Edge Angle As A Functional Indicator: A Test

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Abstract

Archaeologists traditionally have relied upon the examination of stone tool edge angles as an efficient method for defining and attributing use categories to the tools. However, this approach has not been adequately tested by researchers. In the present study the results of a low-magnification microwear analysis of 67 morphologically defined end scrapers are presented. Six categories of scraper wear were observed, and the mean edge angle values for each group were compared. Based upon an analysis of variance test, it was found that there are no statistically significant differences between the different functionally defined scraper groups in terms of edge angles. It was concluded that edge angle might be a useful variable to monitor in narrowing down gross categories of tool use (i.e., longitudinally vs. transversely oriented motion). However, to derive more specific functional assignations, one needs to conduct an intensive use-wear analysis of all tools.

Introduction

Tool edge angle has been used as a functional indicator by archaeologists for a number of years (Wilmsen 1968, 1970; Crabtree 1973; Nissen and Dittemore 1974). The reasoning behind this practice relates to intuitive notions about what tool edge angles are most efficient in particular activities and for specific classes of worked materials. Investigators continue to use edge angle as a functional indicator (e.g., Eisenberg 1978:133), but as yet there have been no extensive studies to test explicitly this relationship.

In the present study, edge angles are evaluated among a particular assemblage of tools. The assemblage is comprised of 67 morphologically defined end scrapers recovered from a Late Prehistoric/Early Historic site located in Barrow, Alaska (see Dekin 1981). The tools were examined using low-magnification microscopy, the methods and results of which are outlined elsewhere (see Siegel 1984). Based upon the microwear analysis it was determined that the tools were used solely as scrapers in connection with six categories of worked materials (Siegel 1984:Fig. 3).

In terms of scraping activities Wilmsen (1970-71) asserts that tools with edge angles of 46° to 55° are probably associated with hide scraping while tools with edge angles ranging from 66° to 75° are better suited for scraping wood and bone. Wilmsen supports this claim by presenting photographs of the wear patterns of two individual tools, one from each of the edge angle categories with which he was concerned (Wilmsen) 1970: Fig. 31). It is more appropriate to define functional categories of scrapers first on the basis of the observed wear patterns. After the functional categories have been determined, it would then be informative to compare the different groups in terms of the respective edge angles. This is the approach followed in the present study.

Methods

As mentioned above, the details of the microwear analysis are discussed elsewhere (Siegel 1984), and therefore only a brief description of that study is presented here. A Leitz-Wetzlar stereoscopic microscope with inter-changeable objectives was used. Wear patterns were observed under magnifications ranging from 25X to 100X. Variables selected for analysis consist of abrasive and fracture wear types. Variables originally presented by Odell (1977:584-587) were modified somewhat for this study. The raw material of the scrapers is composed of a blue gray chert, derived from the Ikpikpuk formation in northern Alaska.

Edge angles were measured using a contact goniometer. There are a number of problems in monitoring edge angles. For instance, where on an edge does one take a measurement? How does one deal with variations in edge angle along a single edge? A series of three measurements was taken along the distal edge of each scraper, and the arithmetic mean of each series was used as the edge angle for the scraper. This method seems superior to Wilmsen's (1970:21) method of using polarcoordinate graph paper. By placing a tool on the graph paper one cannot take into account the variability of the angle along an individual edge (for detailed discussions concerning the measurement of edge angles see Burgess and Kvamme [1978], Dibble and Bernard [1980], and Patterson [1980]).

As a test of the notion that particular edge angle ranges are associated with particular scraping activities, a one-way analysis of variance was performed. Edge angle was considered to be the dependent variable, and the various defined activities constituted the independent variable. The analysis of variance method in the General Linear Models (GLM) procedure of the Statistical Analysis System software package was used for this test (Goodnight 1979). The analysis of variance method in the GLM procedure is appropriate to use in this case because a balanced model is not required (i.e., the cell sizes from group to group may be unequal).

Results

Based upon the functional variables six categories of scraper wear were defined. These are wood, clean bone, silty bone, hide de-hairing, silty hide, and antler scrapers (Siegel 1984:Table 2). In several situations the tools exhibited more than one category of wear, and this provided a basis for defining a seventh category of multi-use scrapers (see Siegel 1984:43-45).

As displayed in Fig. 1 there is a considerable amount of overlap among the six categories of scraper wear in terms of the associated edge angle measurements. The analysis of variance tests further demonstrates that scraper edge angles (dependent variable) are not related significantly to the various scraping activities (independent variable), for which the tools were used (Table 1). Since one of the assumptions made in analysis of variance is that there are equal variances among all levels in the independent variable (homoscedasticity; Blalock 1979:343), the variances of the mean edge angle measurements were examined for each of the functional scraper groups (Table 2). It was found that the variances were approximately the same except for the silty bone (SILBON) and antler (ANTLER) categories. Therefore, an additional analysis of variance test was computed, in which SILBON and ANTLER were deleted. As can be seen an $\underline{F}$ value of 0.13 was generated, which is statistically insignificant for this model (Table 3). Further, the associated R-square value is 0.008. In other words, the different functionally defined scraper groups (minus the scrapers within the silty bone and antler use categories) account for 0.8% of the variability in

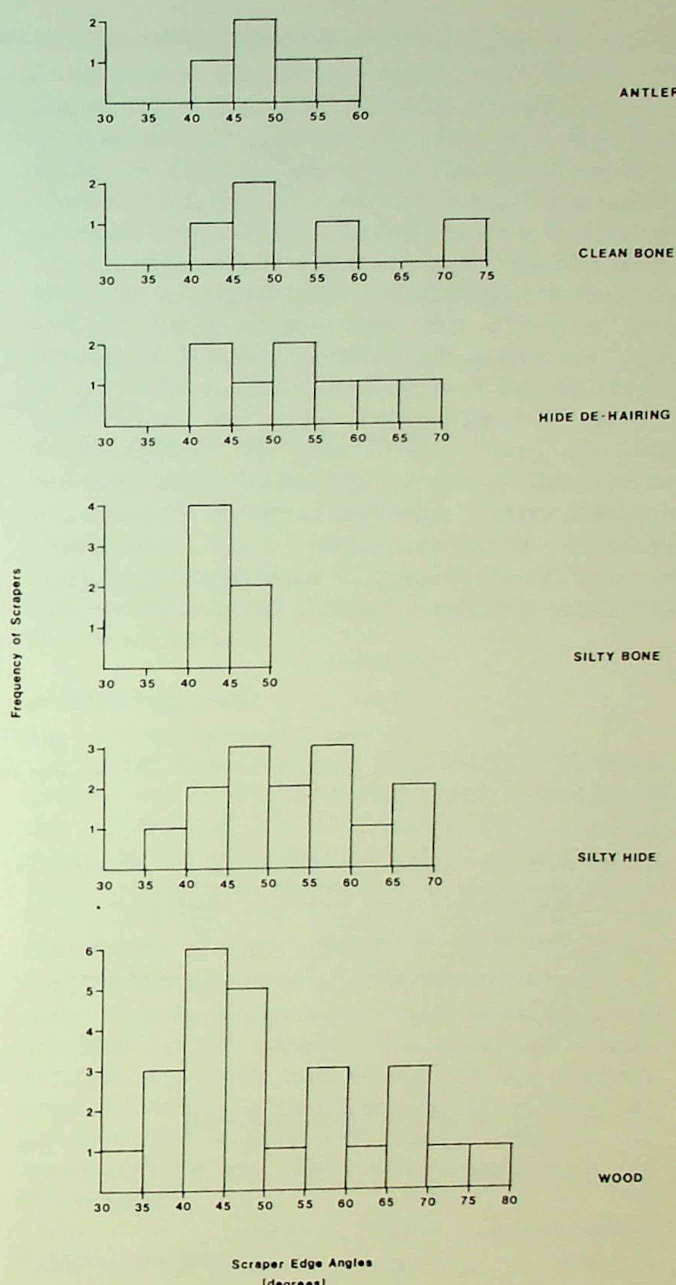

Figure 1. The frequency of scrapers within each category of scraper wear with respect to the tool edge angles. Note that a considerable amount of overlap exists across the different wear groups in terms of the observed edge angles.

the edge angle measurements. If the assumption of homoscedasticity is relaxed for the moment, it is seen that when the silty bone and antler scrapers are included in the analysis of variance test, the resulting $\underline{F}$ value is 0.78 (insignificant in the model), with an associated R-square value of 0.06 (Table 1). Therefore, when evaluating the different categories of scraper wear it was found that edge angle was not a relevant factor to consider.

Table 1. Analysis of Variance of Scraper Edge Angles with Respect to Different Activities.

General Linear Models Procedure

Class Level Information

Class	Levels	Values
Activity	6	Antler scraper wear
		Clean bone scraper wear
		Hide de-hairing scraper wear
		Silty bone scraper wear
		Silty hide scraper wear
		Wood scraper wear

Number of observations in data set = 63[a]

Dependent variable: edge angle — Edge angle mean = 51.63174603

Source	Degrees of freedom	Sum of squares	Mean square	F value	Probability > F	R-square
Model	5	404.72143175	80.94428635	0.78	0.5731	0.063721
Error	57	5946.71507619	104.32833467			
			Standard deviation = 10.21412427			
Corrected Total	62	6351.43650794				

[a]For three of the scrapers the wear categories were undetermined. A fourth scraper was hafted in a mount in such a way that an accurate edge angle measurement was not possible.

Table 2. Descriptive Statistics for the Edge Angle Measurements with Respect to each of the Functionally Defined Scraper Groups. (Note that the variances are approximately the same across categories except for the silty bone and antler scraper wear groups.)

VARIABLE = Edge Angle

ACTIVITY = Antler scraper wear

N	5		
Mean	49.96		
Standard Deviation	5.36078	Variance	24.738
T: Mean = 0	20.8391	Probability > |T|	0.0001
W: Normal	0.853581	Probability < W	0.257

ACTIVITY = Clean bone scraper wear

N	5		
Mean	53.94		
Standard Deviation	11.9232	Variance	142.163
T: Mean = 0	10.1159	Probability > |T|	0.0005
W: Normal	0.915807	Probability < W	0.462

ACTIVITY = Hide de-hairing scraper wear

N	8		
Mean	53.7		
Standard Deviation	9.25851	Variance	85.72
T: Mean = 0	16.4051	Probability > |T|	0.0001
W: Normal	0.931277	Probability < W	0.496

Table 2. (Continued)

ACTIVITY = Silty bone scraper wear

N	6		
Mean	44.63		
Standard Deviation	3.05789	Variance	9.35067
T: Mean = 0	35.7531	Probability > |T|	0.0001
W: Normal	0.935194	Probability < W	0.569

ACTIVITY = Silty hide scraper wear

N	14		
Mean	53.2357		
Standard Deviation	8.93916	Variance	79.9086
T: Mean = 0	22.2828	Probability > |T|	0.0001
W: Normal	0.968515	Probability < W	0.807

ACTIVITY = Wood scraper wear

N	25		
Mean	51.62		
Standard Deviation	12.2091	Variance	149.063
T: Mean = 0	21.1416	Probability > |T|	0.0001
W: Normal	0.932738	Probability < W	0.121

Discussion

Mean edge angles from the functionally based scraper groups were compared as a test of the assumption that subtle variations in edge angles reflect differing tool functions. The results of the analysis of variance tests indicate that there is no statistically significant relationship between particular scraping activities and the corresponding tool edge angles.

It might be suggested that tool edge angle is related to gross categories of activities. In other words, tools whose edge angles fall into the lower range (i.e., 26° to 35°) may be considered likely to have been used in activities based upon longitudinal motion. These would include cutting, sawing, whittling, and carving. Tools with edge angles in the higher ranges may be considered as having been used in activities based upon transverse motion, such as scraping, planing, and adzing. These relationships must be considered speculative, however, until tested by future research. Once edge angle observations have been used to narrow the probable use of the tool down to gross categories (such as longitudinal vs. transverse motions) I would argue that it is then necessary to rely upon the use-wear characteristics of the tools in order to generate more specific functional determinations.

A problem that affects the analysis both of edge angles and microwear traces is multiple use and re-sharpening episodes. As tools are used and dulled they are re-sharpened, and therefore the edge angles are modified, as well as wear traces leaving the tool with the re-sharpening flakes. Consequently, what we are left with on tools recovered in the archaeological record are wear traces resulting from the final episode of use, and edge angles resulting from the final episode of re-sharpening.

A potential solution to this problem on some sites is to follow an aggressive retrieval program for the small re-sharpening flakes, and attempt to refit these flakes onto the parent tools (see Frison [1968] for one such study). In this way, it might be feasible to reconstruct the functional life histories of particular tool assemblages. The problem with this approach, of course, is the case where a tool is used and re-sharpened at one location (site A in the archaeological record), transported to another location (site B), where another round of re-sharpening might occur, and transported to a third location (site C), where the tool might be used again and finally discarded.

Summary

A functional classification of 67 end scrapers recovered from a Late Prehistoric/Early Historic site in northwest Alaska was conducted (Siegel 1984). Based upon the wear patterns six categories of scraper use were defined. In order to evaluate the utility of tool edge angle as a functional indicator, the mean edge angle values for each of the scraper groups were compared. Based upon the results of a one-way analysis of variance test it was found that there is no significant relationship between the scraper edge angles and the different wear categories. It was concluded that edge angle might be a useful variable to consider when narrowing tools down to gross categories of activities (longitudinally vs. transversely based motions), however, this relationship too cannot be assumed but must be demonstrated with further research. Furthermore, more specific functional determinations than longitudinal vs. transverse motions can only be documented through a carefully conducted microwear analysis.

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