# APPENDIX L

# SYNTHESIS OF USE-WEAR STUDIES IN DELAWARE

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**By**

**Christopher T. Espenshade**

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## 1.0 INTRODUCTION

Any area of archaeological analysis evolves, and it is appropriate to stop from time to time to see where the discipline stands and what we are learning. In the case of lithic use-wear analyses, there has been a range of approaches taken on DelDOT-sponsored and other projects in the state of Delaware. Before either dismissing certain approaches or blindly following others, it is important to evaluate the various findings. As an element of refining our proposed use-wear analysis, DelDOT and the SHPO requested preparation of an overview of previous work on use wear.

Such an overview is called for, in part, because there have been a number of cautionary tales in the regional literature. For example, stone tools that had been used for a known function in the Old Rag living archaeology experiment were submitted for analysis upon the excavation of the "site" 30 years later. Watts (2004:12) reports:

> Following the excavation, interpretation, and disclosure phases of this project, 16 tools from the 1972 experiment were submitted to an independent facility for use wear analysis. This collection included utilized flakes, hafted flake and bifacial knives, a sickle, unhafted bifaces, hafted and unhafted axes, and abrading stones. These were all the well documented tools from the project. . . The results of the analysis were surprising. Hide working and animal processing activities were assigned to many of the tools, when in fact they were used almost exclusively for plant harvesting and processing (foraging, house building, cordage/lashing preparation, etc.). Some tools that had seen extensive use (documented in the field) were assigned to a slight use category. The discrepancies between the interpreted uses and actual uses were unsettling and useful.

## 2.0 BASIC APPROACHES

Before looking at the Delaware case studies, it is appropriate to consider the various options in conducting use analyses. These choices are not mutually exclusive, and some of the better studies have combined one or more of these approaches.

### 2.1 Morphology-Based Inferences

The morphological school of use assignment still rears its ugly head from time to time. This school argues that the gross morphology of a tool directly reflects the primary intended function of the tool. By this school, all hafted, late stage bifaces become projectile points. Likewise, all steep-edged unifaces are scrapers, and all flakes are wastage. As archaeologists have conducted more and more detailed analysis, it has been discovered that a single tool form (e.g., a hafted biface) may have been used for a number of functions including projectile, meat knife, butchering pry tool, shell-fish opener, antler carver, and wood whittler. Even generic "waste flakes" are now commonly spotted as expedient cutting or scraping tools.

### 2.2 Inferences Based on Edge Angle

The edge angle school of thought argues that, all other factors being held constant, pre-contact actors had set expectations about what edge angles are best suited to which activities. Through cross-cultural ethnographic and ethnohistoric studies, regularities have been identified. Wilmsen's (1970) study of Paleoindian tools recognized the following edge angle ranges and prevalent functions: 26-35 degrees, lateral edge cutting; 46-55 degrees, fleshing, scraping, shredding, and cutting; and 66-75 degrees, wood and bone scraping and heavy shredding. Keeley (1980) examined both archaeological artifacts and replicas to define expected edge angle ranges (Table L-1).

**Table L-1.**
**Keeley Edge Angle Ranges by Activity**

| Activity | Edge Angle Range (mean) |
|---|---|
| Hide processing, cutting and slicing | 42-57° (45.7°) |
| Hide processing, scraping | 40-90° (64.5°) |
| Wood sawing | 25.8° |
| Wood scraping | 30-88° (51.0°) |
| Wood whittling | 30-44.4° (40.5°) |
| Wood wedging | 30.4° |
| Wood chopping | 59.6° |
| Meat cutting/butchering | 32-61° (52.6°) |
| Bone sawing | 40.6° |
| Bone scraping | 35-90° (52.2°) |
| Bone chopping | 42° |
| Bone whittling | 45° |
| Bone wedging | 39° |
| Bone prying | 33° |
| Antler sawing and whittling | 35-100° (60.8°) |

Source: Keeley (1980).

The difficulty with the edge angle approach is that there are gray areas, where two or more angle ranges overlap. Likewise, similar angles were suited to more than one tool use. In addition, edge angle will change as tool edges are rejuvenated, even though function remains the same. Therefore, it is impossible to create a one-to-one linkage between edge angle and tool function. In the absence of use-wear analysis, a given edge angle may infer several possible activities.

### 2.3 Inferences Based on Macroscopic Wear Analysis

Macroscopic wear analysis falls into two basic camps. The one camp, following Ahler (1971), focuses on resharpening and/or breakage patterns among bifaces to address their likely uses. By using replicas of hafted projectile points and knives in a variety of functions, Ahler was able to identify resharpening and breakage patterns associated with uses. For example, impact

fractures to the distal end of bifaces are common among projectile points, as are snaps immediately above the haft. In contrast, twisting and prying motions with a hafted knife commonly result in traverse fractures across the mid-section of a biface. This type of analysis is best used at the assemblage level (e.g., 90% of the hafted bifaces show impact fractures, suggesting use as projectiles), because there may have been occasional cases of atypical use. A hafted knife might have been accidentally dropped on its point, resulting in a misleading impact fracture. Likewise, a spear-mounted projectile might have been expediently used to dig a tuber, resulting in a somewhat misleading traverse fracture. It must also be emphasized that Ahler and others did not conduct exhaustive experiments, and not all possible causes of a given break pattern were considered. When Ahler suggests that twisting or prying was associated with large mammal butchering, the archaeologist in the coastal marshes must wonder if similar breakage patterns may accrue from opening shellfish. There has also been a problem with subsequent researchers equating traverse fractures from prying/twisting action to use as a knife. Truncer (1990:26-27) reports:

> Although some authors (Custer and Mellin 1986:2; Dunn 1984:15-16) have credited Ahler with demonstrating that transverse fractures occur on points used experimentally as knives, Ahler (1971:87) explicitly stated that this was not the case. In fact, the present study is the first to demonstrate a clear correlation between transverse fractures and disjointing using bifacial stone tools. Transverse breakage occurred when a prying motion was used.

Truncer (1990:34) also noted, based on his controlled use of replica Perkiomen points, that "not all points used as projectiles or knives developed diagnostic macroscopic fractures."

The second camp uses macroscopic or low-level (up to 20X) magnification to characterize the types of edge damage seen on artifacts. The wear is generally scored relative to expectations from controlled use experiments, too frequently conducted on other raw materials than what is found locally. This approach is best suited to either the crypto-crystalline raw materials that readily show wear or for tools that have experienced extensive, heavy wear. At this level of analysis, it is not possible to differentiate similar activities, such as scraping of wood, antler, or bone. It is also not always possible to discern expediently used artifacts (e.g., a flake used to skin a muskrat). This analysis is best suited to providing a quick measure of the relative frequency of utilized flakes and tools in the assemblage.

## 2.4 Inferences Based on Microscopic Wear Analysis

Medium (40-100X) to high-powered (100-500X) microscopic analysis can provide strong inferences of tool use. These analyses compare observed edge damage to patterns seen on controlled replicas. In its strongest form, replicas of local raw materials are created and used in a controlled fashion for a wide variety of activities (see next section). This approach can also be applied by resorting to photographs and/or wear descriptions from other studies with comparable raw materials.

As with any comparison-based analysis, it must be remembered that diverse activities may have caused similar signatures, and that a close match with a controlled activity (carving antler) does not necessarily mean that the artifact was used for that activity. The individual inferences on possible types of activities must be interpreted within broader contexts by considering the entire assemblage, the site contexts, and other data. For example, time-consuming antler and bone-working might be expected in a relatively stable residential site, but not in an isolated location in the woods. In contrast, the whittling of hardwood for the manufacture of a trap trigger-stick would fully be expected in rather isolated contexts.

## 2.5 Inferences Based on Replica-Enhanced Studies

As with any experimental archaeology, the strength of the inferences increases when there is a close match with the pre-contact raw material, technology, and activities. Ideally, the raw material is closely matched, replicas of tool types are made, and the replicas are used for varying duration for various tasks. Such an approach provides study specimens showing what intensive hide scraping does to an endscraper of local quartzite, and how that differs from the pattern created by intensive wood shaping (as in the manufacture of a bow). The limitation of this study is that it is time consuming, and that it is not possible to capture all the possible functions of pre-contact tools. In addition, even with microscopic analyses of the replicas, there will still be cases where the signatures of different activities are indistinguishable. In addition, ethnographic studies show that tools are often used for adjunct functions different from their primary intended function, placing multiple use-wear patterns on top of one another.

One positive aspect of the experimental approach to use-wear analysis is that blind testing can provide a measure of how well use wear is being recognized and interpreted. For her study of use-wear, Smith (2000:Table 2) examined blind test data from a number of use-wear studies. Her data, presented in Table L-2 below, suggests that the skilled analyst can

generally recognize in 80-90 percent of the cases where there was utilization on a tool, and can identify the work actions at a slightly lower rate. Smith (2000) does not provide quantification on the last step, identifying the material on which the action occurred.

**Table L-2.**
**Blind Test Data, Use-Wear Studies, Western United States**

| Study | Percent Used Regions Correctly Identified | Percent of Work Actions Correctly Identified |
|---|---|---|
| Briskell 1986 | 90 | 56 |
| Odell and Odell-Vreeken 1980 | 79 | 72 |
| Keeley and Newcomer 1977 | 87 | 75 |
| Gendel and Pirnay 1982 | 91 | 82 |
| Richards 1988 | 90 | 90 |
| Bamforth *et al.* 1990 | 83 | 78 |
| Shea 1991 | 92-100 | 75-89 |
| Smith and Lam 1990 | 84 | 62 |
| Smith 1990, 1995, 1996 | 88 | 79 |
| Smith Average | 86 | 70.5 |

Source: Smith 2000:Table 2.

Smith (2000, emphasis added) argues:

> It is also evident from Table 2 that usewear analysis of lithic implements is an imperfect endeavor; while theory has been relatively stable since the crystallization of this form of analysis (by Keeley) a little over two decades ago, methods have varied, and standardization is not present -- partly due to variable research questions as well as to variable raw materials, ancient activities, and so on. **Usewear must be considered a probabilistic science, and as in other realms of anthropological and archaeological inquiry, it is necessary always to use multiple, independent lines of evidence to make the best case for a given argument**. Within these boundaries, however, usewear remains our best available method for the determination of the past utilitarian function of stone tools (Grace 1990, Jensen 1988).

An additional problem with this approach is that there is the risk of a circular argument, in that all of the artifacts will ultimately be fitted into the activities undertaken with the replicas. If the analyst uses a large flake replica to gather Sea Grass, all of the artifacts with similar sheen will be assigned to such a likely function, even if the artifacts were actually used for harvesting

maize. The narrowness or breadth of the behaviors captured by the replicas must be kept in mind when offering inferences.

Another factor to be considered when pairing experimental artifacts with microscopic use-wear analysis is raw material. Many analysts note that cherts, flints, and similar cryptocrystalline rocks offer the best analytical results. Smith (2000) notes that obsidian is good for identifying the location of wear and the type of action, but is poor for inferring the worked material (e.g., antler). A blind test using lithic replicas of material similar to the archaeological sample should be run before expending additional time and money on analysis.

A final factor, of great importance to the Site 7NC-B-54 (Ronald McDonald House) study, is the intensity of use necessary to create definable use-wear signatures. Many studies simply use replica tools to a point that the user can be confident of visible use wear. However, this raises the question, how much was a typical pre-contact tool used? For certain formal tools, such as unifacial endscrapers, fairly intensive use might be expected. After all, the time necessary to make and haft a formal endscraper generally reflects an anticipated long use life. Projectile points may not fit this pattern. A projectile point is made to pierce an animal, and it may take a lot of pierces before visible wear is developed. At the other end of the spectrum, an expedient flake that is used to skin a muskrat may not yield legible use wear. Replicative studies must recognize that not all uses will leave signatures. Especially when studying assemblages from very short-term sites (e.g., 7NC-B-54), archaeologists must expect that some of the activities may have left no sign recognizable by use-wear analysis.

## 3.0 CASE STUDIES

The archaeologists of DelDOT and the SHPO were interviewed for leads on major studies in the state which included some level of use-wear analysis. The following 21 projects spanning the past 20 years create a good picture of recent or current use-wear studies in Delaware. The review of these studies can provide perspective on the strengths and weaknesses of various approaches.

### 3.1 Hawthorn Site (7NC-E-46)

In the time span of *ca.* 1,000-750 B.C., a "staging/processing" site was established at the Hawthorn site (Custer and Bachman 1984). The site was situated near the Fall Line on White Clay Creek and Christina River near Christiana, Delaware.

Custer and Bachman (1984:74-75) report their methods:

> Analysis of gross morphology and wear patterns observable without magnification was carried out using the methods and techniques described by Ahler (1971). Low power magnification (20x) study of edge wear was also undertaken using the techniques described by Wilmsen (1970), Odell (1980; Odell and Odell-Vereecken 1980), and Semenov (1964). High-power magnification studies (e.g. – Keely 1980) were not undertaken.

It is clear that Custer and Bachman (1984) did not utilize any replicas produced of local materials and used in a documented fashion. Their use of Ahler (1971) is problematic; transverse fractures are presented as evidence of twisting and prying, but then mysteriously become evidence of cutting (Custer and Bachman 1984:77). Likewise, their use of edge angle expectations does not acknowledge that edge angle will change through the use life of an artifact, even though function remains the same.

The conclusions of site function suggest a self-fulfilling prophecy. Custer and Bachman (1984:87) argue:

> While at the site they hunted game, probably white-tailed deer, and processed their products with cutting and scraping tools from their prepared tool kits as well as with expedient tools manufactured at the site from local cobbles.

The researchers appear to have made an effort to simplify all data to fit a romanticized image of Native Americans hunting deer in the woods. The wood or bone/antler cutting mentioned for several observed wear patterns becomes simplified to deer bone or antler. The many, steep-angled scrapers are dismissed as possible wood-working tools, and must instead suggest a very unusual popularity of the bone and antler scraping. The Custer and Bachman (1984) study suggests the need for stronger mid-range theory (linking various use-wear patterns to possible activities) and more explicit wear pattern identification using replicas.

### 3.2 Dairy Queen Site (7NC-D-129)

The Dairy Queen site (7NC-D-129) is a Woodland I "hunting/processing camp" (Custer *et al.* 1988). The site was located on the Fall Line near Ogletown, Delaware.

Custer *et al.* (1988:29) specify their apparent methods only in passing, saying of one projectile point that "limited distal polish is visible under 50x magnification of the chert point." There is no mention of control replicas, and only very generalized interpretations are offered. For example, Custer *et al.* (1988:31) report:

> When examined under 50x magnification, no easily identified wear patterns were apparent. For the most part, the flake tool assemblage indicates expedient resharpening of flakes for generalized cutting activities with little or no preparation of specialized tools.

These undocumented interpretations are hard to accept. If recognizable use-wear patterns were present, the researchers should have documented the patterns.

### 3.3 Hockessin Valley Site (7NC-A-17)

This small site was located in the Piedmont Uplands section of the state (Custer and Hodny 1989). The Phase III excavation included 133 1.0 x 1.0 m (3.3 x 3.3 ft) units. Sparse artifacts and a house pattern with an internal hearth were discovered, and an occupation *ca.* 3,300 B.C. is suggested.

It appears that the study utilized macroscopic or low-level analysis to record the presence and degree of edge wear. The researchers also screened several tools for blood proteins, and the overlap adds strength to the interpretations. For example, Custer and Hodny (1989:49) report:

> The other jasper biface is a tip section of a late stage biface which shows considerable edge wear and an impact fracture. This biface fragment is probably a projectile point tip which was discarded when the blade broke. This specimen showed a positive blood residue test reaction and is most likely a hunting weapon.

Without conducting microscopic analysis and replicas, the researchers cannot know what type of edge wear was present on their presumed projectile point. Was this tool used both as a hafted knife and a projectile point?

Likewise, Custer and Hodny (1989:51) state:

> A large quartz scraper made from a section of a cobble core was also found and may have been transported to the site. The edges of the tool are badly worn and this tool was probably used to scrape hard materials. Blood residues were present on the tool and would indicate that it was used primarily on bone and antler.

There are several unsupported premises in this type of analysis. First, because the tool looks like a scraper, it must have been used for scraping (rather than for chopping joints during butchering, for example). Further, the degree of wear is presented as evidence of hard material scraping, yet we know that hide scraping can result in severe wear. In this case, the blood residue is presumed to come from two sources very low in blood (antler and bone), based in large part on the misleading equation of heavy wear with hard material scraping.

Custer and Hodny (1989) are commended for combining blood residue and use studies. However, their results underline the need for more objective, replica-based, microscopic studies of use wear.

### 3.4 Perkiomen Point Study (Regional)

In 1990, Truncer produced an experimentally based study applying Ahler's models of fracture type to Perkiomen points of New York, Pennsylvania, New Jersey, Delaware, and Virginia. Sixteen jasper, chert, or argillite replicas of Perkiomen points were produced by modern knappers using traditional methods and tools. Ten of the points were mounted on wooden shafts for use as projectile points, and six were mounted in wooden or antler handles. The projectile points were repeatedly thrown at a fresh deer carcass, three handle-mounted tools were used in combined cutting/prying to disjoint the carcass, and three handle-mounted tools were used to cut fresh bone and dried hardwood.

Five of the projectiles showed no damage, two had microscropic damage to the tip, and three had the distal fractures expected by Ahler's (1971) approach. No transverse fractures occurred among the projectiles.

The three bifaces used for disjointing all suffered transverse snaps, again as expected under Ahler's (1971) approach. In contrast, the handled bifaces used for cutting bone and wood had no macroscopic fractures. Truncer (1990:27) notes that the argillite-handled biface was dulled after very minimal cutting (10 strokes on wood), but that the jasper bifaces did not achieve similar dulling until after 1,000 strokes.

Truncer (1990) next examined 492 archaeological examples of Perkiomen points from throughout the region. He found evidence that this type was used both as a projectile point and a hafted disjointer, and that both functions occurred in a broad range of environmental settings.

Truncer's (1990) study sought to prove that Ahler's general rules applied to local raw materials and biface forms. He is to be credited for his controlled use of accurate replicas. The limitation of his study is that Truncer (1990) did not pursue a broad range of activities with his replicas. He is correct to note transverse fractures occur frequently in disjointing a large mammal, but does not consider other prying-dependent activities.

### 3.5 Lewden Green Site (7NC-E-9)

A base camp of the Minguannan complex of the Woodland II period was examined during Phase II excavations at the Lewden Green site (Custer *et al.* 1990). The site is located in the High Coastal Plain of Delaware near the town of Christiana.

The wear analysis for this site was limited to addressing breakage patterns on projectile points and bifaces. The only other functional study was blood residue, and a variety of flake tools gave positive results for the presence of blood. The lack of concern with specific tool uses clouds the subsequent settlement model discussions. For example, Custer *et al.* (1990:86) report:

> The absence of features and differential spatial utilization suggests that these habitation sites were not hamlets or villages. Rather they seem to have been base camps, often with multiple overlapping occupations. The Lewden Green Site is similar to other Woodland II base camps in this respect.

Such a clear-cut interpretation of the site is problematic when use-wear studies have not been conducted for any area of the site. How can Custer *et al.* (1990) distinguish a hamlet from a

base camp, in the absence of feature data? Is Lewden Green a multi-functional base camp, or simply a composite of various site use visits during the Woodland II period?

### 3.6 Brennan Site (7NC-F-61A)

The Brennan site was located near Lums Pond and 8.0 km (5.0 mi) south of the jasper source at Iron Hill (Watson and Riley 1994). Forty-six 1.0 x 1.0 m (3.3 x 3.3 ft) units were excavated during the Phase III investigations. The major site component dated to the Woodland I period, and the inferred function was secondary lithic reduction.

Watson and Riley (1994:29) are vague in their exact analysis methods, stating only that "tool function was determined by examining breakage patterns and edge wear. Analysis of gross morphology and wear patterns was carried out by visual and microscopic inspection." Their descriptions of lithic artifacts then mention light, moderate, or heavy use wear, but generally do not identify the likely source of the wear. The exception is a jasper scraper, for which Watson and Riley (1994:31) note that "the steep edge angle and amount of wear on the scraper is characteristic of use on hard material such as bone or wood."

In their conclusions, Watson and Riley (1994:36-37) fall back on a sort of instinctive assignment of activities:

> The large numbers of flake tools and utilized flakes at the site give some indication of the additional activities taking place. Food preparation operations, such as butchering or animal processing, are suggested, but the absence of tools used in the initial stages of butchering indicates that butchering was carried out elsewhere. Only secondary cutting and slicing operations were performed at the Brennan Site. The small amount of wear on most tools indicates that they were expediently used, as might be expected in a situation where high quality raw materials were readily available. One multi-purpose flake tool was found – further evidence that tools were not heavily curated. Flake tools and utilized flakes may have also been involved in the manufacture of non-lithic tools. In particular, the four notched flake tools and the notched cobble tool could have been used to produce other tools of bone or wood, such as awls or needles. The jasper scraper recovered from the site may also have been used on bone or wood.

Their interpretations vary from tentative (e.g., "could have been used. . .") to unjustifiably certain (e.g., "only secondary cutting and slicing. . ."). The problem is that the wear was not compared objectively to any expectations or behavioral replicas. In the end, most of wear could have been

made by almost any activity, and Watson and Riley (1994) are making leaps of faith based on tool form, not wear.

### 3.7 Paradise Lane Site (7NC-D-125)

Described as a "staging/processing station during the Woodland I Period," the Paradise Lane site was located near the Fall Line in New Castle County (Riley and Custer *et al.* 1994). Phase II and Phase III excavations recovered lithic artifacts and ceramics, both apparently dating to the Woodland I period.

For projectile points/knives, use was defined based on the type of fractures, but not on wear. Likewise, the presence of transverse fractures on late stage bifaces was seen as evidence of "twisting and prying motions associated with butchering activities" (Riley and Custer *et al.* 1994:28). Riley and Custer *et al.* (1994) do not address the fact that twisting and prying motions may be associated with a wide variety of non-butchering activities, including shellfish processing, wood working, and root digging.

The vagueness of their use-wear analysis is clear in the Riley and Custer *et al.* (1994:29) passage regarding flake tools:

> Two unifacial tools were recovered in Area A. The first tool, an end scraper made on a thick quartz flake, has cortex on its dorsal surface. . . The second tool is a very small, roughly triangular shaped, chert tool with a sharply-pointed distal tip. One excurvate edge is retouched and forms a steep angle; the other incurvate edge appears to have been utilized. The faceted tip appears to be polished. . . However, the tool appears to have had multiple functions and may have been used in scraping and perforating activities.

The Paradise Lane site provided data for the continued refinement of Custer's Woodland I period settlement patterns. Given the tenuous bases for many of the site interpretations, the resultant models must likewise be questioned. The analysis is weak in its overly literal use of Ahler's fracture study (i.e., Ahler observed this type of break when butchering, so all such breaks must have occurred during butchering), its lack of objective means of describing use wear, its lack of microscopic analysis, and its implicit reliance on overall tool morphology to help assign functional labels.

### 3.8 Site 7K-C-360 and Dover Downs Site (7K-C-365A and 365B)

The three sites in this study were located northeast of Dover (Riley and Watson *et al.* 1994). Artifacts from the Archaic and Woodland I periods were present at 7K-C-360. Locus A of the Dover Downs site yielded material from all pre-contact periods, and Locus B was occupied in the Woodland I and Woodland II periods.

Riley and Watson *et al.* (1994) flip-flop in deciding what attributes are key for inferring tool uses. For endscrapers, it is edge angle and heaviness that define their use, but for other tools, it is the wear patterns (with reference to Wilmsen 1970 and Tringham *et al.* 1974) that are of prime importance. It is unclear how the wear was viewed, classified, and rated. It seems at times as though Riley and Watson *et al.* (1994:49) desire to show that diverse activities occurred at the site, without ever identifying those activities:

> Another artifact class prominent at the site consisted of unretouched utilized flakes. . . Examination of these artifacts reveals a variety of sizes, shapes, raw materials, use-wear attributes and states of curation. This kind of diversity indicates that the flakes originated from a combination of local cobble sources and prepared tool kits and were used in a variety of manufacturing and processing activities.

Because they choose to deal only in generalities, the Riley and Watson *et al.* (1994:51) conclusion that "the utilized flakes appear to have functioned as cutting, slicing, and scraping implements in butchering and processing activities" does little to help them model site function. The researchers essentially say that any known use of a stone tool may have occurred at the site.

Even when a specific function is suggested for a given tool, there is insufficient description of the wear (and the analytical methods) to evaluate the conclusion. Of an example from 7K-C-365A, Riley and Watson *et al.* (1994:123) observe:

> The general morphology of the tool conforms to that described by Grimes and Grimes (1985) for a tool type those authors have designated "flakeshavers." Grimes and Grimes (1985) suggest that such tools functioned as whittling or shaving tools for hard materials such as bone, antler, and wood. The use-wear observed on the Hill A specimen indicates that such a function was probable.

The researchers do not provide a description or illustration of the use wear on the inferred flakeshaver.

Riley and Watson *et al.* (1994) are to be credited for subjecting tools to both use-wear analysis and blood residue studies. Unfortunately, the blood residue studies were so overwhelmingly negative that they did not add significantly to inferences on tool functions. When the researchers did get a positive for blood residue, they linked it specifically to on-site butchering, ignoring the possibilities that the tool was used for butchering elsewhere, or that the tool was used for hide preparation or bone/antler working.

Although one goal of the study was to address the organization of lithic technologies, Riley and Watson *et al.* (1994) do not use any of the tool function (use wear or blood residue) data in their inter-site comparisons. Instead, they rely on cortex percent, crypto-crystalline percent, quartz and quartzite percent, and similar indices to classify and compare sites. The researchers ignore the fact that the original functional labels were often assigned on the basis of unfounded inferences of tool functions.

### 3.9 Wrangle Hill Prehistoric Site (7NC-G-105)

The Wrangle Hill Prehistoric site is located on a ridge nose in the High Coastal Plain of Delaware (Custer *et al.* 1995). The major site components were Woodland I and Woodland II, and the site included large pit features interpreted as the remnants of pit houses. Phase III investigations included hand excavation of the plowzone from 25 percent of the site, followed by machine-assisted stripping of the remainder of the site.

Although the researchers admit the unique characteristics of ironstone (the dominant raw material at the site), they conducted no experiments or use-wear analysis of non-projectile point tools. Instead, Custer *et al.* (1995) only offer vague interpretations, such as "undifferentiated pieces of debitage seem to have served the cutting and scraping needs of the Wrangle Hill Site's prehistoric inhabitants."

Custer *et al.* (1995) rely on the breakage patterns of projectile points/knives to address the functions of these hafted bifaces. Type B hafted points have an unusually high frequency of transverse fractures, and Custer *et al.* (1995:44) label these as knives. There is a general inexactness in the way Custer *et al.* (1995) use this term, both in this and other reports. Very careful reading shows that the damage was likely caused by the prying and twisting associated with disarticulation during butchering of large mammals. Labeling tools for this very specific function simply "knives" invites confusion and non-specificity. These tools were not broken during the slicing of meat, the skinning of an animal, the carving of wood, or the butchering of fish and small game. The terms "disarticulation knife" and "twist knife" would provide greater

clarity and stronger inferences for interpreting site functions. Custer *et al.* (1995) also recorded projectile points/knives with distal breaks suggestive of use as true projectiles.

The Custer *et al.* (1995) study would have been greatly strengthened by the manufacture and controlled use of ironstone tools. This raw material is brittle and sharp, and may have breakage and wear patterns different from cryptocrystalline materials. Custer *et al.* (1995) note that special knapping techniques are necessary to reduce ironstone, and that realization should have prompted controlled experiments on use wear and breakage patterns.

### 3.10 Snapp Prehistoric Site (7NC-G-101)

The Snapp Prehistoric site is located immediately south of the Chesapeake and Delaware Canal in New Castle County, Delaware (Custer and Silber 1995). The site was formerly located on a small ridge nose overlooking St. Georges Creek in the Upper Coastal Plain. Phase III excavations revealed artifacts from all pre-contact periods, and the major occupations occurred in the Woodland I and II periods. The site is interpreted as a large base camp.

In what became an unfortunate pattern in University of Delaware reports, Custer and Silber (1995) apparently conducted use-wear analysis, yet failed to provide any of the data in their report. Custer and Silber (1995:26) report that "edge wear analyses using high and low power magnification were also conducted to help clarify activities undertaken at the site." The researchers then rely only on breakage and resharpening patterns to assign functions to projectile points/knives, again mistakenly assigning a cutting function to hafted tools used in a prying/twisting mode, probably during disarticulation of large mammals. The only mention of microscopic wear (rather lack of it) was for a large biface. There is no description or quantification of the use wear in any other tool class (including four tools with positive or slightly positive reactions for blood residue). Custer and Silber (1995:189-195) instead rely on morphological assignment of tool functions to interpret the site. Custer and Silber (1995:158) argue "the wide variety of tools is indicative of a base camp occupation." Such an argument can be debunked due to a lack of chronological control (i.e., perhaps the diversity is due to multiple visits of differing functions, *sensu* Binford 1982), and because we have no idea of the function of the various tool forms. If microscopic use-wear analysis was conducted at many sites, as claimed in several of their reports, why do we never hear the results and why are these data not used in regional comparisons?

### 3.11 Two Guys Site (7S-F-68)

The Two Guys site is located on a low, sandy ridge in the southern, central portion of the state (LeeDecker *et al.* 1996). Excavation of 173 $m^2$ (approximately 28 percent of the site area) recorded components from all pre-contact periods. The major occupations occurred in the Early Archaic and Woodland I periods.

LeeDecker *et al.* (1996:63) describe their approach to addressing tool function:

> A conservative approach to the identification of edge utilization and retouch was taken because a number of other factors – for example, trampling of materials on living surfaces, spontaneous retouch during flake detachment, and trowel contact, can produce similar types of damage. More precise and accurate information about tool use can be obtained if higher levels of magnification are employed (e.g., Keely 1980; Yerkes 1987), but these methods are time consuming and expensive if large numbers of artifacts are examined. However, an aggressive residue analysis program was undertaken.

This is an interesting argument on several levels. The researchers correctly note that lithic edge damage can occur from non-use sources, but fail to recognize that experimental studies can allow us to filter out most of these problems. The researchers are also correct that high magnification studies can be expensive, but they are clearly willing to spend analysis money on other approaches.

LeeDecker *et al.* (1996:86) present the findings of their analysis:

> The lithic assemblage, in total, represents a limited range of activities. Most of the bifaces and unifaces were used in hunting and associated processing tasks; most of the cobble tools were used in the processing of plant foods; the cores and debitage are wastage from tool production and maintenance.

These conclusions are neither surprising nor terribly informative. Lacking microscopic use-wear signatures and analysis, the researchers rely on the presence/absence of blood residues to infer tool functions. Cores and debitage are dismissed as wastage, without any analysis of their wear. A tool possibly only used once in a blood-intensive function is assumed to have always been used in such a function because no microscopic analysis was undertaken to discover the wood-working signature beneath the blood. Furthermore, the researchers repeat a widely held misconception that all or most of the meat in pre-contact Delaware was obtained by hunting.

The study of the Two Guys site relied heavily on one analysis scheme (residue analysis) at the expense of another (use wear); a more balanced use of time and costs would have produced a better, more detailed understanding of tool functions. Their findings were overly generalized, as might be expected. A sharp flake with deer blood residue may have been used for skinning, butchering, defleshing a hide, scraping a hide, processing sinew, extracting bone marrow, or preparing meat cuts for consumption. Without the use-wear analysis to complement the residue, the Two Guys site analysis could offer only vague interpretations of behavior.

### 3.12 Carey Farm (7K-D-3) and Island Farm (7K-C-13) Sites

The Carey Farm and Island Farm sites are located on the St. Jones River in Kent County, Delaware (Custer and Watson *et al.* 1996). The major occupation of the sites occurred in the Woodland I and Woodland II periods. Domestic base camps of one to several families were suggested, including winter occupations.

In their standard presentation of University of Delaware methods, Custer and Watson *et al.* (1996:51) report that "edge wear analyses using high and low power magnification were also conducted to help clarify activities undertaken at the site." Unfortunately, as seen in many other reports, the results of the use-wear analyses are not presented and are not considered in interpreting areas of the sites. Instead, the reader gets vague statements such as "the utilized core fragment shows that tools and cores were being used for multiple purposes" (Custer and Watson *et al.* 1996:109). No further information is provided on what that core was used for or what was the nature of the wear.

Even when use wear is of prime importance in interpreting unusual artifacts, the wear is not described or compared to controlled experimental tools. Custer and Watson *et al.* (1996:123), for example, report:

> Several features in the South Area contained numerous small utilized flakes, and a sample from Feature 1997 is illustrated in Figure 61. All of these tiny flakes show extensive retouching along their lateral margins. The small size of the flakes makes it unlikely that they were used unhafted. However, these small flakes could have been hafted in sets to produce cutting or penetrating edges for compound tools. Figure 62 shows a reconstructed fishing spear, or harpoon, based on ethnographic examples described by Oswalt (1976). The small flakes are set into the "jaws" of a harpoon and hold the fish. It is important to realize that this projected function of these small retouched flakes is conjectural and other uses are possible.

This is a case where the researchers should have felt obligated to describe the nature of the wear on the flakes. As well, it would be a natural opportunity to back the hypothesized use through experimental use of replicas.

The only discussion of use is based on breakage patterns. Custer and Watson *et al.* (1996) repeat the University of Delaware argument that distal fractures suggest projectile use, while transverse fractures indicate use as "knives." In the absence of breaks, Custer and Watson *et al.* (1995:275) fall back on gross morphology, arguing that "the argillite bifaces' shape and configuration suggest that they were being used as hafted knives."

### 3.13 Leipsic Site (7K-C-194A)

The Leipsic Site was located on the northern bank of the Leipsic River in the Low Coastal Plain of Delaware (Custer and Riley *et al.* 1996). The site saw the most intensive use in the Woodland I and II periods, when it saw a series of residential occupations by one to several families.

Custer and Riley *et al.* (1996:29) report that "low power edge wear analysis was undertaken for all tools. The edge wear analysis was conducted to help clarify the activities which took place at the site." From reviewing the report, it appears that the low power edge-wear analysis was only used to determine if a flake was utilized or not. There is no discussion of use-wear patterns on particular artifacts.

Custer and Riley *et al.* (1996:102) repeat their oversimplification that transverse medial fractures are "indicative of knife use." They fail to mention that Truncer (1990), who they cite, argued that transverse medial fractures were actually diagnostic of tools used in a prying/twisting mode, most frequently in the disarticulation of large mammals. Custer and Riley *et al.* (1996) do not report results of edge-wear analysis, and misrepresent the results of the projectile point/knife breakage analysis. It is unclear how such an approach could possibly achieve their goal to "help clarify the activities that took place at the site."

### 3.14 Iron Hill East Site (7NC-D-108)

The Iron Hill East site is located on the basal flanks of Iron Hill in the Piedmont of Delaware (Petraglia and Knepper 1996). Iron Hill served as a jasper source during pre-contact periods. Phase II investigations were pursued at the site.

The analytical approach used by Petraglia and Knepper (1996) is almost guaranteed to underestimate the frequency of utilized and retouched flakes. The researchers choose to use mass analysis, whereby the emphasis is placed on the size variables of the total debitage assemblage, and flake-by-flake analysis does not occur. The bias introduced by mass analysis is clear in the comparison of Site 7NC-D-108 to four other quarry-related sites in the vicinity. At the other four sites, flake tools represent 1.9 percent, 2.0 percent, 5.0 percent, and 5.6 percent (respectively) of all lithic artifacts. At 7NC-D-108, no flake tools were recognized among the 823 artifacts recovered. Mass analysis is a cost- and time-efficient means of analyzing debitage, but analysts must recognize that it severely limits the potential to identify and interpret utilized flakes.

### 3.15 Drawer Creek Site (7NC-G-143)

Many limited-duration, focused-activity visits to the Drawer Creek site occurred in the Woodland I and Woodland II periods (Wall *et al.* 1997). The site was located on the Upper Coastal Plain, near the confluence of Drawer Creek and the Appoquinimink River. Phase III excavations were completed at the site.

Wall *et al.* (1997:32) describe their combined low-power microscopic and edge-angle approach to addressing tool function:

> Function was inferred from morphology as well as from use wear. Surfaces and edges were examined for traces of use polish and damage with the unaided eye and with a 10X hand lens. Data derived from experimental and ethnoarchaeological research were relied upon in the identification and interpretation of artifact types. . . In the analysis of edge damage, edge angles, and use wear, and breakage patterns, usable margins with angles of 50 degrees or less are viewed as most efficiently used for cutting and scraping soft materials such as skin, hide, sinew, and some woods; margins with angles greater than 50 degrees are best employed in the working of hard materials such as bone, antler, and hardwoods. . . Type of edge damage and wear are also thought to correlate with specific activities.

The researchers seem unsure which authority to follow. For example, in describing a point that broke at the top of its stem, Wall *et al.* (1997:85) suggest “it may have been shattered during manufacture, or was perhaps broken at the haft during use.” No use-wear data are presented for the bifaces. Edge damage is described for the unifaces, but no inferences are drawn.

Unretouched but utilized flakes were apparently not separated from generalized debitage, and no use-wear studies were conducted for utilized flakes.

Given the low level of attention paid to use-wear analysis, it is not surprising that the researchers are somewhat stumped by the question of site function. Wall *et al.* (1997:110) report:

> Although the Drawer Creek South Site was tentatively identified as a Woodland II procurement site following the Phase II investigations, it is still difficult to determine exactly what the site inhabitants were procuring, besides lithic raw material from nearby stream cobbles.

Having failed to look for utilized flakes, the researchers interpret site activities as food preparation (if ceramics are present), lithic reduction, some unspecified function involving a split-cobble scraper, and other unspecified activities utilizing expedient flake tools. Wall *et al.* (1997:116) indicate that "the only tools that showed consistent use-wear were the expedient scrapers and utilized flakes," but do not tell us the nature of that wear or the inferred activities. The researchers lament their inability to interpret the various site visits, but did not choose to make complete use of edge-wear data present in the assemblage.

### 3.16 Pollack Prehistoric Site (7K-C-203)

The Pollack Prehistoric site was located at the confluence of Alston Branch and the Leipsic River in the Low Coastal Plain of Delaware (Custer *et al.* 1997). Limited Paleoindian and Archaic use of the landform was suggested by a few projectile points/knives, but the major occupations occurred in the Woodland I and Woodland II periods.

Custer *et al.* (1997:48) report that "edge-wear analyses using high- and low-power magnification were attempted to help clarify activities undertaken at the site." They also undertook blood and bone collagen residue studies.

Projectile point/knife functions were determined from breakage patterns. Tip damage was present on most of the projectile points/knives, suggesting most were used as projectiles. There are severe inconsistencies in the projectile point/knife counts in the text and in the tables, but it appears that approximately 10-15 percent of this class had transverse medial fractures indicative of use as butchering knives. Certain projectile points/knives had evidence of use as both projectile and butchering knife.

It is important to note that tip damage on a pointed tool, such as a "projectile point" may have been caused by use of that tool to penetrate skin/hide. In the skinning and stretching of furbearer pelts, it is necessary to pierce the skin during the original skinning, and often (depending on the species) to repeatedly pierce the hide to facilitate stretching. It is simplistic to infer, as do Custer *et al.* (1997), that all tip damage is due to use as a projectile.

Custer *et al.* (1997) fail to present use-wear data for any other tool class. The reader is left baffled: why would Custer, who is explicitly concerned with trying to reconstruct site functions and settlement patterns, conduct use-wear analysis but neither report nor consider the results in interpreting the Pollack Prehistoric site? The study stands as an example of the disjointed, check-list approach to analyses, where a number of separate studies may be undertaken, with the results never integrated.

### 3.17 Whitby Branch Site (7NC-G-151)

The Whitby Branch site (7NC-G-151) saw intensive occupation in the Woodland I period and less intensive use in the Woodland II period (Jacoby *et al.* 1997). The site is located on a low ridge extending into tidal wetlands on three sides.

The use-wear analysis methods are not well delineated, but the presentation of the results suggests that use wear was examined at 20X, through comparison with other study results. There are no indications that any controlled-use replicas defined the expectations. Indeed, Jacoby *et al.* (1997:64) question the possibility of attributing wear to specific activities on quartz and quartzite:

> Quartz is an extremely hard material and is particularly abrasion resistant, meaning that striations, polish, and smoothing are not readily apparent (Boudreau 1981; Hayden and Kamminga 1979). Quartzite, although not as hard as quartz, is very granular, and evidence of use-wear is also difficult to detect.

Given that 60.0 percent of their assemblage is quartz or quartzite, it is difficult to put much faith in their functional interpretations. The extremely low frequency of utilized flakes (only 19 of the 13,113 flaked-stone assemblage) may be more related to analytical problems than to actual cultural patterns. It would have been instructive for the researchers to have taken local quartz and quartzite, made and used tools for controlled activities, and analyzed those tools to see if wear was evident at 20X. Rather than simply parroting the conclusion of researchers from other

parts of the country, it would be good to demonstrate whether or not local materials can be used for use-wear analysis.

### 3.18 Lums Pond Site (7NC-F-18)

The Lums Pond site was located on a tributary of St. Georges Creek in the Upper Coastal Plain of Delaware (Petraglia *et al.* 1998). The Woodland I saw the most intensive or repeated site use, but there was also evidence for Woodland II visits. Phase III excavations and analysis were undertaken.

Among other research goals, Petraglia *et al.* (1998) sought to answer the question "what was the nature of settlement in the project area through time, and how do these patterns compare with settlement patterns in other geographic locales?" Despite this goal, the researchers did not endeavor to identify utilized flakes and only addressed tool use on a very general level. They addressed likely function of "projectile points" by examining resharpening and/or breakage patterns. The projectile point discards commonly had evidence of either cutting, use as a projectile, or "heavy force applied in a bending or prying motion" (Petraglia *et al.* 1998:96).

Petraglia *et al.* (1998:98) describe the unifaces from Area 2:

> A relatively large number of unifaces were recovered. Most were similar in shape and manufacture, occurring as end scrapers made on thick chert flakes. The working edges or bits were similar in shape and the undercutting on a number of examples suggested that some had been used against hard materials (although some undercutting may have resulted from crushing during edge trimming). Only one example bore a well-rounded edge, characteristic of extensive use against a smoothly abrading surface such as hide.

A failing of the study is that the blood residue studies conducted were not coupled with microscopic use-wear analysis. When one uniface proves positive for deer blood residue, the reader cannot know if the uniface was used for butchering, bone working, antler carving, wood shaping, or hide preparation. Certain of these functions might be expected at a short-term camp, while others would be expected to have occurred at more permanent residential bases. The reader also does not know if many flakes utilized for meat/skin/tendon cutting were also present in the area yielding the uniface.

The various inferred functions for projectile points/knives and unifaces are apparently forgotten when it comes time to assign site functions. Petraglia *et al.* (1998:183) argue that

"the harvesting and processing of nut was probably a major focus of activity." They further argue that terrestrial animals were probably used, and point to their single strong protein residue result, suggesting that one jasper uniface was exposed to deer blood. Petraglia *et al.* (1998:185) conclude that "Lum's Pond, situated along a tributary of St. Georges Creek, conforms to the expectations about limited duration, so-called 'micro-band' base camps."

The study stands as an implicit and unfounded rejection of the argument that understanding the relative frequency of utilized items is important to interpreting site functions. Not bothering to identify utilized flakes, not conducting any microscopic studies, and not utilizing any controlled sample of replicas, the researchers fall back on the classic deer and hickory nut model. They lack understanding of the nature of hickory nuts in a forested environment – naturally occurring nuts are often charred by natural fires – and place undue emphasis on the blood residue from a single tool, a formal tool that may have been curated with deer blood from another location. They do not reconcile the various activities suggested by their coarse use-wear analysis (use as projectile points, knives, butchering tools, bone/antler/hardwood scraping, and hide scraping) with the ephemeral nature of each site visit. Because they do not address tool function in any meaningful manner, it is impossible to tell whether the inferred micro-band base camp is actually a composite averaging of a number of visits for different site uses.

### 3.19 Hickory Bluff Site (7K-C-411)

The Hickory Bluff site is situated on the St. Jones River south-southeast of Dover (Petraglia *et al.* 2002). The site underwent extensive Phase III excavations. The major component of the site was Early Woodland, but Late Archaic, Delmarva Adena, and Late Woodland (Minguannan and Townsend wares) occupations were also evident.

Petraglia *et al.* (2002:13-60) argue that low-power use analysis is appropriate:

> With any given archaeological tool kit, variations in use and re-use may blur functional interpretations. The purpose of this macroscopic analysis is to provide a basis for identifying patterning along tool edges using a simple and cost-effective approach. Tool edge angles and use wear were analyzed for all collected tools and modified flakes from Hickory Bluff.

Each macroscopically recognizable tool (utilized flakes were apparently excluded) was examined using a 10X hand lens, and the attributes compared to expectations based on generalized lithic studies (Table L-3).

**Table L-3.**
**Attributes and Use Inferences, Hickory Bluff**

| Attribute | Inference |
|---|---|
| Edge Angle, 26-35° | Intended for light cutting activities; cutting meat, skin, or other soft materials; wood whittling; hide processing |
| Edge Angle, 46-55° | Medium cutting and scraping activities; scraping hides; shredding plants; heavy cutting of bone, wood, or antler |
| Edge Angle, 66-75° | Heavy cutting and scraping activities; heavy scraping; sawing, cutting, or working of hard materials |
| Unifacial Microflakes | Scraping activities |
| Bifacial Microflakes | Cutting or sawing activities |
| Rounding or Blunting | Cutting or sawing of soft materials (i.e., soft wood, grasses, hides) |
| Striations | Scraping of material harder than tool; oriented in direction of tool use |
| Polish | Cutting of vegetal materials; soft scraping of hides |

Source: Petraglia *et al.* (2002:Tables 13.20 and 13.21).

The Hickory Bluff analysis assumes that the generalities based on a wide range of non-local raw materials indeed apply to the local materials and local tool design. The analysis also assumes that the level of inference (e.g., they used this tool for either harvesting cattails or scraping a muskrat hide) possible with this approach is sufficient to develop reasonable site interpretations.

The interpretive weakness of the macroscopic approach (10X hand lens) is underlined by the comparison with microscopic analysis (100-500X reflected light microscope) of unifaces. There was only a 46 percent agreement on the presence of wear based on the two methods, and only a 22 percent agreement on the presence of hafting ware (Petraglia *et al.* 2002:22-9). This suggests that the macroscopic approach was regularly either misidentifying wear (i.e., seeing wear when none exists) or missing wear. In the end, the question becomes whether the simplicity and cost-effectiveness of the hand lens approach outweigh the weakness of the results. Should we be happy with a method that properly recognizes use wear only approximately one-half of the time?

### 3.20 Puncheon Run Site (7K-C-51)

Lozny (2001) completed the use-wear analysis for the Puncheon Run site. It stands out as the most complete use-wear study undertaken in the state, in terms of sample size, use of experimental controls, detailed description and illustration of wear patterns, and sophistication.

The study compared use-wear attributes from experimentally produced and used tools against attributes observed on a sample of 100 tools from the site (Lozny [2001] acknowledges that the non-random composition of the sample is problematic). The study considers both edge-angle and edge-damage attributes in defining likely uses of the pre-contact tools. In preparing the replicas for controlled use, the study matched edge angles to intended use, to best mimic the pre-contact record.

Lozny (2001) utilized a stereo zoom microscope capable of 5-400X magnification. He does not specify the exact magnification used, but the images produced have magnifications of 16-100X with 40-50X sufficient for most artifacts.

The limitation of the Puncheon Run protocol was that only 14 replicas were produced. Seven tools each were made of chert and jasper, and for each raw material, the uses included: scraping seasoned wood for 10 minutes; scraping fresh wood for 15 minutes; fleshing fish for 10 minutes; butchering for 30 minutes; sawing fresh wood for 30 minutes; scraping hide for 30 minutes; and cutting grass for 180 minutes. No experimental tools were used for skinning, drilling, boring, antler working, or wood carving (rather than scraping). No consideration was given to non-functional sources of wear, such as human traffic.

The Puncheon Run findings are also not well integrated with expectations by site type. Lozny (2001:G-44) reports:

> The Puncheon Run data suggest scraping/fleshing as the most common identifiable activity. Not much evidence of cutting was found, and only one good example of a grass cutting device. Activities were mostly directed to processing food and general domestic activities.

Scraping and fleshing <u>are not</u> steps in food processing. They most commonly occur during the secondary processing of pelts and hides. Likewise, many domestic activities – production of wood tools, building or maintenance of structures – required much cutting or sawing of wood. There were no tools with wear attributed to cutting or sawing wood. Lozny's (2001:G-44) conclusion that "domestic and food processing activities prevail" seems a gross simplification that does not do justice to the analytical effort.

There is also an apparent disjunction between Lozny's (2001) technical analysis appendix and the conclusions presented by LeeDecker *et al.* (2001) in the main volume of the report. LeeDecker *et al.* (2001:247) correctly point out that the majority of the whole "pebble points" from the site showed wear consistent with their use as projectiles; Lozny does not consider these data in his conclusion. LeeDecker *et al.* (2001:247) stress diversity in the inferred tool functions from the Metate Block area of the site:

> Edge-wear analysis of these tools produced evidence of several distinct activities, including cutting grass, carving wood, cutting soft and medium materials, and scraping soft, medium, and hard materials.

In contrast, Lozny (2001:G-39) apparently recognized the tenuousness of the approach, stating that "use-wear analysis is an interpretive technique and is not designed to make deterministic statements." Accordingly, Lozny (2001) stresses those inferred activities for which there are multiple examples of similar wear, and does not attempt the one-to-one equation between a single example of a type of wear and a specific activity.

In the Feature 30 block, the utilized tools overwhelmingly had wear suggestive of hide scraping. LeeDecker *et al.* (2001:249) cannot reconcile these results to the outcome of a protein residue study, which suggested that fish processing was a major activity. Unfortunately, it appears that the use-wear and protein-residue studies were not integrated, and tools that underwent protein-residue analysis were not analyzed for use wear, and vice versa. If the same tools had undergone both analyses, it might be possible to determine if the Feature 30 area contains the mixed materials from two functionally and temporally distinct occupations.

The Puncheon Run study had several strong points, including: a large sample; replicas of local material used under controlled conditions; incorporation of edge angle and use wear; and high-power microscopic analysis. However, the study underlines the need for well-defined arguments (i.e., middle range theory) to link the analytical results to interpretations.

### 3.21 Frederick Lodge Site Complex (7NC-J-97, 7NC-J-98, and 7NC-J-99)

The Frederick Lodge Site Complex is located north of Smyrna, Delaware, adjacent to bay/basin landscape features (Parsons 2003). Natural and cultural processes allowed researchers to separate components from the Middle Archaic, Late Archaic, Early-Middle Woodland, and Late Woodland. Short-term, limited function visits were interpreted for the

Middle and Late Archaic periods, with more substantial occupations (possibly seasonal, single-family camps) in the Woodland periods.

The study used both mass analysis of debitage and detailed attribute analysis of flakes from the Middle Archaic component. The use-wear analysis was limited to hand lens (10X) examination and edge angle measurement of "selected artifacts." The sampling scheme is never specified, and the reader cannot know which artifacts were examined but failed to yield evidence of use. The researchers indicate a fairly basic approach to interpreting use wear: unifacial wear is most commonly associated with scraping; bifacial wear is most commonly associated with cutting; edge rounding or blunting indicate use on a soft material; uniface edge angles of 26-35 degrees indicate light cutting or scraping; uniface edge angles of 46-55 degrees indicate "medium work;" and uniface edge angles of 66-75 degrees indicate "heavy work" (Parsons 2003:5-17 to 5-18). The study did not utilize controlled use replicas of local materials as a comparative base.

No specific inferences (e.g., hide scraping) are presented based on the use-wear results. Neither specific descriptions of the use wear nor the edge-angle data are presented. Instead, the authors offer vague statements such as "Usewear consisted mainly of scalar flaking on the dorsal face of one or more edges." This vagueness in the use-wear analysis (and the lack of adjunct studies such as presumptive blood testing) severely hamper the final interpretations by component. Although the report provides highly detailed reconstructions of what knapping processes are represented by each assemblage, the use wear is reduced to conclusions including "a reliance on expedient cutting tools" (Middle Archaic), "a variety of site activities" (Late Archaic), and "general workshop functions employing both bifacial and flake tools" (Early-Middle Woodland) (Parsons 2003:7-10 to 7-11). Lacking specific function inferences based on use wear, the authors cannot tell us why people were there, what they were cutting, or what they were doing. Also, Parsons appears unable to reconcile inconsistencies such as an inferred Woodland domestic site that yielded only a single ceramic sherd. Having made a decision to focus more on reduction strategies than on tool use, Parsons (2003) finds the data lacking when it comes to interpreting site function.

### 3.22 Losey 3 Site (36TI28), Tioga County, Pennsylvania

Although in Pennsylvania, the Losey 3 site is included here as a possible model for the Site 7NC-B-54 (Ronald McDonald House) study. Cutright (2006) conducted a use-wear study that included manufacture and controlled use of local materials (in this case, Onondaga chert),

analysis with a 40X magnification stereo microscope, and intepretations integrated with edge angle and association/feature data. The weakness of the study is the low number of replicas and controlled uses. However, the analytical ability to properly recognize the signatures of specific use wears on replicas was impressive. Cutright (2006) report that “the analysts’ accuracy in terms of motion and material was scored, and the analysts were correct in approximately 75% of the trials.” Likewise, there was close matching of the inferred functions from the pre-contact artifacts with expectations based on tool morphology, the assemblage of the activity area, and the associated features. The Cutright (2006) study suggests the utility of analysis of Onondaga chert at 40X magnification.

## 4.0 CONCLUSIONS AND RECOMMENDATIONS

The review of previous use-wear analyses in Delaware has recognized the strengths and weaknesses of various approaches. Twelve key points have been drawn from the overview, and each has implications to future analyses of site assemblages.

### 4.1 Value of Replica-Based Studies

The most reliable and replicable analysis of use wear involves an extensive, controlled experiment using the same raw materials as used in pre-contact times. Conversely, the weakest use-wear analyses utilize only generalized trends in degree of wear (light, moderate, or heavy) and gross morphology to suggest activities.

Any future proposed site studies should include the manufacture, controlled use, and analysis of artifacts made of Delaware quartz and quartzite. The study should also rely on the wear patterns for local chert and jasper, as previously documented by Lozny (2001).

### 4.2 Importance of a Blind Test

Smith (2000) presents data of the effectiveness of microscopic analysis in detecting and interpreting use wear on stone tools, mostly obsidian. Other researchers (e.g., Jacoby *et al.* 1997:64; Boudreau 1981; Hayden and Kamminga 1977) have suggested that use-wear analysis is unproductive on quartz artifacts. Unlike many previous studies that simply accept on faith their ability to identify and interpret use wear (e.g., the many University of Delaware studies), future studies should begin with a blind test to demonstrate and quantify accuracy. A number of quartz and quartzite replicas should be either non-utilized, trampled, bag tumbled, or used in a controlled action. For those used in a controlled action, the location of the use on the artifact should be recorded. The artifacts should be secretly coded, and then provided to the use-wear analysts. The analyst should record if use wear is identified (presence/absence), the location of the wear on the tool edge(s), and the type of wear.

### 4.3 Need for Microscopic Study

Microscopic analysis of use wear has significantly stronger results than macroscopic or hand lens approaches. The results from the Hickory Bluff analyses – there was only a 46

percent agreement on the presence of wear and only a 22 percent agreement on the presence of haft ware, based on the two methods (10X and 100-500X) – underline the weakness of macroscopic analyses (Petraglia *et al.* 2002:22-9).

Any proposed future studies should examine use wear on artifacts and replicas under a magnification of 40X. This level of magnification is obtainable with generally affordable microscopes. The utility of this magnification for analysis was demonstrated for Onondaga chert by Cutright (2006). The studies should begin with a blind test to show that use wear is recognizable on quartz and quartzite at a magnification of 40X. The value of this approach for local Delaware raw materials will be demonstrated by the results, and will undermine the argument that high magnification, use wear studies cannot be pursued because they are too costly.

### 4.4 Inappropriateness of Hand-Lens Analyses

Hand-lens sorting is only suitable for creating a general impression of how many tools were utilized. The Puncheon Run study was noteworthy for demonstrating that low-level analysis misses a significant number of utilized tools. Hand-lens sorting should not be used in future proposed studies.

### 4.5 Value of Edge Angles as Complementary Data

Edge angles should be recorded to augment the use-wear data. Although there is not a one-to-one correlation between intended use and edge angle, this attribute can help support or question other findings. A goniometer should be used to record edge angles at three locations along each use segment of any tool.

### 4.6 Value of Integration with Other Studies

Whenever possible, the same tool sample should be used for blood/protein residue studies, phytolith studies, and use-wear studies. The more lines of evidence that can be brought to bear on the use of a specific tool, the more confidence that can be placed in the interpretation. Morphology, edge angle, microscopic wear, and organic residues can together make a strong argument. However, disjointed analyses – those in which different items are used for each analysis – are counterproductive.

The same artifacts and replicas should be luminol-screened for presence/absence of blood-like proteins, should have their edge angles recorded, and should be microscopically examined to describe edge wear.

### 4.7 Value of Non-Biased Samples

Analyses of use wear (and residues) should avoid circular arguments, and all classes of tools and a random sample of seemingly unused debitage should be analyzed. In the name of budget considerations, many archaeologists perform wear analysis on just a sample of morphologically inferred stone tools. Too often, the sample is based on circular arguments about what types of lithic artifacts would have been used (rather than being simple wastage). Alternately, some analysts select only those artifacts with the heaviest, most obvious wear, thereby prejudicing site interpretations toward heavy-use activities.

### 4.8 Value of Large Samples

Inferences are strengthened by multiple artifacts reflecting similar activities, and sample size is important. There is a danger in oversimplifying human behavior when archaeologists try to assign site function based on a few use indicators.

If the 40X analysis proves viable for quartz and quartzite, all the artifacts from an assemblange should be examined to determine if use wear is present. However, huge assemblages from large sites may require sampling. The analysis of all the artifacts from an assemblage will greatly strengthen the reliability of the findings, especially when coupled with luminol testing of all artifacts.

### 4.9 Need to Model Non-Use Wear

Use-wear experiments should include replicas subjected to non-use wear such as human traffic. If nothing else, consideration of non-use wear will preempt the excuse that we cannot recognize such wear, and therefore should never undertake microscopic analysis. Indeed, certain non-use wears (e.g., pedestrian traffic) can help inform our interpretations of site formation processes.

Any analysis should include experiments in non-use wear. These should include the trampling and rigorous bag-bruising of non-utilized replicas. The damage/wear signatures of

each of these replicas can then be described through microscopic analysis. For the trampling, quartz and quartzite replicas should be placed on the surface in a high traffic area, such as at an elementary school. After one week, the artifacts should be collected.

The bag-bruising is designed to mimic the possible damages associated with screening and bag transport with other artifacts. Non-utilized artifacts can be placed in a soil sample bag with each other, a handful of sherds, and a few marble-sized pebbles. The bag can then be tied to the handlebars of a mountain bike for a 15 minute trail ride.

### 4.10 Need to Expand on Truncer's Experiments

Because a number of regional researchers have depended heavily on Truncer's (1990) studies, it is important that his experimental parameters be expanded. The key problem with Truncer's study is that alternative sources of transverse medial fractures have not been identified. It is clear that the prying and twisting associated with disjointing a large mammal will cause transverse medial fractures, but what other actions may lead to similar damage? A relatively high frequency of transverse medial fractures have been recorded at Delaware sites yielding shellfish. Could the opening of oysters cause transverse fractures in hafted knives? Could the prying and twisting to dislodge oyster colonies during intertidal gathering result in transverse breaks? Turtles were a major dietary and ceremonial item among pre-contact groups. Did the cutting and prying necessary to separate the bottom plate from the upper shell on marine turtles and snapping turtles result in the distinctive snaps? Does the prying/digging of cattail roots result in such fractures?

If breakage experiments are not undertaken to expand the possible explanations of this type of break, Delaware archaeologists may continue to misinterpret or simplify site functions. Replicated quartz bifaces can be used for various controlled functions, including shellfish opening, shellfish harvesting, cattail root extraction, and Indian potato excavation. These functional studies can evaluate the possibility that transverse breaks are being too narrowly interpreted.

### 4.11 Need for Detailed Wear Descriptions

Use-wear analyses cannot be fully evaluated or accepted if there is no detailed description of wear patterns on each artifact. It is frustrating to researchers to be presented only with the conclusions of use-wear analysis, without any primary data.

Future studies should provide artifact-specific descriptions of wear patterns and edge angles. If multiple use areas are present on a given artifact, each should be described separately. The level of detail should parallel that provided by Lozny (2001). These studies should also integrate the edge angle and blood residue results for each artifact.

### 4.12 Avoidance of Simplistic Interpretations

Major themes of study include the following:

1) multiple lines of evidence must be considered in crafting and supporting inferences of site use;

2) the complexity of human behavior demands avoidance of overly simplistic explanations; and

3) most archaeological analyses are probabilistic, not deterministic.

Interpretations should recognize that blood-bearing or use wear-bearing stone tools may be curated from another, functionally discrete location, and the nature of complete behavioral clusters should be considered when addressing multiple possible tool functions. Archaeologists generally agree that many formal tools were heavily curated, but many interpretations of use wear and blood residue have the implicit premise that any indicated activities must have occurred at that site. Bifaces used as projectile points were probably present at almost all male-occupied or used locations, but hunting did not necessarily occur at each location. Pre-contact males wanted the ability to hunt should the chance present itself, but the presence of projectile points does not necessarily imply a hunting-related site.

What happens to our site interpretations if one accepts the reasonable premise that a given tool was often used for various tasks? There is the very real risk for locational displacement of activity-specific wear. A projectile point is tip-damaged during a kill. It still represents a tool of high utility for butchering and cutting, so the hunter saves the point for future rehafting. The rehafted biface is later used as a knife, but retains the marks of having been a projectile. However, the projectile use was spatially and temporally removed from the tool's deposition.

Lithic studies must avoid the simplistic. We must embrace the idea that tools may have been used in a number of roles, in a number of contexts, perhaps over hundreds or thousands of years. Some landforms, for example, saw little to no soil accretion during the Woodland I

period. The flakes from one reduction episode may have been reused during a later, nearby visit, as the material would still be present on the site surface.

Research programs should be built on bringing multiple lines of evidence to bear on the interpretation of each behavioral locus. Use-wear inferences should be made in conjunction with luminol results, edge angle results, refit data, and the overall nature of the assemblage. In addition, the possible interpretation of visit functions will not be limited to a few tired, easy explanations too often seen in the literature: knapping station, deer-hunting camp, or nut-gathering station.

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