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CHAPTER ONE
Introduction

Understanding the relationship of pottery and society is fundamental to archaeology. Inevitably, pottery, its production, and its distribution change through time, and these changes provide fruitful sources of data for making inferences about an ancient society. But how precisely do changes in ceramics and ceramic production reflect history and the social, political, and economic changes in a society? How are social changes materialized in the pottery of a society? This book attempts to provide some answers to these questions by examining the relationship of sociocultural change to the production and distribution of pottery in Ticul, Yucatán, Mexico, over a period of thirty-two years.

Although the study of modern preindustrial pottery production, distribution, use, and discard has become increasingly popular among archaeologists (D. Arnold 1993; P. Arnold 1988, 1991a, 1991b, 2000; Arthur 2006; David and Hennig 1972; David and Kramer 2001; Gould 1978, 1980; Hayden and Cannon 1984b; Kramer 1979, 1985, 1997; Longacre 1991; Longacre and Skibo 1994;

Miller 1985; Sillar 2000; M. Stark 1991a, 1991b, 2003; Underhill 2003; van der Leeuw and Pritchard 1984) and some have documented changes in modern ceramics over time (Arnold 1987; Arnold et al. 1999; Longacre and Skibo 1994; Thieme 2007), there has never been an ethnographic study of pottery production and distribution that spans a period of more than thirty years using data collected by a single investigator. This unique perspective is both a weakness and a strength. Its weakness is that a single investigator produces a much smaller amount of data than larger ethnoarchaeological projects. The strength of such an approach, however, lies in benefits that relate directly to the scientific questions of validity and reliability. Observation through time by a single set of ethnographic eyes provides a relatively objective perspective honed through repeated visits that takes one beyond one's own culture into the culture of the potters and their technology. Consequently, such an approach provides a holistic perspective of the relationship of pottery and social change that is directly relevant to archaeologists' study of the past.

PARADIGMS OF POTTERY AND SOCIAL CHANGE

Currently, several paradigms seek to explain social and technological change through time and relate that change to pottery. Using several paradigms provides a holistic perspective on change that transcends the limitations of any single perspective.

Specialization and Evolving Complexity

One paradigm that relates pottery and social change involves the relationship of changes in technology to changes in production organization, and how those changes can be read from ancient ceramics to infer increasing social complexity. Such complexity involves an increase in the number of social groups in a society and their interconnections. Variously described as the evolution of specialization and the study of socioeconomic complexity, these studies have their roots in the work of eighteenth-century economic philosopher Adam Smith (1953 [1776]) and nineteenth-century sociologist Émile Durkheim (1933 [1893]). For both of these writers, the first major step in the evolution of socioeconomic complexity involves the division of labor not according to gender. Adam Smith (1953 [1776]:7–22) argued that labor was divided for three reasons: (1) the improvement of dexterity (skill), (2) time savings that resulted from the elimination of the time required to move from task to task, and (3) the labor-saving role of machinery. All of these factors were underlaid, he argued, by the human "propensity to truck, barter, and exchange one thing for another" (Smith 1953

[1776]:23). Durkheim (1933 [1893]) recognized the profound significance of the shift to specialized tasks in the evolution of society, but he was more concerned about the nature of the glue (i.e., its "solidarity") that held these kinds of societies together. In order to sustain itself with a change to organic solidarity, a society had to engage in some kind of trade or exchange so that food could be obtained by nonagricultural specialists.

In more recent years, some scholars have focused on series of social types or modes of production (Peacock 1982; van der Leeuw 1976) that relate to the organization of production, whereas others have been more concerned about the hypothetical material correlates of specialization, such as product standardization (Arnold and Nieves 1992; Benco 1987; Blackman et al. 1993; Crown 1995; Rice 1981, 1991; B. Stark 1995; Underhill 2003).

Rice (1981, 1991) has proposed transition points of emerging socioeconomic complexity. The first transition point, she argued, like Adam Smith and Émile Durkheim, was the division of labor when some households became potters rather than farmers and exchanged their pots for food. Using Adam Smith's explanation, she proposed that the second transition point occurred when pottery making became more efficient, technological changes made economies of scale possible, and pottery became more standardized.

Ethnoarchaeological studies, however, have revealed that the dimensional standardization of pottery vessels is quite complicated and can be produced by a diverse set of causes. First, it is hard to assess standardization in antiquity given different size categories in an archaeological context (Longacre et al. 1988). Second, standardization is not necessarily an outcome of fabrication technology and does not take into account the agency of the potters; some vessels may deliberately be more standardized than others (P. Arnold 1991a; Arnold and Nieves 1992). Similarly, in a study of conical cups from the late Bronze Age on the islands of Kea and Melos in the Aegean, Berg (2004) has shown that their homogeneity may not be the result of economic or technological factors but rather is simply the result of potters trying to make perfect copies of prestigious vessels used in rituals associated with the Minoan culture on Crete. Intentional standardization, Berg proposed, has very different implications than accidental standardization. All of this research suggests that even in antiquity, the reasons for standardization are more complicated than one may think. Further, in ceramic pastes, many factors can account for standardization that may have nothing to do with specialization (D. Arnold 2000).

Cathy Costin (1991, 2001, 2005, 2007), Christopher Pool (1992), and Christopher Pool and George Bey (2007) have brought a great degree of coherency to much of the specialization literature. Costin (1991) presented four parameters of specialization that consist of a range of variation of behavior between extremes. Her description emphasized degrees of changes on a gradual progressive scale rather than just the presence or absence of different features, types, or modes of production. Although she also proposed eight types using these different parameters, she argued that it is more important to describe specialization accurately, how it develops, and how these parameters are expressed differently in different environmental and cultural conditions (Costin 1991:9).

Costin (2005) provides compelling reasons why the production of all crafts should be considered together. Nevertheless, pottery production is uniquely different from other crafts. These differences include the unique nature of clay minerals that require certain environmental conditions for fabrication, drying, and firing. Because Pool (1992) and Pool and Bey (2007) focus uniquely on ceramic specialization, their work resonates more clearly with the ethnographic realities of pottery production than with attempts to lump all crafts together. Rather than describe Costin's parameters in terms of all crafts, I will summarize her parameters as they are applied to ceramics. This summary will also include some refinements based on my research in studying pottery making in Peru and Guatemala and on some of Pool and Bey's critique (2007) of Costin. Detailed interactions with Pool (1992), Pool and Bey (2007), Costin's more recent work (2001, 2005), and her critique of her previous syntheses of the study of specialization in general (Costin 2007) are far beyond the scope of this book.

Context. Costin's first parameter consists of the demand for the potter's wares. At one end of the range are what Brumfiel and Earle (1987) called "independent specialists" who produce utilitarian vessels for ordinary consumers. Such vessels are used for food preparation, cooking, and serving and generally are vessels used for household sustenance. Production in this context, Costin (1991) proposed, is most often driven by profit or efficiency. Consumers, on the other hand, choose among alternative vessels based on cost, quality, or sociological factors, or some combination thereof.

At the other end of the range of Costin's context parameter, attached specialists produce vessels for limited demand by a highly restricted clientele. These vessels have critical importance within the political economy and for the status, power, or control structure of the society because they are symbols of wealth, power, and status. Consequently, access to these vessels is restricted to the elites who control their distribution by regulating their production. This kind of distribution thus restricts consumption because elite sponsorship controls the timing, availability, cost, quality, and kind of production of certain types of ceramic vessels and their ultimate distribution (Costin 1991:11–12).

Costin (1991) argued that economic factors underlie the evolution of independent specialists and differ from those that promote attached specialization. Sufficient demand must exist to support specialists economically (D. Arnold 1985:155–166), and Costin suggested that demand may be a consequence of a large population size and density. Population size and growth do provide deviation-amplifying feedback for the demand for ceramics and influence the development of specialization, but the relationship is more subtle and nuanced than one might think (D. Arnold 1985:155–166). Large populations provide a large market for pots, and a growing population increases the demand for pottery, resulting in an increase in the number of potters to supply the larger population of consumers. The demand for ritual pottery, however, probably provides the greatest deviation-amplifying effect on demand (D. Arnold 1985:158–165) and was elaborated by Spielmann (2002) with an extensive literature review. Further, trade and transportation networks extend the demand for ceramic products (D. Arnold 1985:165–166), and this extension may reflect higher levels of political integration (Costin 1991:11–12).

Finally, Costin proposed that specialization may evolve under conditions of unequal resource distribution, especially when individuals and communities lack sufficient subsistence resources (agricultural land, water, or pastures) to sustain themselves. This explanation is affirmed by pottery-making communities in the Valley of Guatemala and in Quinua, Peru (D. Arnold 1975a; 1978b:330–334; 1985:168–196; 1993:52–71), where the existence of ceramic resources and lack of subsistence resources (limited, nonexistent, or poor-quality agricultural land) are complementary explanations for the development of specialized ceramic production. More specialized pottery production probably was selected because the eroded land exposed abundant ceramic resources and because potters lived near critical markets for their pottery. Potters in Quinua, Peru, for example, lived at a crossroad of prehistoric, historic, and modern routes through the south-central Andes and were thirty-one kilometers from Ayacucho, the regional capital (D. Arnold 1993:23, 39, 41–47). Similarly, potters in the Valley of Guatemala lived a few kilometers from Guatemala City, the country's political and economic center, which provided a significant transportation hub for buses and trucks (D. Arnold 1985:165–166; Reina and Hill 1978).

The resources, limited and poor-quality agricultural land near Quinua, and favorable weather and climate down the slope in the ancient city of Huari placed potters in a favorable position to intensify their craft by producing a greater variety of polychrome wares. When drought threatened agriculture during the Middle Horizon, potters were strategically located to intensify their craft and distribute their polychrome wares widely utilizing socioeconomic and sociopolitical institutions to buffer their decreasing subsistence returns (Arnold 1993:209–217).

More recently, Costin has used "demand" for this parameter, and in reality, it is a clearer way to describe it. In effect, this terminological change mitigates the problems of "phenomenological classification and lexical semantics" that Costin (2007) herself enumerates in her most recent work.

Concentration. Costin's second parameter concerns the spatial distribution of potters and their spatial relationship to one another and to the consumers that they supply with pottery. At one end of the range are potters that are evenly distributed across the landscape. At the other end, potters are aggregated in such a way that many production units are located in a single community and their products must be traded and exchanged for the products of other communities that do not have these specialists (Costin 1991:13).

Within the more specialized portion of this range, the spatial arrangement of potters has multiple layers. First, the distribution of specialized potters in the regional landscape consists of spatially discrete (rather than continuous) populations of potters relative to non-pottery-making populations. In such cases, the greatest distance between production units within a local population is less than the distance of the aggregate of those production units to another population of potters.

Second, this distribution of potters occurs relatively close to resources. Costin argued that independent specialization is often nucleated because production communities are close to resources, which are unequally distributed across the landscape (Costin 1991:14). Clay deposits, however, are often widespread and widely distributed. Although high-quality clay deposits are not so widespread, individual production units are seldom located more than a seven-kilometer walk from their resources (D. Arnold 1985:35–57; 2005a), except perhaps in the short term. Although Rice (1987:116) argued that other factors affect the distribution of pottery-making communities relative to their resources (such as markets and fuel), these factors are, in reality, secondary. In a survey of fuel resources of the Near East, Frederick R. Matson (1966) found that fuel resources for traditional crafts were varied and abundant and one type easily could be substituted for another. Often agriculture provided combustible by-products that were used for fuel or substituted if more desired fuel sources were not available. Further, markets and ceramic-distribution networks are culturally constructed. Potters' distance to clay and temper resources, however, is partly the result of evolutionary forces selecting communities with small distances to resources rather than the distance itself influencing the location of production.

In order for ceramic resources to play such a role in the location of potters, there must be a push away from agricultural subsistence. This change occurs when potters live on or near marginal agricultural environments and ceramic specialization is selected because agriculture is insufficient for subsistence needs (D. Arnold 1975a; 1985:168–196).

Finally, a third level of spatial arrangement consists of the distribution of production units within a local population. At this level, spatial distribution of potters is more complicated. In Yucatán, potters are located in nucleated communities of potters and non-potters. By way of contrast, in Quinua, Peru, they are disbursed over the rural landscape but also within a population of non-potters (D. Arnold 1975a; 1993:49–51, 65). Similarly, in the northern Valley of Guatemala, potters' production units are not totally dispersed or highly nucleated but occur both in agglutinated settlements and in dispersed settlements (D. Arnold 1978a, 1978b).

Scale. Costin's third parameter consists of scale and involves two interrelated variables: size of the production unit and the principles of labor recruitment. Size consists of the number of potters per unit, and labor recruitment consists of the composition of the unit and the way in which potters are brought into those units. At one end of the range are small, family-based units in which recruitment is based on kinship, whereas industrial production lies at the other end of the range where the recruitment is contractual and is based on skill and availability. Costin proposed that as production units grow, recruitment of close kin gives way to more distant kin, or fictive (or adoptive) kin, and ultimately, non-related individuals are added to the production unit (Costin 1991:16).

Based on a visit to a ceramics factory in Ticul in 1997, recruitment for industrial production may be contractual, but it is not based on skill. Although the Ticul factory (as well as other factories) requires some skilled positions, skills may be acquired on-the-job. Furthermore, skills and knowledge required for a specialized position in a factory are less holistic and much less demanding than those of a traditional potter (see Arnold 1971, for example, for a potter's knowledge of raw materials).

Costin argues that the primary factor determining the scale of production for independent specialists is efficiency and is a function of the technology used and the level of production-unit output. She proposed that production-unit size will rise to take advantage of economies of scale if per-unit costs can be lowered through sharing expensive technology or by dividing tasks among many workers. Furthermore, larger units with greater output may be able to exploit certain marketing strategies (Costin 1991:16). As we will see, however, pottery production in household-based production units has the advantage of household labor in the form of unskilled children and other relatives who can participate in production. These personnel resources can temporarily increase production-unit size when demand for their wares increases.

More recently, Costin (2001) separates size of the units from the composition of the units and calls the composition their "constitution." Similarly, Pool and Bey (2007) have challenged Costin's conflation of production-unit size and labor recruitment into the same variable. They argue that these two components must be separated if one is to understand the degree to which they are related. The Ticul data show that Pool and Bey are correct in their argument for the importance of separating size and recruitment because they are very different phenomena; there are real limits to the size of production units that are kin-based. Further, as this study will demonstrate, overall output of a population for potters can be increased even with a very small increase in mean size of the production units in that population.

Intensity. Costin's last parameter consists of the amount of time that potters spend on their craft. The lower end of the intensity range consists of part-time specialization in which craft production supplements subsistence. At the other end of the range is full-time specialization where potters exchange their vessels for all required goods and services.

Costin proposed three economic factors that determine whether production is part-time or full-time. First, efficiency affects intensity because routinizing production lowers per-unit costs. This change increases output and gives full-time potters a competitive edge over part-time potters. Capital investment in technology can be spread out over the production output, and per-unit costs are reduced by keeping tools and equipment operating as much as possible. Capital-intensive production thus requires full-time production to be cost-effective and eventually requires fewer full-time workers by requiring more skill and training (Costin 1991:16–17). The Ticul data, however, suggest that more capital-intensive production requires less skill and training (D. Arnold 1999). With some forming technologies, such as molding and slip casting, for example, capital investment replaces traditional skill. Second, risk affects the intensity of production in that part-time specialists who are also farmers can buffer the risk of producing unmarketable products by raising their own food (D. Arnold 1975a, 1985). Third, Costin argues that scheduling affects intensity because of agricultural demands. For ceramics, this explanation is illustrated in highland Peru (D. Arnold 1975a), where potters are farmers who make pottery during the part of the year that has fewer agricultural responsibilities; this situation is generally true worldwide (D.

Arnold 1985:99–108; Underhill 2003). Making pottery, however, also is affected by an additional scheduling factor that involves the limiting effect of weather and climate on production because of the chemical structure of clays (D. Arnold 1985:61–98; Underhill 2003). One way to solve scheduling problems with agriculture is by assigning conflicting tasks to different genders (D. Arnold 1985:99–108), but the problems of weather and climate can be surmounted only by building structures to protect drying pottery or by greatly reducing production output so that pots can dry within domestic space (e.g., Arthur 2006:42–44).

Discussion of Costin's parameters. As important as these comprehensive categories are for the description of complexity, they do not really explain how ceramic production changes or how socioeconomic complexity develops. Rather, Costin and other theorists use efficiency as an explanation for changing complexity (e.g., Brumfiel and Earle 1987:1, 5; Costin 1991:15–16, 37–39; Pool 1992:278–279; Rice 1981, 1984:244–245, 1991). This view, of course, can be traced back to Leslie White (1949:368–369), who formulated his law of cultural development that "culture evolves as the amount of energy harnessed per capita per year is increased, or as the efficiency of the instrumental means of putting the energy to work is increased." Specifically, he argued that "the degree of cultural development varies directly as the efficiency of the tools employed, other factors remaining constant" (White 1949:374–375).

Efficiency usually concerns the relationship of input to output and can be described as occurring along at least five dimensions: time, labor (energy), personnel, space, and output. There are at least two strategies to developing efficiency. One strategy involves maximizing the output per unit of input, and a second strategy involves minimizing inputs per unit of output. In the archaeological literature of specialization, however, efficiency is often linked to the speed of the fabrication technique such that as the technique changes, the output (pots) per unit of input (labor or time) increases. A more efficient fabrication technique thus produces more vessels per unit of input (whether time or labor) than another, less efficient technique. As technology evolves and more efficient techniques become available, such techniques are presumably selected by the population and the result changes the organization of the craft.

Consequently, sociocultural evolution is believed to be the product of a rational mechanistic process, and when faced with a choice, humans will choose alternatives of least effort and those with greater efficiency and cost-effectiveness (e.g., Brumfiel and Earle 1987; Costin 1991; Feinman et al. 1984:299–303; Rathje 1975; Rice 1991; Zubrow 1992). As a result, efficiency and economies of scale brought on by different fabrication technologies are believed to explain greater degrees of ceramic specialization (Costin 1991:15–16, 37–39; Rathje 1975:430–434; Rice 1984:244–245).

This rational-choice perspective, however, is based on a Western world view that has its roots in contemporary economic theory and *may* not, and indeed probably *is* not, characteristic of populations of ancient potters in the way that one might think. Rather, this view is tainted by a view of technological development that is profoundly affected by the American cultural value of the efficiency of time that permeates our industrial society.

Most recently, Costin (2001, 2005) has retreated from her position on efficiency. She argued that the use of the concept of efficiency in the literature of craft production "is problematic and misleading" (Costin 2001:289), citing theoretical and methodological problems. Indeed, in an ethnographic study of a pottery-making community in northern Mexico, Estes (2003) has demonstrated just how complicated efficiency is. One expects efficiency to be highly valued in this community and more "contaminated" by the values of an industrial society, but Estes has shown that efficiency does not clearly exist in the way that archaeologists conceive of it. Although it may seem that efficiency is the driver of technological evolution, evaluating efficiency is complicated by the unique production sequence of making pottery and by its cultural and social embeddedness.

By applying Costin's parameters to the evolution of ceramic production in one community in the ethnographic present, it should be possible to evaluate their usefulness and universality. Further, this application should provide deeper insight into the details of the evolution of ceramic production and the process of specialization and determine if the evolution of ceramic production in the modern world follows a trajectory similar to that believed to occur in antiquity. Is the evolution of specialization described by archaeologists universal, or are its principles restricted to the unwritten past?

Evolutionary Processes

A second paradigm for the study of social and technological change consists of an evolutionary paradigm and complements the limitations of some of the specialization literature just described. In many respects, it is probably the most powerful and comprehensive explanation for changing patterns of organization and the development of social complexity. Part of this power comes from its theoretical maturity for explaining biological change. Nevertheless, cultural evolution is not the same as biological evolution because, among other reasons, humans are intentional agents who try to influence their own behavior and evolution in spite of their inability to effect the kind of change that they intend (Kean 2006). Nevertheless, cultures and human behavior have inherent systemic properties, such as self-organization, that can be described by power laws that go far beyond the intentions and immediate understanding of human agents (Bentley and Maschner 2001; Bentley et al. 2004; Bentley and Shennan 2003). These properties suggest that processes such as random drift are at work, and that at least some aspects of decision-making processes are value neutral (Bentley et al. 2004).

Some archaeologists go to great lengths to show the similarity, or lack thereof, of archaeology to the terminology of evolutionary theory. But without clear application to actualistic societies, this terminological fundamentalism obfuscates the usefulness of evolution for those who are trying to use the models. Shennan (2000), however, simply uses the Darwinian notion of "descent with modification" to explain culture change. Assuming that a parallel exists between biological and cultural evolution, the study of culture change then should address the descent mechanism in societies and how that mechanism relates to cultural change. Unlike biological organisms, however, cultures pass on their traditions through learning rather than through biological processes, and thus, one should address the learning mechanisms and learning contexts if one is to address culture change using this model. For social and technological change among potters, then, some attention should be given to the study of learning and learning contexts in which the craft is perpetuated. As we will see, learning and learning contexts are important considerations, but they are only two out of many factors.

The evolutionary model is also based on using selection to explain change. Selection operates on two interrelated levels that affect both production and distribution. On the first level, the forces of selection act on the population as a whole to eliminate or favor individual potters (or specialists) just as in biological evolution. The second level involves the ceramic vessel itself and includes changing factors of demand that a population of consumers uses to acquire, or not acquire, a pot (Neff 1992, 1993). Consequently, changing values, functional considerations, and aesthetic preferences are powerful selective forces acting upon the marketing success of potters' distributing, exchanging, trading, or selling their wares. If potters do not adapt to these changing preferences, they will not be able to use their craft to sustain themselves, and they will have to change to another occupation.

Technological Choice

A third paradigm for explaining cultural change is technological choice (Lemonnier 1986, 1992; Loney 2000). This paradigm focuses on the participants who have a choice in the innovations that are accepted. Although technological reasons may explain why a particular selection or choice is made, social reasons also exist for making choices that may have no technological basis. The cultural and social contexts are critical in this paradigm, and it is much more culturally particularistic, requiring the archaeologist to reconstruct the choices available to the ancient potter. More effective for the study of modern material culture and cultural change, this approach appears to require full knowledge of the social, cultural, and environmental contexts in order to ascertain which choices are technological and which are not. Ironically, although the technical choices with a technological basis probably can be understood from the study of materials and climate of an area, those truly social choices cannot be ascertained from archaeological data alone except by technical/material criteria. Consequently, social choices are believed to be at work when technical criteria have been excluded. This approach seems to limit our understanding of the past.

The notion of technological choice has been a part of Western civilization for at least 3,000 years. In the archetypical origin story of human beginnings in the first book of the Jewish Torah (the book of Genesis), the procurement of one subsistence resource was emphasized and involved two actors (Adam and Eve) who made a choice based on social rather than technological criteria. From this story, the notions of choice, human responsibility, and the consequences of choice have been a part of Western religious and moral thought for centuries. Given its deep roots in the ideology of the West (whether recognized or not), it is perhaps inevitable that this notion of human choice should become a part of anthropological and archaeological understanding of technology. It applies to technological and non-technological phenomena and is fundamental to any holistic understanding of human culture.

Although decision making and the use of choices are part of the nature of the human brain (Koechlin and Hyafil 2007; Sanfey 2007) and are fundamental to understanding human culture, the distinction between technological and social choices has limited utility. Humans obviously make choices in technology, but it is equally obvious that those choices are not always technological—or even rational, for that matter. Since the ideology, social organization, and technology of a culture are interrelated, choices in technology (narrowly conceived) may have social, ideological, and religious bases that have nothing to do with technically advantageous properties. Potters thus make choices based on tradition, religion, market, social feedback, and other non-technological criteria that have nothing to do with rational choice or technological reasons. The issue about choice for potters has been described before, particularly in relationship to ceramic design (D. Arnold 1984; Krause 1984, 1985) and fabrication technology (D. Arnold 1972b; 1978b:349–351; 1993:73–100), although it was not emphasized as such.

The argument for focusing on the particulars of the past using the technological-choice approach to ceramics (rather than their commonalities with the present) is really a movement toward suppressing an awareness of the process of knowing and interpreting. It is a move away from understanding the integrity of the process of archaeological inference and retreats into unexamined, unintended unawareness of the social theory that is embedded in ceramic analysis. Can we abandon an examination of our implicit assumptions and presuppositions about social theory and its relationship to technology by arguing that we should only examine which choices ancient potters made?

This technological-choice approach (Lemonnier 1992; Loney 2000; Roux 2007; van der Leeuw 1993), however, also can be seen as a reaction to the nomothetic concerns of the role of efficiency in the specialization literature, the rational-choice theory embedded in selectionist and ecological approaches to change, and the perceived notion that other theories are deterministic. They are not, and they do allow choice. Although proponents of technological choice like to cite its exclusiveness and the social dimensions of choice, notions of choices are also embedded within the cultural-ecological approach (Steward 1955:36) and are "not deterministic" (D. Arnold 1975c:637, 1993). This combination of an ecological approach and social choice is represented in my own work with the variability of choices that a community of potters uses in their pottery (Arnold 1983, 1984, 1993). Constraints on design choices appear to be social and structural and may have a foundation in the local community and the way in which it has adjusted to the environment, although there is great variability. Human choices thus have multiple dimensions—social, economic, technological, and religious—with multiple layers of complexity. What varies, however, are the constraints for those choices, which may be environmental, social, political, or technological.

Nevertheless, the notion of technological choice reminds us of the importance of the multidimensional causes of social change, and that the individual, and the choices that the individual makes, are important, just like the story from the first book of the Jewish Torah. Despite the problems with technological choice, understanding the importance of choice helps us to focus on those aspects that influence choices, such as the feedback from the environment, technology, society, and the influence of the learned semantic categories of a culture.

Cognitive Anthropology and Engagement Theory

The data in this study also reflect two other implicit paradigms. One of these is cognitive anthropology (D'Andrade 1995), which focuses on the semantic categories of a culture and their structure as revealed in the definition and structure of the categories of its language. Originally, I approached the potter's craft in

Ticul through the language of the potters (Yucatec Maya) and elicited the Maya names and descriptions for ceramic technology. This approach was begun even before I knew Spanish and was accomplished through a technique then known as "ethnoscience" (Black 1963; Black and Metzger 1965; Frake 1964; Metzger and Williams 1963a, 1963b, 1966). "Ethnoscience" was a question/response technique using a field language that revealed semantic structures of informants who used that language. Eventually, I learned the Maya vocabulary of ceramic technology and the semantic distinctions made by Ticul potters. Although these data were foundational for this study, a full description of the ceramic technology using this paradigm will be the subject of a future monograph.

A second implicit paradigm used in this work is one that has come to be known as "material engagement theory." Still in its nascent stages, engagement theory has the potential to be a truly unifying theory for the study of material culture. According to Renfrew:

> Material engagement theory is concerned with the relationships between humans and the material world and focuses upon the use and status of material objects (mainly created objects or artefacts) which are employed to mediate in the interactions between human individuals, and between humans and their environment. Its purpose is to facilitate the analysis and understanding of culture change. . . . It seeks to overcome the mind/matter duality by stressing knowledge-based nature of human action. (Renfrew 2004:23)

Malafouris (2004) provides a more developed schema of engagement theory, and both Renfrew (2004) and Malafouris (2004) appear to be oriented more toward using it in describing the use of artifacts rather than their creation. Nevertheless, Malafouris (2004) uses the potter's wheel as an example for describing the theory. Unfortunately, this example appears to rely more on theoretical understanding of the wheel than on actual practical engagement with it. Although useful, this example and the elaboration of the theory could be enriched.

In some respects, material engagement theory is more useful in ethnoarchaeology than in archaeology and needs to be more rooted in the actual engagement with artifacts in the empirical world of ethnography before it is applied to the past. This approach is not always possible, but it is possible with technological processes such as making pottery, agriculture, and metallurgy. Nevertheless, material-engagement theory has the potential to draw together strands of cognitive anthropology, cultural ecology, practice theory, notions of habitus (including motor habits), as well as data from the environment and the inherent characteristics and constraints of the material used. With ceramics, for example, engagement theory can take into account the importance of the way in which potters categorize their raw materials, the characteristics that are derived from tradition, and the places from which they come (e.g., Arnold 1971). It also can take into account the role of the environment in providing choices for production (cultural ecology and technical choice theory) and the actual physical properties of raw materials learned by the potter. Third, engagement theory can take into account the habitual nature of human culture. Although part of this notion is habitus, there is a firm physiological basis for habitual muscle syntax (e.g., motor habits) that is stored in a different part of the brain than language. Finally, engagement theory has the potential to incorporate feedback (D. Arnold 1985) from aural, visual, and tactile percepta derived from the interaction with the raw materials, the behavioral chain of the pottery-making process, and the language of other humans. The notion of feedback developed in *Ceramic Theory and Cultural Process* (Arnold 1985), for example, was one way of describing the engagement of the potter with the social and natural environment that recognizes that potters are agents, that they are not oblivious to the social and natural world around them, and that they receive information (feedback) from it in a way that affects their behavior. The point of that book was to restore a neglected perspective to ceramic studies that potters live and work in a natural world, not just a social, or socially constructed, one.

I also utilized engagement theory in this monograph because I was able to participate in the pottery-making process and understand the way in which potters engage the behavioral chain of pottery making. This embodiment and interaction have enriched this description greatly and illustrate why participant-observation is so important in anthropological research. Because technology is artifact, activity, and knowledge, actual participation in the technological processes permits a degree of understanding beyond verbal interaction and observation. I learned how to select raw materials and then selected them myself. I learned how to fire pots by first eliciting descriptions of the process in Yucatec Maya and then fired them under the watchful eye of my informant. The result of this engagement aided me in understanding the nature of technological knowledge, how it is learned, maintained, changed, and passed on to others. After learning the categories of the Maya potter and firing five times by myself, I realized the complicated, multifaceted nature of human engagement with technological processes.

Similarly, by engaging in some of the activities of mining raw materials, I learned lessons about the procurement process that I otherwise would not have understood as deeply. When geologist B. F. Bohor and I visited the clay mine at Hacienda Yo' K'at in 1968, we crawled through an entrance tunnel that was barely fifty centimeters wide and twenty centimeters high (see Figure 5.8). It was so small that I had to move through it on my stomach with arms stretched out in front, propelling myself forward by the action of elbows and toes. As my toes dug into the bottom of the tunnel, my heels simultaneously scraped its ceiling. Although the tunnel opened up inside the mine into a large excavated room, I was profoundly aware of the challenges and dangers of clay mining. The air was bad and the recording I made there revealed rapid breathing. Reflecting on this experience afterward proved to be psychologically traumatic. Showing slides of the interior of the mine to my classes and playing the audiotape made there had devastating effects on my mental state. Nightmares about claustrophobia in the clay mine plagued me for years. Nevertheless, experiencing the embodiment of technology and partially engaging in the process were necessary to understand the problems of clay mining.

Visiting the Ticul clay source again in 1984 also reflected the importance of understanding the embodiment of technology and engaging in at least some of the technological processes. By this time, the 1968 mine was abandoned and clay was extracted through a series of vertical shafts sunk five to eight meters into the ground to reach the clay layer. I lowered myself into one of these shafts, as miners had instructed me, by wrapping the rope around one hand, grabbing the rope with the other, and using the footholds on the shaft wall to provide support for changing hand positions on the rope. Climbing out of the shaft was much more difficult. Using the rope to raise myself from foothold to foothold was a daunting task, and I had to rest frequently by placing my back against the side of the shaft and pushing my feet against the opposite wall. Miners had insisted that I remove my shirt and jeans to descend into the shaft in order to keep them clean, but I had only removed my shirt. Forcing my back against the wall of the shaft loosened a considerable amount of marl behind me and deposited itself in my jeans and underwear. By the time I reached the top of the shaft, I was carrying considerable extra weight. The miners' advice took on a new meaning after my own experience of descending into a clay mine. Rather than just a dirty body that could easily be brushed off, I had a dirty body and dirty clothes and had expended unnecessary energy carrying marl up the shaft in my clothes.

The lack of actual engagement in the pottery-making process is one reason why some archaeologists have a difficult time understanding ethnographic perspectives of pottery making, such as the embodied flow of feedback from the senses (e.g., eyes, ears, touch, and taste) presented in works such as *Ceramic Theory and Cultural Process* (D. Arnold 1985). It perhaps is one reason why some archaeologists want to deny the relevance of the ethnography and ethnoarchaeology of pottery making to the past. This lack of engagement is probably also responsible for the lack of understanding of the effect of the constraints of the raw materials and the environment on the pottery-making process.

Summary

None of these paradigms has an exclusive corner on explanatory validity. Furthermore, they are not, as some would have us believe, in competition with one another. Rather, they are complementary paradigms that explain different aspects of ceramic production, and like all paradigms, they are incommensurable. Sadly, ethnoarchaeology, like archaeology, is often practiced in a "context of theoretical atomism, interparadigmatic hostility and ignorance of alternative perspectives" (Fitzhugh 2002:789).

The use of multiple paradigms in ceramic description depends on how interested one is in understanding human culture holistically rather than using the latest avant-garde theories. The study of the past, and the use of the present to interpret it, should be done with a commitment to understanding real people in real situations, not to try out the latest theories and perspectives to be "in style" with the current academic fashion of the times (D. Arnold 1991).

Unfortunately, anthropological and archaeological theories have made dramatic swings from one extreme to the other, switching from particularistic concerns to nomothetic themes and then back again. Rather than building on previous work, investigators tend to justify new paradigms by stereotyping previous theories (such as the erroneous belief that ceramic ecology is deterministic) and then dismissing them as anachronistic because they do not fit the prevailing paradigms. Such condemnations are common in an academic culture where theoretical change and innovation seem to have a higher value than the truth value of holistic understanding (D. Arnold 1991). They appear to reflect a belief that science is propaganda, as philosopher of science Paul Feyerabend argued (Broad 1979).

Because this work covers thirty-two years of rapid social and technological change, it provides a unique opportunity to explore and evaluate these paradigms and their ability to explain this change. Are the assumptions used to infer the development of ceramic specialization in antiquity valid and useful? For example, are Rice's (1981) transition points in her trial model in the evolution of ceramic specialization and Costin's (1991, 2001) explanations used in her parameters of context, concentration, scale, and intensity universal enough to be used in a contemporary context? Further, are efficiency and selection drivers for the change and stability of the craft? Do they explain production organization through time? Do production units grow in the way that Costin proposed that they do?

THE LIMITS OF ETHNOGRAPHIC ANALOGY

One of the problems of using data from the present to understand the past concerns the perceived limitation of the use of analogy. Cultures change and the conditions of the twentieth century are not the same as those that existed hundreds of years ago. Few modern societies can be related to ancient societies in a direct historical way, and it is often difficult, if not impossible, to determine how much a modern industrial cash economy and an extensive transportation and communication infrastructure have influenced a demand for pottery. All archaeological interpretation, however, is analogical, even that which eschews ethnographic analogy (Wylie 1985). Ancient societies are described and understood as a result of analogical thinking between what is known and what is not known. There is always some degree of ethnographic analogy in archaeology whether or not archaeologists realize it.

In one sense, the prehistoric past is always incommensurable with the present. The real issue, however, is not incommensurability but rather the inexplicit role of one's own presuppositions in understanding the past. All theories of the past come from our minds in the present and have been affected by often implicit and explicit social theories, personal assumptions, and academic tradition. To paraphrase Norwood Russell Hanson's (1958) perspective, all data (even those that come from the past) are theory laden. Although it has been argued that the source of our testable hypotheses does not matter, in anthropology their source really does matter. The world of human culture is highly contextual with often limited possibilities, and archaeological interpretations cannot just be developed through hypothesis testing. Such hypotheses tend to be mono-casual with too little awareness of the theoretical and personal biases inherent in their selection.

One of the ways to avoid some of the limitations of analogy and the problems of a direct historical approach to studying the past is to build a theory that focuses on the common linkages cross-culturally between ceramic production and behavior. By comparing these links with those in other societies, it is possible to formulate cross-cultural regularities that can be applied to both the present and the past. If the interpretation of ceramics is ever going to get beyond its tradition-bound categories, naïve inductivism, and culturally myopic interpretations, archaeologists need to use a cross-cultural theory that focuses on the commonalities of ceramic production worldwide.

I have already formulated such a theory (D. Arnold 1985) built on the presupposition that societies that produce ceramics share common adaptive processes by virtue of the chemical similarities of clays. In other words, the behavioral chain of ceramic production has cross-cultural commonalities because of the similar molecular structure of clay minerals. These commonalities provide universal problems to which potters must creatively adapt if they are to make pottery. In some cultural and environmental contexts, there is more latitude in the choices to adjust to such problems than in other contexts (Steward 1955:36).

I have applied this theory to one community of potters in a single point in time (D. Arnold 1993) using both universal adaptive processes of ceramic production (developed in D. Arnold 1985) and those more humanistic factors (like social patterns and religion) that affect the patterning of human technological choice in production, decoration, and distribution. I argued that the community of potters, rather than the pots, is the unit of adaptation and evolution, and that this unit has specific expressions in the design structure of the pottery that are different from those of neighboring communities, even though there is great choice in design within the limits of the design structure (D. Arnold 1983, 1984, 1993). This approach is consonant with the community-level analysis of Kolb and Snead (1997) and Yeager and Canuto (2000). The community of potters is thus not only a unit of adaptation, evolution, and production, but its material expression in the ceramics suggests that it should also be the unit of analysis and interpretation in the study of ancient pottery (D. Arnold 2005b). When the community of potters is understood in relationship to the local environment, distance to raw materials, subsistence scheduling, and settlement patterns, it is possible to infer the location, paste variability, settlement pattern, and intensity of ceramic production in antiquity. In the case of the Ayacucho Valley, Peru, understanding the contextual factors of pottery production around the village of Quinua provides some understanding of location, paste variability, scheduling, and intensity of pottery production within the great pre-Inca city of Huari, which flourished between A.D. 600 and A.D. 800, less than three kilometers down the slope from the location of most of the Quinua potters (D. Arnold 1975a, 1993:204–226). Ceramic production is, of course, far more complicated and needs to be understood through other paradigms, but using an ecological approach and the notion that the community of potters is an adaptive response does provide a basis for developing ethnographic analogies that have comparability with the past.

Other scholars have successfully examined ethnographic cases of pottery production and distribution cross-culturally and provided a framework for interpreting the past. Pool (1992) synthesized a variety of production and distribution data for ceramics and developed some principles with which to understand production and distribution issues as well as the meaning of material residue patterns of ceramics. Similarly, Costin (1991, 2000, 2005) focuses more generally on issues of specialization cross-culturally, even though increasing ceramic specialization provides some unique adaptive problems that cannot be dealt with in a one-model-fits-all format. Spielmann (2002) examines the role of "social demand" in the development of specialization, elaborating on my argument that utilitarian demand was insufficient to generate deviation-amplifying feedback for the development of specialization (Arnold 1985:158–166). Tourist demand today is much like ritual demand in that it is open-ended and has the potential to provide deviation-amplifying feedback for the development of increased intensification and specialization of ceramic production, much as it has in Ticul since 1965.

The ethnographic study of social and technological change in a modern peasant community is not unrelated to understanding the past. Although there are many differences between the present and the past, there are also many similarities. The processes of social and cultural evolution do not change, and in a real sense, the Yucatec Maya, like other Indian peasants of Latin America, are products of a complex blend of forces operating on a society that had its foundation in the pre-Columbian past. By studying this evolution in the present, it is possible to understand some of the processes that were responsible for continuity and social and technological change in ceramic production and distribution more generally. Indeed, this was the point of the generalizations developed in *Ceramic Theory and Cultural Process* (Arnold 1985) and also the refinements of the threshold model of ceramic resources (Arnold 2005a).

Finally, I was reminded about the universality of evolutionary processes that are shared by the present and the past when I was perusing a copy of *World Trade: The Journal of International Logistics*. In an editorial, the journal's editorial director responded to a colleague who had emphasized the downside of increased international trade and globalization.

> [T]he dynamics of global flows—capital, labor, materials, technology, markets—are transforming the world from one economic order (industrial/national) to another (informational/multinational). This is not the first time such transformation has occurred. Human society went from rural agrarian feudalism to mercantile kingdoms to private commerce and nation states. One might as well order the seas to stop reshaping the shoreline as to curtail this social law of nature. (Shister 2007)

Although Shister uses considerable hyperbole (e.g., "social law") and seems callous about the social and personal costs of globalization, his comments do serve to remind us that cultural evolution is a continuing process that began in the remote past. Ethnoarchaeology makes it possible for us to learn about some of the forces and generalizing principles that have led to accelerating social and economic change and are rapidly reforming ceramic production and distribution. On the contrary, to argue that the current world has no relevance to the non-globalized past is to believe that there is an evolutionary discontinuity of the present and the past—an epistemology that I have already argued was naïve. It is reminiscent of a "creationist epistemology" that denies that the processes observed in the present have any relevance to understanding the past. In reality, cultural evolution in the present is accelerating at a rapid pace, collapsing centuries of cultural evolution into the span of a scholar's lifetime. A thirty-two-year diachronic study of ceramic production thus has the potential of helping us understand ancient cultural evolution, which with the proper cautions can help us understand the evolution of ceramic technology in the past.

COLLECTING DATA IN THE FIELD

The bulk of the field research for this book took place during ten visits to Yucatán, Mexico, over a period of thirty-two years. I first went to Yucatán in 1965, when I spent six months studying potters in the city of Ticul. Between 1965 and 1970, I returned five times and then went back again in 1984, 1988, 1994, and 1997 (D. Arnold 1967a, 1967b, 1971, 1987, 1989a, 1989b, 1991, 1997, 1998, 1999, 2000, 2006; Arnold and Bohor 1975, 1976, 1977; Arnold and Nieves 1992; Arnold et al. 1999, 2000; Ralph and Arnold 1988). I also returned for a brief visit of a few hours in 2002. Although it was not a formal research visit, it brought additional time depth, data, and insight to this study. The scope of this study thus spans 37.5 years and provides an unusual ethnoarchaeological perspective that details continuity and change in the production, organization, and distribution of pottery through time.

One advantage of long-term research in the same location is its high degree of validity. Because I have returned to the same community again and again for more than thirty years, I have become well acquainted with potters, their relatives, their residence locations, and their technology. Many potters have become my friends. Each visit built on the rapport and knowledge of previous visits, and as a result, I could assess, even with a brief visit, the veracity of informants' statements and the validity and continuity of long-term patterns. Consequently, I can detect both deliberate and involuntary deception and can easily verify and cross-check data. I can easily identify changes from previous visits, and because I have known most of the potters in the community, I could ascertain, often from observation alone, who is making pottery and where they are making it relative to the patterns of residence and social organization of the community. The relationships established with Ticul potters thus were a major contribution to the success of my research, and the information from them was validated again and again through the three decades of this research.

From a methodological perspective, participant-observation was foundational. This classic anthropological methodology provides a holistic perspective of human behavior that helps the investigator get beyond the cultural, theoretical, and paradigmatic myopia of interpreting ceramics. Through participant-observation, one comes to understand pottery production and distribution from both the inside and the outside. As a result, one begins to comprehend linkages between phenomena that may never have been envisioned previously. At the same time, one's objectivity is never completely lost because the investigator is still an external observer, not a native (Arnold 1991).

Such a holistic approach is complementary to a rigorous scientific methodology and analysis both in the field and in the laboratory. Just as scientific and technical studies of ceramics (Arnold et al. 1991, 1999, 2000; Glowacki and Neff 2002; Pinto et al. 1987; Rice 1987; Rye 1981; Skibo and Schiffer 1987; Skibo 1992, 1994) are essential for understanding the past, so a holistic approach to ceramic production is necessary for inferring the links between ancient ceramics and the nonmaterial behavior patterns that produced them. Such an approach is foundational for understanding how pots relate to people. Similarly, there is no other way to learn the semantic categories, the motor habits, and the choices of the potter than through a personal engagement of the investigator with the people and their craft production. All ethnographic work also is socially embedded, and ethnographers, like potters, learn their craft in a social context.

To chronicle this research experience, detailed field notes were written to supplement data obtained by surveys, photographs, and a question/response technique (called "ethnoscience") used early in the research (Black 1963; Black and Metzger 1965; Frake 1964; Metzger and Williams 1963a, 1963b, 1966). As the research progressed, I began to see the importance of field notes as an independent data source and eventually came to use them as a description about everything that I learned about pottery production, whether or not it was relevant to the goals of the research at the time. Eventually, I discovered the importance of emptying my brain into my typewriter or computer until everything that I had learned on a given day had been written down. The ideal was not to return to observing and talking to informants until the recording process was complete. This ideal was not always realized because in some situations, two or more days elapsed before field notes were transcribed. During some days in 1965, for example, no written field notes existed because I did not have the time to do it. To solve this problem in 1968, I experimented with the use of a tape recorder. Although it provided a useful way to record field notes in the backseat of a Volkswagen driven by a colleague, lying in a hammock, or deep within a clay mine, getting the information off the tape and placing it into its appropriate context proved to be a difficult task, and one with which I still struggle more than thirty years later. Not the least of my difficulties was the occasional unintelligible gibberish I uttered into the recorder while lying in my hammock, exhausted after a hard day's work. Thinking that I could record my field notes before I went to sleep, I soon discovered that my consciousness usually shut down before my mouth did. Recording field notes had to be more deliberate, conscious, and intentional with a fuller description of the context of the day's experience. So I abandoned the use of a tape recorder after 1968 and considered my use of it for field notes as a failure.

My visits to households often jogged informants' memories of incidents that I had long forgotten and provided almost instant rapport. In 1997, a widower I had not seen for thirteen years invited me to his house for lunch. He was living with his only daughter and her husband. During our conversation, he proudly showed me a tinted 11 × 14–inch enlargement of a photograph of a young couple and their baby that I had taken thirty-one years earlier. It was one of many Polaroid photos that I had provided to informants in 1966 in order to build rapport with them when I had surveyed potters' households, collected temper samples, and asked for information (D. Arnold 1967a, 1967b, 1971). The enlargement process, however, had not only amplified the image but had exacerbated the testimony of many years of handling of the original photograph and ragged wear around its edges. I was puzzled why an enlargement of my photograph was such a cherished memento until I returned home and examined my genealogical database (see below). At the time when the photo was taken, the potter had been married for two years and his wife had given birth to a daughter. A year later, however, his wife had suddenly died. My photograph appeared to be the only image that the widower had of his deceased wife and was the only visual record that he and his daughter had of her.

Comparison of the data from Ticul with other pottery-making communities in Latin America has provided a comparative perspective that highlights significant insights in this work for archaeology. Having been a participant-observer in other pottery-making communities in Guatemala (D. Arnold 1978a, 1978b; Arnold et al. 1991) and Peru (D. Arnold 1972a, 1972b, 1975a, 1983, 1984, 1993) since the beginning of this study in 1965, I come to this book with diverse ethnographic experiences in the study of preindustrial ceramic production. These experiences have enhanced my relative objectivity in approaching the data presented here because I understand them within a comparative framework. This perspective increases the effectiveness of the archaeological application of this work because my experiences studying pottery-making communities in two other areas of the Americas serve to de-emphasize those data that do not have cross-cultural relevance or application.

This book joins a rich legacy of ethnographic and ethnoarchaeological descriptions of pottery production in Mesoamerica (D. Arnold 1978a, 1978b; P. Arnold 1991a, 1991b; Deal 1988, 1998; Druc 2000; Foster 1948, 1955, 1960a, 1960b; Friedrich 1970; Hayden and Cannon 1984b; Kaplan 1974, 1980; Krotser 1974; Lackey 1982; Papousek 1974, 1981; Pastron 1974; Reina and Hill 1978;

Thompson 1958; Weigand 1969; Williams 1992, 1994a, 1994b, 2006; Williams and Weigand 2001). Although the most direct application of this work will be in the Maya area and in Mesoamerica, this work should provide understanding of some basic processes of pottery production and distribution that have wide-ranging application to the present and the past.

DATA REDUCTION AND ANALYSIS

From all of this research, three electronic databases were assembled. The major purpose of these databases was to compare the data from all ten of my visits and trace individual potters and production units through the thirty-two years of this project. The databases thus provided a means to organize information, facilitate writing the text, and support the points in the text with evidence.

The Genealogical Database

Genealogies of the entire population of potters in Ticul provide the data for assessing change in social organization. My primary purpose in developing this database was to graphically represent the relationships among potters across all of the generations and provide links among the seventy-one kinship charts elicited in 1984. These links were complex and it was difficult (almost impossible in some cases) to see patterns from chart to chart.

In order to understand the kin structure of the community, I needed to represent the genealogical data holistically and from the perspective of several different families. So the data from the 1984 kin charts were entered into a genealogy program (Parsons' Family Origins program). The resulting compilation consisted of 1,024 individuals, 287 nuclear families (e.g., mother, father, and children), and 659 events. The events category consists of a group of fields that includes birth date, marriage date, death date, residence, place of origin, occupation, and other information. The events data, however, are uneven because some individuals have many such events and other individuals (such as those deceased for more than one generation) have no entries in the events fields.

This database has proven to be a great advantage for analyzing the data, and for writing this book. First, it provided an easy way to correct and update the kin relationships with new data collected in 1988, 1994, and 1997. Second, the genealogical data can be accessed in a variety of formats, including ancestors, descendants, family groups, and standard family trees. Third, it made quantification of the data much easier. Fourth, it provided a quick and easy way to answer specific questions about kinship relationships. Each time a question arose about the relationship of one potter to another, I went to this database and answered questions such as, Who were the descendants of Potter X? Who were the ancestors of Potter Y? How many children did Potter Z have, and what were their names? How are the five generations of Family A related to the five generations of Family B?

The data in the genealogical database were supplemented with data from microfilmed records of marriages from the Ticul church. Early in my research I had learned that a colleague was using microfilmed birth and marriage records from Ticul that were available at the genealogical library in Salt Lake City. I had always wanted to consult these records and expand my genealogical data. During more than thirty years of research in Ticul, all of my observations seemed to fit with my genealogical data. There were, however, some ambiguities that always seemed to slip through the cracks, and I was anxious to resolve them. Furthermore, I was hopeful that the microfilmed records might provide more precision on birth and marriage dates and also more data on potters than I had collected in the field. Much to my delight, I discovered that my genealogical data proved to be accurate, and the church records succeeded in resolving ambiguities that had puzzled me for almost fifteen years. The data also aided me in filling in some missing details, such as birth and marriage dates.

The Production-unit Database

The second database used in preparing this book was compiled from data collected during visits to production units. Each potter who was making pottery during each visit has a record (N = 300) in the database and each record contains a set of fields for each visit from 1965 to 1997. In total, there are eighty-eight fields for each record.

The set of fields includes the type of potter (an owner of the production unit, worker, or relative of the owner), production location, type of production, its address, the type of pottery produced, and the names of other potters working there. Three other data fields were used to record the data about any pottery store that was associated with a production unit. After the 1997 fieldwork, fields such as "helpers" and "painters" were added because some production units were becoming increasingly specialized with workers who were not potters. Additional summary fields were added to provide quantitative comparison between the different visits.

Some fields have few data (such as those from the 1967 and 1968 visits), whereas other fields (such as those for the 1965, 1966, 1984, 1988, 1994, and 1997 visits) have many data. Since the 1965 and 1966 visits were only six months apart and the data were complementary, the data from these visits were considered contemporary and were combined into a new set of fields, the 1965–1966 fields.

The production-unit database facilitates tracking individual potters and production units through the many years of my research. These data revealed changes in the composition and size of production units over time, changes in pottery produced by each production unit, and the growth of stores used to sell the pottery. I have also used this database to write a historical narrative of each production unit showing the change of each through the three decades of my research, but these narratives will be a subsequent monograph.

The Potters Database

This database has a different structure than the genealogical database and the production-unit database. It consists of 451 individuals who learned pottery making sometime during their lifetime and organizes data about learners and active, inactive, and deceased potters compiled from the seventy-one genealogical diagrams collected in 1984. In this database, each potter (or learner) has a record. These potters include active and inactive potters, potters learning the craft in 1984, and those elicited from informants to the limits of their memory; sometimes this memory included deceased individuals living as much as four or five generations previously. Each record consists of twenty-nine fields that include the potter's name, gender, relative age, marital status, and the years that the potter was active. In addition, this database contains fields that indicate the type of individual from whom the potter learned, why they learned, and the intergenerational learning lineage (e.g., FaFaMoFa). Fields also include the name of the household in which the potter lived, the type of household in which he or she lived (e.g., Fa, MoBr), names of other potters in the extended family, and the kind of fabrication technique that the potter used. This database includes distance data (in blocks) that consist of the distance of a potter's residence to that of the individual from whom a potter learned the craft, the distance from a potter's residence to his/her father, and the distance of a potter's residence to the nearest pottery-making family. A parallel set of fields was set up with distances to their work location.

Several fields focus on finding selective factors that affected the potters' residence, work location, and the perpetuation of the craft. During the preparation of the kin diagrams in the field, for example, I noticed that the children of single mothers seemed to become potters more often than children in other potters' households. So I added a field in this database to flag single mothers and the type of single mother (e.g., unmarried, widowed, or abandoned). A related field includes the percentage of a potter's children who learned the craft, the percentage of children who became potters, and the percentage of one's children who did not become potters and why. A final field was added that listed the reason why a potter had abandoned the craft if he or she was no longer active.

The principal limitation of this database is that it does not contain much information from 1988 and 1994 and no data from 1997, because the fieldwork since that time was not primarily oriented to obtaining information in the fields in this database. It thus does not include individuals who have become potters since 1984.

THE PLAN OF THE BOOK

The Social Dimension of Production

The first section of the book focuses on the social dimension of production and emphasizes the social embeddedness (Sillar and Tite 2000) of technology, distribution, and agency (Dobres and Hoffman 1994). Although apparently new to archaeology and materials science, these perspectives are rather obvious to those of us who are ethnographers and who have spent all of our professional lives focusing on the ethnography of technology. We understand that technology is produced by human beings who creatively adjust to environmental, social, and infrastructural circumstances to solve problems, make choices, and interact with one another to pass on their knowledge. This knowledge is cognitive, but it is also embodied in the muscle patterns that may, or may not be, conscious. Further, ceramic technology is community-based within a population of potters that differs from that of other populations of potters nearby (D. Arnold 1971, 1978a, 1978b, 1991, 1993:9–12, 233–236, 2005a).

This section emphasizes how the social dimension of production plays a significant role in the craft apart from the engagement of the potter with socially embedded knowledge, tools, and techniques. The first chapter of this section (Chapter 2) focuses on the population of potters, details its composition and change from 1965 to 1997, and shows how the craft is passed down from generation to generation. It describes those mechanisms that operate over time and select for, or against, certain members of the population and causes them to aggregate into larger production units.

Besides production, distribution is a critical feature of any ceramic production system and also has a significant social component. Distribution consists of two different dimensions. First, demand is critical because producers must exchange their products for food or some commodity (like money) that can be readily exchanged for food. Consumers must desire the pots, and demand thus relates closely to the values of the consuming population. Like production itself, demand is also socially embedded and socially embodied because pottery shapes must be congruent with the values and the habitus of the consuming population, which includes its motor habits, carrying patterns, and furniture configurations

(D. Arnold 1985:151–166). In some contexts, however, pluralistic populations of consumers may have varying uses for pottery vessels, and potters must respond to the container desires of these varying constituents. Chapter 3 thus details the demand of different consuming populations and how that demand has changed over time.

In addition to the demand for ceramic vessels, distribution involves the way in which potters place their pottery into the hands of consumers. Although demand is embedded in human populations according to the values and motor habits of the consumers, actual distribution of pottery is embedded in a different way and often on a different level and is closely related to the economic infrastructure, such as transportation and trade networks. This infrastructure requires that the potters develop strategies to successfully market their wares. Chapter 4 thus details the methods of distribution by which potters meet the demand and how this system has changed since 1965.

The Production Sequence

The second major section of this book describes the change in each of the major segments of the behavioral chain (Schiffer 1975) of pottery production through time. Probably one of the most fundamental problems with using ceramics in archaeology is failure to understand how the ceramic production sequence is limited by the molecular structure of clay minerals and how the embodiment of the craft comes from the potters' engagement of their learned patterns with the visual, tactile, and aural feedback from the production process.

Because many of the technological realities of the behavioral chain are isomorphic across time and space, the five chapters in the second section of the book are organized around that sequence. No matter when or where production occurs, potters must first procure clays, prepare the paste, form the vessels, dry them, and then fire them—in that sequence. For archaeologists without experience in real-world ceramic production, however, the emphasis on the behavioral chain is an important reminder that ceramic production is not totally responsive to culture but has important constraints because of the nature of clay minerals and the limits that those minerals place on the production sequence.

The basic behavioral chain of making pottery is thus culturally universal and accounts for some of the cross-cultural regularities of ceramic production across time and space. Understanding this sequence permits inferences about ceramic production in the remote past that are based on processual analogies derived from the fundamental chemical processes of pottery production (D. Arnold 1985). In the study presented here, it is possible to see the changes in different parts of the ceramic production sequence that have relevance to the past and those that do not.

Chapter 5 describes the changes in clay procurement and shows how these changes relate to landownership, micro-political factors, and procurement organization. Then Chapter 6 does the same with temper procurement. Chapter 7 focuses on the changes in the preparation of the paste and assesses whether the changes in procurement in the clay and temper can be seen in the chemical composition of pottery. Chapter 8 details the changes in the forming technology and evaluates theories of how technological change affects the fabrication technology. This chapter concludes with an evaluation of the oft-repeated assumption that efficiency is the driver of technological changes of independent specialists. Chapter 9 examines the firing technology and its changes through time. It concludes with another evaluation of the role of efficiency in changes in this technology over time.

Finally, the concluding chapter of the book (Chapter 10) examines the larger picture of change in the system of production and distribution of pottery in Ticul from 1965 to 1997. First, it answers the questions posed at the beginning of this book by providing a summary of the relationship of pottery to the nonmaterial social world. Second, it describes the relationship of time and change by evaluating those aspects of production and distribution that change most rapidly and those that do not. Finally, the conclusion answers the question "What does pottery tell archaeologists about social change?" and elucidates the insights that the book provides that are relevant to archaeological interpretation. It also reviews the contributions of this work to the themes of the development of craft specialization and use of ceramics as a surrogate index of social change. Finally, the chapter summarizes the processes responsible for these changes and the contributions that the data can make to understanding the development of ceramic specialization in antiquity.