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Cover: Microblade inserts and Perkiomen bifaces (from Andrefsky: Figures 1, 4).
THOUGHTS ON STONE TOOL SHAPE AND INFERRED FUNCTION

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ABSTRACT

Inferences of site function from stone tool function based upon tool typologies are very common in the contemporary archaeological literature. A brief review of some ethnographic and archaeological studies confirms the long standing proposition that stone tool shape does not always correlate to a particular function and that some stone tool shapes may have been effective for multiple functions. It is shown that processes such as tool production and tool use as well as situational constraints encountered by tool makers are responsible for much of the variability in stone tool shape and that these processes and constraints should be accounted for when building stone tool typologies. As a result, it is argued that site functions can not be inferred from artifact functions based upon morphological typologies in all cases.

INTRODUCTION

Close to 20 years ago George Odell (1981) wrote a definitive paper on the relationship between stone tool morphology and function. His conclusion emphasized the fact that stone tool functions could not be inferred from the shape of particular tools and that most individual tool shapes were used for multiple functions. Most researchers familiar with stone tool analysis would agree with Odell’s findings, yet the archaeological literature is still full of inferences on site functions based on artifact shapes believed to be associated with artifact functions. For example, a quick perusal of recent M.A. theses and Ph.D. dissertations dealing with stone tool assemblages reveals an almost universal acceptance of stone tool shape equating to function. Dissertations and theses are not the only place where such arguments are made. I have recently seen archaeological research designs for compliance projects that require investigators to determine site functions on inventory forms based upon artifact typologies. In some cases the projects required determinations of site functions from artifact noncollection surveys.

Given the fact that so many American archaeological researchers continue to equate stone tool shape to function probably means there is good reason to do so. However, direct functional studies of stone tools based upon microwear evidence continue to reject such arguments in most, but not all, cases. With this contradiction in mind I provide a brief review of stone tool shape as it relates to function. I also examine some of the processes that affect stone tool morphology other than functional design constraints. Ultimately, this review leads to a discussion about the relationship among stone tool style, typology, and the processes that act upon stone tool morphology.

STONE TOOL STYLES AND FUNCTIONS

It is easy to imagine that ever since researchers began naming stone tools after modern-day functional tools, some stone tools were ascribed functions. For instance, a stone tool shaped in a similar fashion to an iron spear tip and called a stone spear tip was probably believed to function as an iron spear tip. Terms such as knife, scraper, drill, graver, and perforator have been used to identify various morphological artifact types. These names imply an artifact function. Traditionally, such terms also imply a single
function for each artifact type. For instance, scrapers were believed to be used for scraping hides and not necessarily anything else; similarly, dart points were believed to be used to tip projectiles and not necessarily any other function.

The controversy involving Mousterian lithic artifact variability was responsible for generating a great deal of literature on the function of lithic artifact types (Binford 1972; Binford and Binford 1966; Bordes 1979; Bordes and de Sonneville-Bordes 1970). In this debate Bordes believed that the variability found in an assemblage of Mousterian stone tool types was attributable to differences in prehistoric cultural groups depositing such tools. Variability within the same lithic assemblage was interpreted by Binford as differences in functional tool varieties associated with different activity areas. Most of the researchers working on this topic recognized that formal variation in stone tool types could be attributable to one of two sources, style and function (Dunnell 1978; Sackett 1977). Once the formal variability associated with the style of a stone tool was defined, the remainder of variability became functional or nonstylistic. A problem with this approach was how to define style (Close 1978; Sackett 1986). Other archaeologists muddied the waters between style and function by determining that style was functional or that style had a function (Conkey 1978, 1980; Wiessner 1983; Wobst 1977). Function in this sense usually referred to the role of stylistic variability as a social group marker or as a means of information exchange, and not to design constraints on tools related to task or activity performance.

The notion that stone tool morphological variability related to functional constraints or to functional and stylistic constraints led investigators to evaluate the relationship between the form and function of stone tool types. Jelinek (1976:27) suggests that the reason archaeologists have had difficulty determining stone tool characteristics associated with function is because the criteria they employ for the classification of lithic artifacts is neither explicitly functional nor morphological, but a mixture of both. Jelinek's interpretation seems correct, but the problems for archaeologists are even more basic than the clarity of classification criteria. Until relatively recently there has been no adequate, objective way to assess the function of lithic artifacts. One of the problems with evaluating lithic studies that explored the relationship between form and function was the lack of an independent technique to determine the function of stone tools. After Semenov's (1964) pioneering work in microwear analysis of stone tool functions, many archaeologists have been able to effectively determine the function of lithic artifacts (Ahler 1971; Bamforth 1988; Gould et al. 1971; Hayden 1979a; Kamminga 1979; Keeley 1974; Nance 1971; Odell and Odell-Vereeken 1980; Vaughan 1985; Yerkes 1994). Several studies have specifically compared morphological artifact types to function and for the most part, established that various morphological shapes of stone artifacts are functionally heterogeneous (Ahler 1971:118-120; Keeley 1974:86-165; Nance 1977; Wylie 1975:27). Since artifact form does not appear to correlate with artifact function in all cases, the following sections examine various lithic artifact forms and their functions and provide a brief review of the related literature.

Microblades and Microliths

Lithic tools manufactured on relatively small bladelets are commonly found in many parts of the world. They are sometimes called microliths in the European and Levantine Mesolithic (Myers 1989; Olszewski 1993). In the Arctic regions of northeast Asia and northwest North America these forms are known as microblades (Ackerman 1996; Andrefsky 1987; Kobayashi 1970; Morlan 1970; Yoshizaki 1961). These bladelets have been classified into a variety of forms based upon overall size, number of edges, location of retouch, and type of wear. Generally, these tools are made on small parallel sided blades that are modified into a desired shape. They are usually not more than 2 cm wide nor are they usually more than 5 mm thick. In addition to being relatively small, they have the characteristic of very sharp and uniform edges produced from some kind of a systematic core reduction strategy.

Microblades from the Arctic have traditionally been interpreted as projectile point components. The Arctic microblades are believed to have been used as side or lateral inserts along the length of a smooth bone shaft that had been slotted to accept the microblades. Ackerman (1994:110) recovered such a slotted bone point with an embedded microblade from the Lime Hills Cave in Alaska. Various examples of microblades and microliths hafted as projectile point tips, barbs, and inserts are illustrated in Figure 1.
Microliths from the European Mesolithic were long believed to be used as hunting tools on projectiles (Clark 1969). Microliths with three sides or "triangles" were believed to be used as point tips and as point barbs (Mellars 1974). Triangular microliths found in Africa have also been interpreted as barbs or points for projectiles (Deacon 1984; Olszewski 1993). Four-sided microliths have been interpreted as inserts for projectiles (Myers 1989).

Although a great deal of evidence is mounting that microliths and microblades were used as projectile tips, barbs, and side inserts, there is also evidence that such tool forms were used for other functions as well. Both Odell (1994) and Yerkes (1983) have used microscopic techniques of analysis to determine the function of bladelets. Independently, they determined that bladelets were used in a variety of activities that included cutting, graving, drilling, shaving, and using as projectiles. Additionally, Odell suggested that when bladelets were used in a ceremonial context, they were only used to cut and scrape soft materials (1994). Microlith inserts have been determined to be used as sickle blades for harvesting plants (Garrod and Bate 1937). Additionally, Curwin (1930) illustrates several examples of sickles excavated from various locations in Europe and the Middle East; these sickles have rectangularly and triangularly shaped microliths inserted along the inner curved edge of wooden handles or blades. Clearly, these bladelets (or microblades or microliths) as a group cannot necessarily be associated with a single activity, but instead with
a combination of activities such as hunting, grass harvesting, or bone graving. The function of individual bladelets may vary depending upon the context, shape, size, and wear of the specimen.

Endscraper Functions

Another form of artifact that has been repeatedly assigned a function in the literature is the endscraper. Many researchers have ascribed the function of animal skin working or scraping to the endscraper (Nissen and Dittemore 1974; Stanford 1973), and this function has been observed in the ethnographic record (Murdoch 1892; Nelson 1899). These stone tools are usually hafted, and according to Hayden (1986:66), were held nearly parallel to the skin surface, with the scraper blade drawn both toward the worker and pushed away from the worker, so that wear occurred on both the dorsal and ventral surfaces. The endscraper cutting edge or bit approximates an angle of between 70° and 90° and makes the edge effective for scraping but not acute enough to accidentally slice or cut the material being worked. The wide edge angle on endscrapers is probably one of the reasons most researchers ascribe a scraping function to this tool form.

Endscrapers are found in almost all parts of the world and in practically all time periods where stone tools are used primarily. Meltzer (1981) conducted a discriminate analysis to assess whether endscraper form was the result of function or style and concluded that the form or shape of endscrapers was attributed to endscraper function. However, his analysis did not determine the type of function for which endscrapers were used. Dumont (1983:132-137) specifically evaluated the function of endscrapers recovered from Star Carr. He found that endscrapers were used for working hide, bone, wood, and antler, and his results contradict the popular notion that endscrapers were used solely as hide working tools.

Another functional study of endscrapers looked specifically at the action or mode of use for this form of artifact. Using microwear analysis on lithic tools from a Dutch Mesolithic site, George Odell (1981) compared classic morphological types to observed functional wear, and found that endscrapers were used in many activities other than scraping. Endscraper activities identified in Odell’s study include scraping, graving, boring, chopping, and using as a projectile. Other classic morphological types such as side scrapers and burins were also found to have been used for several different functions.

Siegel (1984) actually tested the proposition that endscrapers were used solely in hide working activities. His functional analysis was done on two populations of endscrapers, one from the Utikivik site in Alaska and the second from the Lowie Museum collections located in Berkeley, California. The results of his analysis showed that endscrapers were used on wood, clean bone, silty bone, silty hide, hide with hair, and antler. Siegel found that wood and not hide was the predominant material worked by endscrapers examined in his study.

Admittedly, there are problems associated with microwear analysis, particularly on stone tools that may have been used on more than one kind of material, but it is noteworthy that several microwear studies have shown that endscrapers were multifunctional tools. It is probable that endscrapers were not only used on several kinds of materials, but that they were used with several different kinds of actions or motions such as graving, boring, and slicing.

Hafted Biface Functions

One of the most common tools ascribed a function in the American archaeological literature is the hafted biface or projectile point. Hafted bifaces are often assumed to be the tip or apex for a spear, dart, or arrow. It is not difficult to be persuaded that a hafted biface has a projectile function; hafted bifaces look very similar to tips found on modern day projectile weaponry such as archery and lancing equipment. Figure 2 shows several examples of prehistoric hafted bifaces along with contemporary projectile point tips from archery hunting equipment. The similarity between the prehistoric and contemporary morphologies certainly suggests similar functions. In fact, many recent studies have found that some hafted bifaces were used as projectile tips of some kind (Churchill 1993; Patterson 1985). However, it should also be noted that some microwear functional studies have demonstrated that hafted bifaces were used as cutting and butchering tools in addition to their use as a projectile. Ahler’s (1971:108) analysis of hafted bifaces
from Roger’s Shelter indicated that less than 25% of the hafted bifaces were used as projectile points or tips. His study showed that hafted bifaces were also used for slicing, cutting, sawing, whittling, scraping, splitting, and piercing. Nance (1971:365) has also conducted functional analysis on hafted bifaces and concluded that they had multiple functions. Greiser’s (1977:114) work with Plano hafted bifaces from Colorado led her to the conclusion that this form of artifact was purposely manufactured as a multifunctional implement for use as a projectile, butchering tool, and skinning tool.

All these studies specifically evaluated the function of hafted bifaces and showed that hafted bifaces were used as projectiles at least some of the time, but that they may have primarily been used to perform other functions. This does not mean to suggest that some hafted bifaces were not specialized tools used exclusively as projectile tips. There are certainly cases where small arrow points or even large Paleoindian fluted points from North America were probably never used for functions other than as projectile tips.
However, even the late Paleoindian Dalton bifaces on the American Plains studied by Goodyear (1974) showed evidence of being used as cutting and slicing tools. In fact, during the use-life of these Dalton points the blades were dulled by cutting and ultimately sharpened to such a degree that they were reworked into a morphology traditionally recognized as a bifacial drill.

Other Morphologies and Functions

Unlike the numerous studies of microliths, endscrapers, and hafted bifaces, there have been few functional studies of other traditional forms of artifacts specifically perforators, nonhafted bifaces, side scrapers, drills, burins, and spokeshaves. However, Lewenstein (1987) and Odell (1981) have examined some of these forms of artifacts. Lewenstein conducted a functional analysis on a sample of 1449 chipped stone artifacts from Cerros in Belize. Her formal categories corresponded to many types recognized in several different parts of the world. She identified three different kinds of nonhafted bifaces: oval bifaces, thin bifaces, and nonstandard bifaces. Her functional analysis revealed that chopping and pounding were the two most common functions for oval bifaces; other functions for oval bifaces included sawing, scraping, scraping/planning, abrading, and using as an adze. Thin bifaces were predominately used to cut and slice, but also for sawing, scraping, scrape/planning, and butchering. The nonstandardized bifaces were found to have had 13 different functions; however, scraping was by far the most common function for nonstandard bifaces. Lewenstein’s analysis provides some idea of the diverse uses of nonhafted bifaces.

Odell’s (1980, 1981) analysis of chipped stone tools from the Netherlands also provides some indication of the diversity of functions for several different kinds of chipped stone artifacts. Although no bifaces were included in his sample, 109 side scrapers were analyzed. The two most common functions were the transverse motions of scraping and graving. Odell also found side scrapers were used in a cutting motion, chopping, as a projectile, and various combinations of these functions.

Lewenstein (1987) has also examined lithic tools that could be considered drilling and boring tools. Her results have identified these tools as primarily being used for perforating functions. Functions such as scraping, graving, and cutting were also identified, but only as secondary functions.

Several other studies primarily using retouched and nonretouched flakes in the analysis of artifact function demonstrated without exception that these artifacts, regardless of form, have multiple functions (Kamminga 1978; Semenov 1964). For example, Keeley’s (1980) analysis of flake stone tools from Essex, England, revealed the functions of wood whittling, wood scraping, wood sawing, wood chopping, meat cutting, bone boring, and bone graving, among others. From Keeley’s work alone it appears that flake tools were used for almost any function.

ETHNOGRAPHIC OBSERVATIONS ON TOOL FUNCTION

The microwear data presented above provides compelling evidence to suggest that stone tool style does not necessarily conform to function in all cases. However, the utility of microwear analysis as a technique to determine stone tool function has been challenged in blind tests and the results of such tests have not always produced satisfactory results (Grace 1989; Keeley and Newcomer 1977; Newcomer et al. 1986). Additionally, some microwear studies have produced contradictory results (Hayden 1979a, 1986; Siegel 1984, 1986). As such it is important to review other evidence that may have a bearing upon the relationship between stone tool shape and function.

Correlations of artifact form with artifact function are almost universally rejected by ethnographers and ethnoarchaeologists. White’s (1967:409) observations in the highlands of New Guinea conform to this position. He indicates that the New Guinea population does not regard a flaked stone as a functional whole in the archaeological sense; these people do not treat a stone tool as a type, but rather as a piece of stone that can be used to get the job done. White and Thomas (1972:278) make similar observations, and they indicate that modern New Guinea Highlanders regard their stone tools as pieces of stone and do not
recognize any series of formal or functional types. Hayden's (1977:179) work with Australian Aborigines also supports this lack of correlation between artifact form and artifact function. He remarked:

There was no indication of any overall morphological ideal type, "classic" form, or "perfect" specimen, as collectors are wont to say, and as archaeologists often tacitly accept in conversation. Rather, the traditional attributes of importance in the Western Desert were: effective edges (which were surprisingly variable in morphological expression), and a suitable size for holding in the hand and exerting pressure.

Gould's (1968:119) ethnographic observations of the Ngatadjara of western Australia led him to the conclusion that stone tool functions were based upon the working edge of tools rather than the overall form of the artifact. Heider's observations of stone tool forms and functions used by the Dani of New Guinea suggest that functional terms used by archaeologists for various forms of tools do not correlate with artifact function and actually misrepresent the functional character of assemblages. He (1967:56) cautions:

In many cases archaeologists prejudice their own attempts at reconstructing particular cultural behavior by building time-hallowed functional terms such as scraper or handaxe into their original typology. In the archaeological process, functional attributes should be end products, not opening assumptions.

Ethnographic and archaeological evidence casts some doubt upon the assertion that artifact style conforms to a particular function. Essentially, it can be said that various forms of stone tools may have several different functions and that no artifact function can be ascribed to a particular form in all cases. It is also important to remember that when the function of a tool has been determined with a high degree of certainty, the multifunctional character of the tool must then also be considered. Most stone tools were probably used for several different functions and the degree to which a tool was specialized or used for a single function or became generalized and multifunctional probably varied with individual tools. The multifunctional character of individual stone tools relates to aspects such as availability of raw materials for tool production, efficiency of tool design relative to task performance, and particular cultural or individual preferences for task performance. Additionally, many activities carried out by stone makers and users probably required different kinds of tools in different degrees so that any activity may have required various combinations of tools for variable amounts of work.

STONE TOOL MORPHOLOGICAL PROCESSES

Since it is apparent that stone tools may not be designed along functional parameters in all cases, it is important to inquire about the conditions that affect stone tool morphology. Recent stone tool studies have identified several processes other than functional constraints that influence the morphology of stone tools (Andrefsky 1997; Hayden et al. 1996; Rondeau 1996). Use processes and production processes have been identified as important factors affecting stone tool shape, yet archaeologists seldom account for such processes in the classification or analysis of stone tools. All stone tools undergo a process of production, and a process of use that act upon the stone tool and the population of stone tools to create different shapes and sizes of individual specimens. These dynamic processes cause the lithic tools to change and evolve, both individually and as an assemblage. Any processes that are responsible for changes in lithic artifact morphology are important for a better understanding of stone tool classification and function. Provided below is a brief discussion of production and use processes as they affect the morphology of stone tools.
Figure 3. Schematic drawing of a bifacial reduction sequence from raw material blank to notched biface. Adapted from Andrefsky (1998).

Tool Production Processes
Some stone tool types such as bifaces go through a sequence of production stages (Callahan 1979; Whittaker 1994) that gradually transforms the piece of stone into a weapon capable of dispatching a large animal. Figure 3 illustrates various stages of biface production from acquisition of raw material to
production of a hafted projectile point. Anywhere along this production continuum the projectile point can break and be discarded. Broken specimens are frequently found at production locations such as quarries (Reher and Frison 1991; Torrence 1984). Also it is possible that the tool maker may halt production of the bifacial projectile point at any stage of production for use at that point in the production process or for transport to another location for further reduction and/or to be used as a tool.

Kelly (1988:719-721) introduced the concept that any particular biface may have multiple functions depending upon its context. Other stone tool studies also support this position (Goodyear 1979). For example, an early stage biface is quite practical for use as a chopper or hand axe because of its relatively wide edge angle; its blade is ideal for chopping or hacking on hard materials such as wood with little danger of breaking. This same biface can be resharpened when the edges become dull, or it can be thinned to better perform a cutting or slicing task. If flakes are needed to slice soft materials, the early or middle stage biface can act as a core or source of raw material for flake reduction. As usable flakes are removed from this bifacial core, it can be simultaneously thinned to yet a later stage in the production process. If needed, the biface can be notched and hafted onto a handle or foreshaft for use as projectile point tip. However, the hafted biface does not need to be used exclusively as a projectile point. It can be used as a hafted knife for sawing or cutting materials, and when necessary, inserted into a spear or lance for use as a projectile point tip.

The various stages of bifacial production yield specimens with different qualities suitable for various activities. It is conceivable that a biface ultimately attached to a haft and used as a projectile tip or a lance was previously used as a chopping, scraping, or cutting tool. This production process not only changes the morphology of the biface, but may also change the function of the specimen. The production process may be responsible for a great amount of morphological variability.

Even less formalized lithic tools undergo a sequence of manufacture in their production processes. For instance, if triangular microliths are needed for the production of arrow barbs (see Figure 1), a core is prepared from which microliths can be detached. The suitable microliths are then fractured and retouched to their final triangular form. During this production process, there is a good chance that some of the blades removed from a core will not be suitable for modification into triangular microlith segments. Those specimens and even the ones that may be suitable for microlith production can be drafted into service as slicing tools, drills, gravers, or some other function. There is also the possibility that the microliths will not be adequately shaped into triangular segments during the production process due to production failures. It is also possible that the selection of individual microliths for use as barbs may vary depending upon other circumstances, such as the availability of lithic raw materials, the capabilities of the maker, and the amount of time available to prepare the tool. Clearly, the microlith production process has the potential to produce a great amount of individual morphological variability within the assemblage, and individual artifacts may undergo a production cycle that continually changes their form.

Tools requiring little or no effort in their production are called expediently manufactured or informal tools (Andrefsky 1994; Bamforth 1986; Kelly 1988). An expediently made tool may be as simple as an unmodified flake or blade removed from a core. Such detached pieces have been found in the ethnographic record to be used for any variety of tasks such as cutting, slicing, or scraping (Hayden 1979b; Miller 1979). Different shapes of detached pieces can be used for the same tasks or the same shapes of detached pieces can be used for different tasks. These expediently produced tools immediately introduce a great amount of variability into the lithic tool assemblage because their morphology is not constrained by design requirements.

The production process is important in lithic technology because the range of variability of lithic artifacts has implications for immediate tool use as well as flexibility of tool design. The modern concept of tool design and tool use is fundamentally different from the design and use of prehistoric lithic tools. In most contemporary contexts we perceive tools as finished products. These include all manner of tools from simple hand tools such as hammers, knives, spoons, wrenches, pens, and pencils to more complicated tools such as blenders, coffee pots, table saws, and calculators. We perceive tool use in a context where these finished tools are drafted into service for a particular task or tasks. The process of making tools to
perform an immediate or anticipated task is seldom incorporated into our contemporary tool use context. However, as described above, lithic tool design and use is more closely linked to production processes. As such, the dynamics associated with lithic tool production processes have implications for stone tool typology as it relates to tool design, function, and formal qualities.

Tool Use Processes

Stone tools can be modified to meet specific task requirements after they become dull or break while they are used to slice, scrape, engrave, and/or puncture materials. The process of use and modification for additional use can change the morphology of the tool very quickly or gradually. For instance, during the use life of a lithic tool, minor modifications such as sharpening or shaping an edge can be compounded to make great changes to the overall morphology of the specimen. However, this change occurs very gradually as the specimen is used and modified by small amounts. On the other hand, lithic tools may change shape almost immediately if they are broken and reworked into a usable tool. It is also possible that a tool may be dramatically reworked without being broken if no other alternatives are available for the prehistoric tool maker and user.

A good example of the manner in which use processes can gradually and in some cases very quickly affect the morphology of stone tools would be to examine the Perkiomen Broadspur biface assemblages from the Delaware River drainage in the Eastern United States (Kinsey 1972; Kraft 1970). Perkiomen points are relatively large-bladed, corner-notched bifaces with high width to thickness ratios. In some assemblages from the Delaware River drainage these points are found in association with what have been called Perkiomen drills and endscrapers. Perkiomen drills and endscrapers have haft elements identical to Perkiomen points, but the blades have been modified to apparently perform different kinds of functions. The endscraper specimens have classic steep edged bits and were probably made on broken Perkiomen points when the haft elements were still attached to a handle. This is probably why Perkiomen endscrapers have the same shaped haft elements as Perkiomen points. In this case the use processes changed the tool morphology very rapidly. The Perkiomen drills were probably modified over a longer period of time as the biface edges were used and resharpened repeatedly. Perkiomen drills are noted for having protruding lateral margins or wings (Figure 4). This characteristic probably developed as a result of the original blade being partially inset into the haft or handle during resharpening. In effect, the lateral wings were probably produced as an unintentional by-product of the use and resharpening process and not as an intentional design or stylistic characteristic. Similar observations were made by researchers experimenting with Perkiomen production strategies (Moeller 1990; Truncre 1988, 1990). This same kind of phenomenon has been observed on Paleoidian endscrapers. For example, several researchers have remarked that the spurred endscaper is a diagnostic type of endscaper associated with Paleoidian assemblages from North America (Rogers 1986; Wilmse 1968). However, new evidence suggests that the spur on such endscapers is a result of the gradual resharpening process in much the same way that Perkiomen points are gradually changed into drills. Shott's (1995) research with spurred endscrapers shows that the spur may actually be an unintentional characteristic derived from resharpening the endscaper blade while it is mounted in a haft.

Another example of the way use processes can modify the shape of stone tools is found in the study of the Dalton assemblage conducted by Albert Goodyear (1974). The Dalton assemblage was traditionally recognized as having several diagnostic tool forms such as knives, drills, and projectile points; these tool forms were recognized as characteristically Dalton by their notched haft element. Through a set of use and resharpening experiments, Goodyear demonstrated how the same specimen could change from one form to another through gradual use and resharpening. In effect, he showed that traditional types believed to have separate functions may in fact have been the same specimen type at different stages of its uselife. One of the characteristics of highly resharpened hafted bifaces is a dual cross-section. The blade usually reveals a beveled cross-section that extends from the tip to the location on the biface where hafting covered the tool. The portion of the biface covered by the haft element will usually have a plano convex cross-section indicating that the edges were not resharpened. Almost all hafted bifaces that were
Figure 4. Examples of Perkiomen winged drills (a, b, c); endscrapers (d, e, f); and hafted bifaces (g, h, i) from sites along the Delaware River. The examples are illustrations taken from photographs found in Kinsey (1972) and Kraft (1970) and from original photographs taken by Andrefsky of materials excavated from the Faucett site and Brodhead-Heller site.
resharpened while being hafted show this dual cross section to some extent. Hafted bifaces traditionally identified as drill forms reveal the most pronounced dual cross sections when comparing the blade area to the haft area. Again, this suggests that the morphology of the bifacial "drill" was produced as a result of use during the life of the tool as opposed to intentionally shaping the biface blade into a drill bit.

SUMMARY AND DISCUSSION

From the review of literature on stone tool shape and function presented above it should be apparent that the function of most stone tools cannot always be determined from the shape, form, or style of the tool. It should also be apparent that factors such as production processes and use processes have a great influence on the shape of stone tools and that individual stone tools may drastically change shape during the time that they are being handled by tool makers and users. Researchers are becoming aware that stone tools and debitage are the end result of a complex life history. The sequence from tool-stone procurement to stone tool discard is decided by cultural influences and situational constraints that can contribute to the dynamic character of stone tool types. Such constraints include, but are not limited to, availability of tool-stone, relative sedentism, economic organization, and individual aptitudes.

Ethnographic (Gould 1980:134; O'Connell 1977:280) and archaeological (Goodyear 1993) studies have shown that different patterns of stone tool production will occur depending upon the relative abundance of lithic raw materials, and therefore the characteristics of tool morphologies are influenced by the relative availability of lithic raw materials. Similarly, the quality of lithic raw materials has been shown to be an important factor associated with the kind of tools produced (Andrefsky 1995; Goodyear 1979; Hayden 1982). In areas that contain high quality, chippable raw materials in abundance, most artifacts will be made from those materials, regardless of the amount of effort expended in their production. Conversely, one of several different tool production patterns may occur when high quality lithic raw materials are not readily available. Other studies have shown that factors such as relative sedentism of the population can affect the kind of tools the group made (Andrefsky 1991; Henry 1989; Jepsen 1992). Groups on the move tended to reduce the risk of being unprepared for a task by transporting tools with them; such tools were portable, multifunctional, and readily modifiable. Sedentary groups did not necessarily need to consolidate tools into a multifunctional, lightweight configuration. All these factors combined have a great influence upon the shape of an individual stone tool.

Also among the constraints that can affect stone tool shape is the intended function of the tool. Researchers have shown that some aspects of function can determine the shape of stone tools. For instance, it is well established that small bifaces fitted for hafting probably functioned as arrow points and not as knives or dart tips (Christenson 1986; Patterson 1985; Shott 1997). Similarly Melzer's (1981) study reveals that scraper morphology is determined by function. In this instance, we are not sure what the function of scrapers were, only that scraper form was derived from its intended function. Although artifact function may be important as a tool shape constraint in some instances, it is not always correlated with tool shape and may have very little influence on tool shape in some cases.

The notion that stone tool shapes are the product of complicated and dynamic processes is, in some instances, incompatible with the way some archaeologists use typologies. Typologies extract stone tools from dynamic contexts and view them in static contexts. Frequently artifacts are pigeonholed into a certain type and the identification of that type becomes more important than understanding the processes responsible for creating the artifact's shape. This is further complicated by the common archaeological presumption that artifact shape reflects artifact function. Although stone tool shape may indicate a function, this is not always true and some stone tool shapes may be associated with more than one function. Archaeologists must move away from static typologies that pigeonhole an artifact into a single type with a single function. Any single artifact may be classified in a number of ways depending upon the criteria and rules for classification. Similarly, any artifact may have multiple functions or multiple meanings depending upon the context of classification.
STONE TOOL SHAPE AND INFERRED FUNCTION

Most archaeologists, but not all, understand typologies as heuristic devices and as techniques to condense massive amounts of variability into manageable quantities. For instance, any two or more people could classify the same parking lot full of cars into different types. One person might separate cars into types based upon make and model. Another person might separate the same cars into types based upon size or shape (sedan, station wagon, van). Both typologies are legitimate, and both are valid techniques of ordering variability. In the same way, a biface may be identified as a particular type of core in one instance, but it may be identified as representative of a particular type of cutting tool in another instance. In both cases the biface carries different kinds of interpretive information. However, such information is lost if we unwaveringly try to pigeonhole the biface as exclusively a core type or as a knife type. All too often I have had long fruitless discussions with archaeologists trying to explain to them that a particular morphological shape such as a biface is a core and at the same time is also a chopper or knife; the biface may in fact be all of these things. The problem often boils down to the fact that for many archaeologists an artifact name connotes a certain artifact shape and that shape connotes a certain function. Such a position is not reasonable given the discussion presented above.

This paper was introduced with several examples of archaeologists inferring site functions from artifact typologies. Clearly, typologies are not only useful but necessary to do almost any kind of stone tool analysis. However, given the fact that stone tool typologies do not necessarily equate with tool function, it does not follow that site functions can necessarily be inferred from the style, shape, or morphology of stone tools.

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