventually might fall under the scope of a single high-level theory (that also could function as social theory).

To date, few links have been established between c-transforms and principles of other disciplines (an exception being the linkage of mortuary studies to role-and-status theory in sociology and cultural anthropology). The general lack of external relations probably results from the unique interest archaeologists take in some of these processes.

Noncultural Formation Processes (N-Transforms)

Artifacts and sites interact with the natural environment and, as a result, are modified. Environmental processes influence the formation of the archaeological record and also produce a record of their own operation, consisting of ecofacts, which furnish evidence for paleoenvironmental reconstruction (Dincauze 1987).

Noncultural formation processes are the least autonomous domain of reconstruction theory in that most principles were established by other sciences such as geology, biology, and chemistry. For example, principles of wood decay, important in interpreting some radiocarbon dates and in understanding architectural deterioration, have been formulated in biological disciplines (see Schiffer 1986, 1987). Similarly, principles of animal behavior are used by archaeologists to understand the effects of rodents and other denizens of the soil on sites (e.g., Bocek 1986; Stein 1983; Wood and Johnson 1978). A final example is the laws of geomorphology, which are essential for reconstructing ancient landscapes and for appreciating site-environment interactions (Butzer 1971; Pyddoke 1961; Vita-Finzi 1978).

Although n-transforms mainly derive from other disciplines, making their way to archaeology through multidisciplinary collaborators, archaeologists do carry out experiments and take part in studies that refine extant principles or fill nomothetic gaps. The well-known contributions of archaeologists such as Brain (1981), Binford (1981), and Gifford (1981) to vertebrate taphonomy are handy examples.

For the most part, archaeologists do not require the deeper understanding of environmental phenomena that is central to other disciplines. For example, archaeologists usually are satisfied to know how eolian processes work—i.e., mechanisms of particle transport and deposition—and seldom worry about high-level theories of climate dynamics that explain the origin and distribution of wind patterns on earth. Thus, experimental laws and lower-level theories are the principles most useful to archaeologists.

The hierarchy of principles in this domain is illustrated easily with decay processes of wood and other cellulosic materials (see Schiffer 1987:163–180). Wood is attacked by many organic agents, among the most important of which are bacteria, fungi, beetles, and termites. The living requirements of these organisms are expressed as experimental laws that make it possible to specify the conditions under which wood is subject to attack by particular decay agents. For example, bacterial attack takes place only when wood has a high water content (in excess of 100 percent of dry weight), whereas wood-rotting fungi thrive with a moisture content that is less than 100 percent saturation but more than 30–50 percent. Wood also is altered by weathering, a synergistic process involving both water and sunlight.

The laws of wood decay are accounted for by diverse theories from the biological and physical sciences. For example, the moisture requirements of bacteria and fungi are explained by principles pertaining to the digestive processes of these organisms. Similarly, the actions of sunlight and water on wood are accounted for by principles of organic chemistry, such as those detailing the effects of

ultraviolet radiation on chemical bonds in polymers. In short, a more comprehensive understanding of wood decay processes, while interesting, moves us away from purely archaeological concerns. As noted above, the most useful principles of noncultural processes for archaeology are at the lowest levels.

METHODOLOGICAL THEORY

The principles of reconstruction cannot, by themselves, furnish knowledge of the past, for they must be applied to archaeological evidence. Such evidence has no existence independent of the research processes employed for recovering and operating upon materials in the archaeological record (Patrik 1985; Schiffer 1987). These research processes are governed by the realm of methodological theory, which is composed of recovery theory, analytic theory, and inferential theory (adapted from Clarke 1973; Rathje and Schiffer 1982; Sullivan 1978). Methodological theory provides guidance in selecting methods and techniques (of recovery, analysis, and inference) and in applying the principles of reconstruction to given bodies of material. The processes and domains of methodological theory represent areas of traditional archaeological concern that have become greatly differentiated and much more explicit in the past few decades (cf. Schiffer 1978).

Recovery Theory

Recovery theory comprises a large domain of principles, many of them well founded upon more than a century of practical experience. (In effect, every field project provides data for testing these principles.) In earlier decades, this knowledge was passed from one generation of archaeologists to the next by word of mouth and by example in field projects. As Reid (1985) and Clarke (1973) note, the expansion of modern archaeology overloaded that intimate master–apprentice system, fostering new mechanisms of information transmission. Thus, in the 1960s, archaeologists increasingly began to make explicit and organize the principles of fieldwork, a development reinforced by calls of the new archaeologists for a more explicitly scientific discipline (e.g., Watson et al. 1971). At the same time, new techniques were developed or applied more widely, including flotation and nonsite survey. Experience gained in the use of these techniques occasioned the formulation of still more principles of recovery theory in a process that continues to this day.

Like cultural formation processes, recovery theory has few external relations; most principles were created pragmatically by archaeologists. In recent years, however, sampling theory from statistics has played a role in some formulations (Nance 1983). Principles from physics and chemistry also figure in explanations for the functioning and applicability (or its lack) of prospection techniques such as magnetometry. It is safe to predict that the external relations of recovery theory will in the future expand.

Examples of recovery theory can be drawn from the principles of survey, an area that has seen a flurry of recent theory building (e.g., Dunnell and Dancey 1983; Mueller 1974, 1975; Nance 1983; Plog et al. 1978; Redman 1974; Ruppé 1966; Schiffer 1987; Schiffer et al. 1978; Schiffer and Wells 1982). Many experimental laws govern the relations between particular survey techniques and the discovery of given archaeological phenomena. For example, as the crew-spacing interval (using the pedestrian tactic) decreases, the ratio of small to large sites discovered increases. Another experimental law is that windshield surveys (seeking sites from a moving vehicle) find mostly large, prominent sites. Explanation of such principles must make reference to human perception, what can be seen—and recognized as cultural—in particular circumstances. Such theories remain to be formulated fully, but an example can be pieced together, focusing on pedestrian-tactic survey, that explains some laws of site discovery.

"Discovery" is defined as the recognition that a material phenomenon—e.g., an object, a group of objects, a rise or depression in the landscape, a particular sediment—has culturally produced characteristics. It is assumed that surveyors have been well trained in correlates, c-transforms, and n-transforms, and so are able to recognize cultural phenomena reliably. That being the case, the act of discovery depends upon (1) the distance of the surveyor from the phenomenon, (2) visibility—the extent that intervening phenomena (e.g., pine duff, shrubs, overlying sediments) are present,

and (3) physical characteristics of the phenomenon, such as size, color, shape, and elevation, which collectively constitute its obtrusiveness. Phenomena of high obtrusiveness contrast sharply with their immediate surroundings. Stated in more explicitly causal terms, the theory becomes: The discovery probability of any phenomenon varies directly with its obtrusiveness and visibility and inversely with the crew-spacing interval.

On the basis of this theory, one can deduce several subsidiary principles. First of all, if one holds constant visibility and crew-spacing interval, discovery probability varies directly with obtrusiveness. Thus, all pedestrian surveys are biased against phenomena of low obtrusiveness. Similarly, if visibility and obtrusiveness are held constant, discovery probabilities vary inversely with the crew-spacing interval. That is, one can ameliorate (but never eliminate) the bias of pedestrian survey by reducing the distance between crew members. Still other laws and theories are employed to make specific decisions about crew spacing, use of probability sampling, unit sizes and shapes, etc., and these principles necessarily involve complex evaluations of cost effectiveness (Mueller 1974).

Principles of survey pertaining to other techniques of site discovery, such as the creation of artificial exposures, also are being developed explicitly. McManamon (1984) has compiled data on the effectiveness of various techniques of artificial exposure, including shovel testing, that can contribute to decision making in survey design. He also presents a mid-level theory that appears to subsume most of the experimental laws included.

Weymouth (1986) recently has made explicit many principles—at several levels—governing the use of electronic survey aids, such as resistivity surveying, which are used mostly for intrasite studies. The high-level principles obviously are those of physics, and these are of little interest to the nonspecialist. The most useful principles for the archaeologist relate gross characteristics of cultural phenomena to anomalies detectable by particular techniques. Such principles make it possible for an archaeologist to decide which techniques will be most appropriate and productive in a given case. Weymouth (1986:387) summarizes some of these experimental laws in a table comparing the attributes of resistivity, magnetic, and radar surveying. For example, buried brick features often provide a good magnetic contrast with surrounding sediment, facilitating their detection by magnetometry.

Regrettably, the formulation of explicit principles of excavation has proceeded slowly. The most impressive work to date is Harris' (1975, 1979) partial codification of the principles of archaeological stratigraphy. One hopes that attention soon will be directed to other excavation principles, most of which still are implicit.

Analytic Theory

The boundary between analysis and inference is seamless, and so any division is somewhat arbitrary. Nevertheless, several reasonably discrete functions and corresponding bodies of theory make it possible—and necessary—to distinguish analysis and inference.

In analysis, one manipulates and strives to understand variability in a particular artifact class (e.g., chipped stone, radiocarbon dates, and animal bone), arriving at low-level inferences specific to the life history of those remains. Archaeologists use principles from several domains to carry out analysis, including correlates, c-transforms, and n-transforms. In addition, principles unique to the analytic domain guide and facilitate the process.

Until recent decades the principles of analysis, like those of recovery, largely were implicit and passed down in master–apprentice settings. A major exception was the early formulation of explicit typological theory (cf. Dunnell 1971, 1986b). With the advent of the new archaeology, pressures arose for the elaboration of explicit analytic theory beyond typology. Some of the first efforts were devoted to quantitative—especially multivariate—analysis, as investigators grappled with the choice of techniques to solve given problems. Scattered efforts at establishing low-level principles in the 1960s and the 1970s (e.g., Cowgill 1968; Hodson 1970; Schiffer 1975; Speth and Johnson 1976) foreshadowed the growth of a large and difficult literature (e.g., Aldenderfer 1987; Carr 1984, 1985; Clarke 1982; Doran and Hodson 1975) that contains the germs of quantitative analytic theory.

Some work has been done on analytic theory at the highest level. Using Sullivan's (1978) for-

mulations as a starting point, one can begin to appreciate the nature of high-level analytic theory. The key entity of analytic theory, which has great antiquity in the discipline, is trace. According to Sullivan's (1978:194) general definition, a trace is "an alteration in the physical properties of an object (or the relations between objects) or a surface (or the relations between surfaces)." Thus, a trace is any perceptible consequence of an activity or process; Sullivan (1978:195) groups the latter into related causal processes called "trace production contexts." The four major trace-production contexts are interactive, depositional, discard, and archaeological, and these represent "*generalized* situations where information [as traces] is likely to be mapped onto items and surfaces" (Sullivan 1978:194). The first and most important step of analysis, then, is to partition traces by trace-production context in order to isolate those which can serve as evidence for specific inferences. Using correlates, c-transforms, and n-transforms, the archaeologist partitions traces and thereby identifies those most likely to be the result of particular processes. Traces of behaviors or processes of interest become, in analysis, attributes; the latter usually are subjected to additional manipulation during typology construction, and the resultant categories serve in further analysis.

The analysts of particular bodies of evidence—e.g., chipped stone, animal bone, tree-ring specimens—form invisible colleges of interacting specialists who have developed numerous material-specific principles for partitioning traces and establishing low-level inferences. These principles tend to be middle-level theories and experimental laws. Analytical specialists working with different bodies of material have confronted analogous problems, and this has promoted the growth of parallel components of analytic theory. Eventually, high-level theories may be formulated that can subsume principles applying to more than one kind of material.

Perhaps the most common analytical problem is the measurement of attributes and the making of basic typological distinctions. In lithic studies, for example, principles (usually implicit) guide the choice of techniques for measuring flake attributes such as length and degree of completeness. Similarly, ceramic analysts have developed principles for distinguishing between slipped and unslipped wares. Paleoethnobotanists identify taxa on the basis of charred specimens, employing principles they have created through painstaking comparative studies.

A second common analytical problem is that of part–whole relations. Ceramic analysts, for example, have established techniques and low-level principles for inferring attributes of vessels from attributes of sherds (cf. Rice 1987; Smith 1983). Similarly, a host of experimental laws makes possible the estimation of human stature from measurements taken on single bones (cf. Ubelaker 1984).

A third recurrent problem is the need to identify traces of formation processes on artifacts themselves. For example, lithic analysts employ principles for distinguishing microflakes and striations produced by trampling (and other formation processes) from those caused by use (e.g., Keeley 1980; Odell 1982). Similarly, taphonomists and zooarchaeologists are creating principles for segregating the traces of processes such as carnivore action and rodent gnawing from butchering marks (Lyman 1987).

A fourth common problem is the choice of abundance measures. Faunal analysis provides good examples because its practitioners have devoted much effort to developing techniques for quantifying the abundance of a taxon within analytic units (e.g., arbitrary level, depositional unit, site). At one time these measures were used rather uncritically to make inferences on topics such as diet. During the past decade, however, Grayson (1979, 1984) and others have formulated principles to guide the choice and manner of application of abundance measures. For example, values of the MNI have been shown to depend greatly on sample size. Thus, techniques for standardizing the MNI are being developed, as are alternative abundance measures (e.g., Binford's [1978] assorted indices). The quantitative study of archaeobotanical specimens also is beginning to mature. Miksicek (1987), for example, describes experiments with techniques for assessing plant taxon abundance. Efforts to understand the behavior of pottery abundance measures now are building momentum (see Chase 1985; Orton 1982; Rice 1987; Schiffer 1987). As additional studies are carried out, we can expect to develop higher levels of theory governing the conduct of quantitative analysis, perhaps theories that crosscut types of evidence.

It should be obvious that the domain of analysis involves long-standing and strong external

relations. Even the names of certain analytical specialties (such as zooarchaeology or paleoethnobotany) emphasize their multidisciplinary content. Nonetheless, these specialists do not merely make introductions from other disciplines but develop new principles of analysis.

Inferential Theory

Archaeological inference is the process of assessing and synthesizing diverse lines of evidence to produce well-founded statements about the past (e.g., chronology, diet, social organization, climate). The principles of inference, then, facilitate comparison and integration of low-level inferences yielded by analyses of different materials. As in analysis, correlates, c-transforms, and n-transforms play a large role in the inferential process. External relations of analytic theory tend with some exceptions to be extensive but shallow. The most conspicuous borrowed principles are those for paleoenvironmental reconstruction, which come mostly from geology and the biological sciences (cf. Butzer 1971, 1982). (For a recent attempt by an archaeologist to grapple with high-level theory of environmental reconstruction, see Dincauze 1987.) Progress in inferential theory is apt to be a function of the willingness of archaeologists themselves to confront head-on the need to integrate diverse lines of evidence.

The levels of inferential theory can be illustrated by chronometric theory, on which there has been tangible progress. In a landmark paper, Dean (1978) presented the rudiments of a high-level theory for relating independent dates (e.g., tree-ring, radiocarbon, archaeomagnetic) to the dates of past events of interest. Although it provides general guidance for those seeking to interpret specific dates, its most important function is to inspire the formulation of middle-level theories and experimental laws that have a direct role in interpreting and integrating specific chronometric dates.

Chronometric theory forces the analyst to consider and evaluate temporal intervals—disjunctions—that intervene between events actually dated by a technique (e.g., the last year a ring grew on a tree) and the behavioral events of interest (e.g., when a house was built). Identification and assessment of recurrent intervening events (and corresponding disjunctions) furnish a basis for generating lower-level principles. Examples of such principles come from radiocarbon dating (cf. Taylor 1987). One of the most widely known is that each kind of dated material (e.g., bone apatite, marine shell, wood, seeds) tends to be affected by different processes during its life history and so is subject to characteristic disjunctions or dating anomalies. Lower-level principles are not difficult to find. For example, marine shell and chunks of wood tend, for different reasons, to date too early. Although seeds and parts of annual plants are free from the "old wood" problem (cf. Schiffer 1982, 1986), such materials can be introduced into sites by burrowing animals and can produce anomalously late dates. On the basis of principles such as these, the archaeologist sorts specimens into more and less promising groups according to potential dating anomalies (Schiffer 1986, 1987). Similarly, additional principles are required for evaluating the formation processes of deposits yielding dated specimens. For example, specimens from deposits of de facto refuse present fewer potential dating anomalies than those from deposits of reworked secondary refuse. Principles such as the latter, which are statistical laws, codify the criteria that many archaeologists use intuitively to "accept" and "reject" specific radiocarbon dates. At a higher level of integration, principles of chronometric theory are needed to assess, compare, and synthesize dates produced by different dating techniques. Likewise, synthesis of chronometric dates with information on relative temporal placement (such as provided by seriation and stratigraphy) calls for additional principles.

The sheer volume of specialized analyses carried out today has placed a premium on the development of inferential theory (cf. Stark 1986). Regrettably, there seems to be a lag; material-specific, low-level inferences remain unintegrated. Quantitative inferences about human diet illustrate this problem. A variety of specific lines of evidence, including remains of the resources themselves, such as plant macrofossils, faunal remains, plant opal phytoliths, and pollen; organic residues in sediments; and the tools and facilities used for procurement, processing, storage, and consumption of the resources, can furnish low-level inferences about what was eaten. Ironically, because the theory needed to integrate these material-specific inferences is so poorly developed, archaeologists often turn to ethnographic analogy when inferring the degree of dependence on specific resources. Although

chemical and morphological analyses of human skeletal remains can provide some quantitative information about diet, the need for integration of lines of evidence is not, thereby, obviated (cf. Stark 1986).

Archaeologists must take the lead in building theory to bridge the many specializations that provide material-specific analyses. The challenge to develop inferential theory is omnipresent because of the continuing rapid growth of analytical techniques and principles and the periodic "discovery" of new kinds of evidence (e.g., nonsites, plant opal phytoliths, lithic microdebitage).

THE RELATION OF METHOD AND THEORY

Earlier in this paper I labeled as theory the principles of reconstruction and methodology. This categorization will strike some archaeologists as odd, for they would maintain that these two realms are not theory at all, but method (e.g., Raab and Goodyear 1984) or even technique (cf. Gumerman and Phillips 1978). If we agree that method consists of tools (conceptual and otherwise) applied to achieve certain goals, then it must be granted that a theory—any theory—can function as method. This conclusion is appreciated widely in other disciplines where, at times, the role of method is played by some of science's most abstruse and formidable theories (e.g., methods for detecting subatomic particles that depend on quark theory).

In archaeology as in other sciences, what is method depends on the goals of a particular inquiry; it is context specific. A few examples can make this clear. An investigator who describes and explains the course of cultural development in a region employs all three realms of theory as method, mere tools for reaching the goal of illuminating prehistory. If one's goal in a project is to advance social theory by evaluating specific nomothetic hypotheses with archaeological evidence, then theories of reconstruction and methodology function as method. On the other hand, in a general study of artifact design (e.g., Schiffer and Skibo 1987), correlate theory becomes an end and all other theories means. Similarly, when a zooarchaeologist seeks new principles for understanding variability in the MNI, other domains of theory, to the extent that they are involved, would function as method. It should be clear, then, that all general principles, which structurally are theory (or experimental laws), can function as method, depending on the specific research context.

There is a diversity of views in archaeology today on which goals are most important. Moreover, a great many lesser goals structure specific inquiries. Thus, one legitimately can pursue a variety of goals, a diversity that contributes to the discipline's vitality. As long as we countenance different goals in archaeology, then there can be no final pronouncements on which principles constitute method. To claim otherwise, by asserting that one's own goal should become the exclusive goal of all archaeologists in all investigations, is to flirt with intellectual fascism. The preceding discussions have shown that archaeology's success as a discipline—however the latter be defined—requires a plethora of goals to ensure growth in all domains of theory.

CONCLUSION

Archaeology possesses an undeniably rich conceptual structure of surprising breadth and complexity. Whereas only two or three decades ago archaeological theory was thought to encompass mainly social theory, today other realms—each consisting of several domains—also are appreciated. It is these bodies of theory, taken as a unit, that give archaeology its integrity as a science.

Most domains of archaeological theory are experiencing rapid growth, with principles proliferating faster than they can be assimilated. Specialization is of course both cause and consequence of this knowledge explosion. Given the great differentiation of archaeological theory and the steady growth of ever-narrower specializations (cf. Schiffer 1978), it should not be surprising that archaeologists discussing theory often talk past each other. Many investigators apparently have staked out a particular turf and are attempting to generalize from it to all archaeological theory. This leads to exaggerated claims for the scope and implications of sometimes limited programs. For example, neither "behavioral archaeology" (Schiffer 1976) nor "symbolic-structural archaeology" (Hodder 1982a, 1982b) have contributed much to social theory, and the latter has not influenced methodological theories. Likewise, "analytical archaeology" (Clarke 1968) furnished new techniques—and

sometimes principles—of analysis, but it rehashed earlier social theory and did not provide correlates, c-transforms, and n-transforms. Despite the limitations of these programs—or perhaps because of these limitations—there is room for a thousand archaeologies. The tasks are so complex and the theories still so immature, that each effort does make a contribution, though doubtless of a lesser magnitude than its originators would wish.

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