A FUNCTIONAL ANALYSIS OF CERTAIN CHIPPED STONE TOOLS

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ABSTRACT

A Late Prehistoric period buffalo kill and butchering site in northern Wyoming (Site 48 JO 312) produced a large number of stone tools. Flakes removed in sharpening stone tools provided much of the interpretation of the activity that occurred at the site and in addition gave a number of ideas concerning tool use and sharpening.

THIS PAPER deals with one aspect of stone tool use: that of stylized means of resharpening stone tools after they became dull through use. Although the evidence here is from a rather limited context, it can undoubtedly be generalized to include a great many others.

During the summers of 1964 and 1965, a buffalo kill and butchering area was excavated in northern Wyoming along the eastern flanks of the Big Horn Mountains (Frison 1967). The date of this operation is believed to have been around the latter part of the 16th century. Approximately 200 buffalo (*Bison bison*) were killed by driving them over a steep slope along a stream called Piney Creek. The site represents a one-year operation, but the number of animals killed probably represents several different drives during the drive season. The kill area at the base of the slope is just above the level of the stream, and about 300 ft. away is the butchering area where the meat was processed, apparently for storage and later use. There is good evidence to suggest that nearly every carcass was carefully butchered, and all bones that contained any significant amount of grease were broken. A large number of stone tools, including biface knives, side scrapers (both biface and uniface), and end scrapers, were recovered. The tools, features, and bones in the butchering area suggest the purpose of this operation was to obtain, process, and preserve meat, probably for use during periods when food was scarce.

In both the kill and butchering areas of this site, known as the Piney Creek site (48 JO 312), nearly all the unworked flakes were relatively small, and they did not appear to have been the result of tool manufacture. The next explanation was that they were somehow related to the activities performed at the site. Using Bordes's (1961) concept of flakes of bifacial retouch and Semenov's (1964) ideas that use on stone tools produced traces of wear that might be interpreted with relation to function, a microscopic examination of some of the flakes was attempted. Other ideas, especially with regard to soft and hard hammer techniques of percussion flaking, were taken from a set of notes compiled by Jelinek (1965) at the Les Eyzies Conference on Lithic Technology. Results were a number of thoughts and ideas on the use of stone tools and some definite evidence as to how these tools were resharpened when they became dull through use.

Stone tools become dull rather quickly but are surprisingly effective if kept sharp and if their structural limitations are kept in mind. Tools such as side scrapers, end scrapers, knives, and drills were continually modified throughout their lifetime of functional utility, and at the time when they were discarded or became nonfunctional, they were usually quite different than when originally completed. Changes in stone tools occurred rapidly compared with metal tools because of the amount of material removed from the tools in the sharpening process. A different set of motor habits is necessary in using stone tools as compared to using tools of metal, and realization of this can narrow the supposed gap of disparity of efficiency between them.

Within certain limits, there are five categories of retouch flakes or sharpening flakes that can be readily identified in the Piney Creek material and into which most of the unworked flake collection can be placed: One includes retouch flakes from bifaces; three include different retouch flakes from side scrapers; and one includes end-scraper retouch flakes. The first category is what Bordes (1961: 6) would call flakes of bifacial retouch which were removed from biface tools, lenticular in transverse cross section, that became dull through use. The striking platforms of these flakes are usually faceted, and ridges between flake scars appear for they include a small part of one side of the biface tool (Fig. 1*a*). The dulled edge of the tool is usually obvious, at least under low magnification, and in the case of the Piney Creek material, a soft hammer-technique is indicated by a broad, thin flake with a definite overhang on the bulbar face (Fig. 2*a*). In some cases there may have been some deliberate dulling of the biface edge to facilitate removal of the retouch

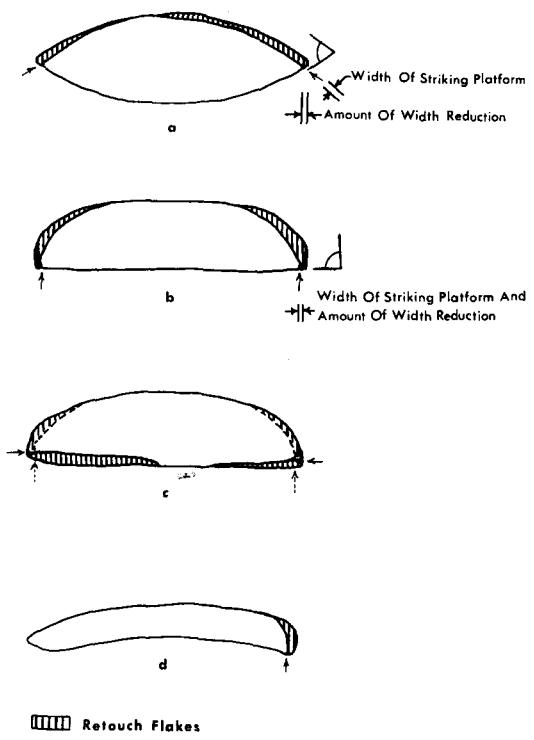

FIG. 1. Schematic representations of different categories of retouch flakes: *a*, transverse cross section of biface; *b–c*, transverse cross sections of side scrapers; *d*, longitudinal cross section of end scraper.

flakes. One of the major problems involved in a functional analysis of this sort appears to be a means of distinguishing between wear produced deliberately and that resulting from use. Several flakes of bifacial retouch were found that match the flake scars on the tools from which they were removed (Fig. 2*c*). A magnified view of these same flakes in their flake scars is also shown (Fig. 2*d*). Other sets of overlapping flakes of bifacial retouch, which had been removed from bifaces in the sharpening process (Fig. 2*b*), were recovered.

The second category of retouch flakes includes those classified as side-scraper retouch flakes. These were removed in sharpening tools that were made from percussion flakes usually long in relation to width and plano-convex in transverse cross section. The flat side of the tool remained unmodified and was the original inner flake face. The side-scraper retouch flakes were different from and distinguished from the first category by the fact that the striking platforms are part of the flat inner flake faces and constitute one side of the tools (Fig. 3*a*) and are usually at nearly a right angle to the adjacent portion of the back of the flake, which is the dulled edge of the tool (Fig. 1*b*). This portion usually demonstrates what can probably best be described in Bordes's (1961: 26) terms as a scalar retouch as the result of small flakes that hinged out through use (Fig. 3*b*). Occasionally a ground edge or a polish or gloss that partially obscured the scalar retouch appeared, which suggests different functions of the tools in the category from which these flakes were removed. This is demonstrated on a side scraper that was broken and of which the largest piece was subsequently used (Fig. 3*e*). A magnified view of this artifact (Fig. 3*d*) demonstrates that the earlier use produced a polished working-edge and the later use produced a scalar retouch.

A third and much smaller category of retouch flakes are those that were removed from the flat side of side scrapers, which technically changed the side scraper into a biface tool but did not change its function. Although these are bifaces, there was deliberate effort to retain the plano-convex transverse cross section.

After studying the tools and the retouch flakes from the collection, there is a strong suggestion that some side scrapers either had, or acquired through use, a flat side that did not provide the proper angle or other conditions necessary for scraping use. To remedy this, flakes were removed from the flat side of the tool (Fig. 1*c*). These flakes are quite distinctive. Striking platforms are the dulled working-edges of the tool and usually demonstrate a scalar retouch or, less commonly, a ground or polished effect. In outline form, they are usually rounded or oval-shaped (Fig. 2*e*, *f*). They often hinged out quite suddenly due to the difficulty of driving thin, rapidly-expanding flakes with enough force to carry across the entire flat face of the artifact. Several tools indicate that after flakes in this category were removed from the flat side of a tool, the tool was sharpened afterward in a conventional way by using the flat side as the striking platform (Fig. 1*c*, dotted lines). These flakes form a fourth category of identifiable retouch flakes. These are similar to other side-scraper retouch flakes, except that the striking platform may be faceted as it usually includes ridges between flake scars (Fig. 2*h*). They are significantly different from flakes of bifacial retouch in that the striking platform is usually at, or near to, a right angle with the immediately adjacent back of the flake. In addition,

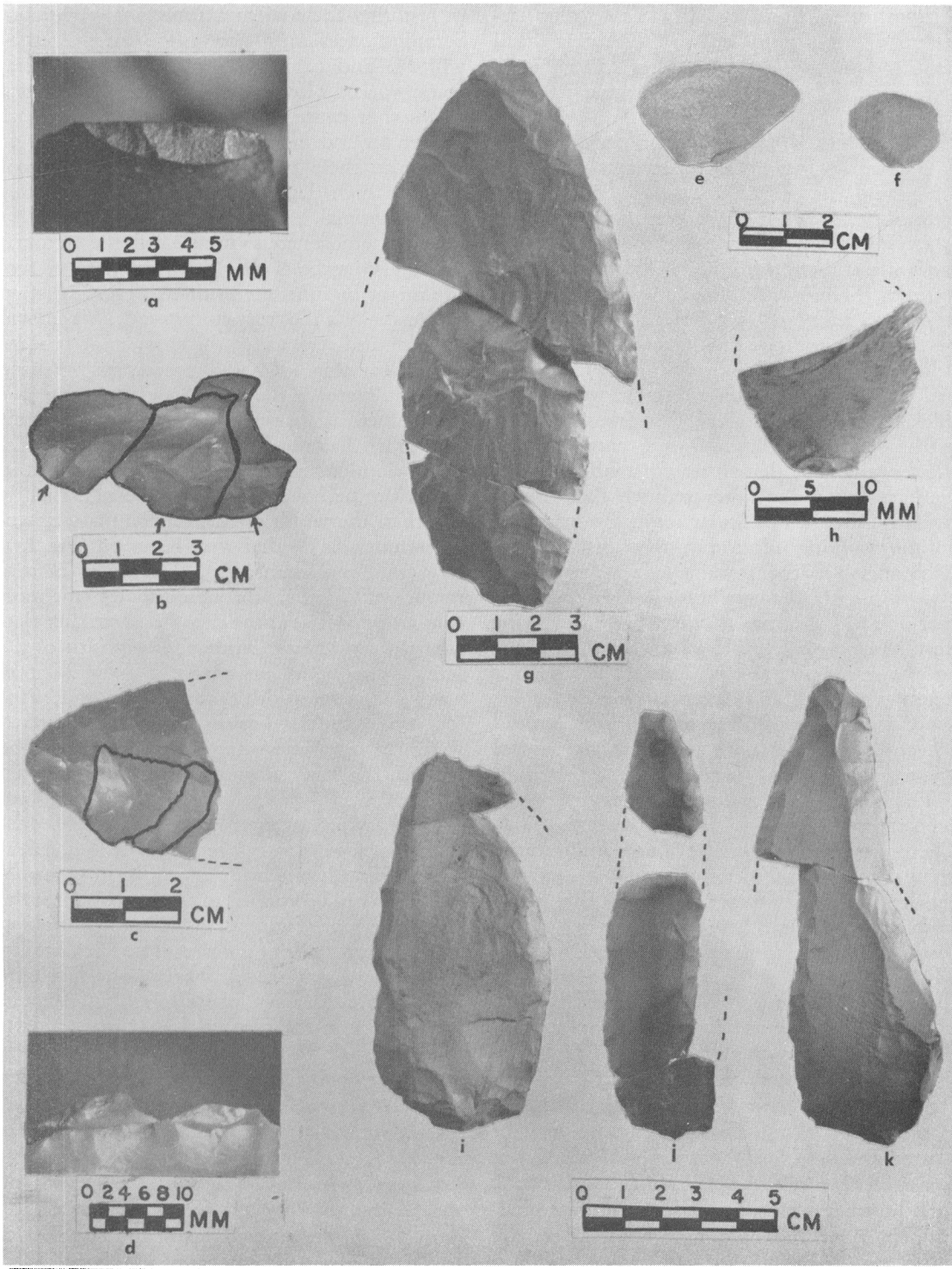

FIG. 2. *a*, enlarged view of striking platform of a typical flake of bifacial retouch; *b*, three overlapping flakes of bifacial retouch; *c*, two overlapping flakes of bifacial retouch replaced in their flake scars; and *d*, enlarged view of the striking platforms and tool edge of same; *e–f*, side-scraper retouch flakes of category three removed from the flat side of a tool; *h*, side-scraper retouch flake of category four with a faceted striking platform; *g*, biface; *i–k*, side scrapers, of which one (*j*) has the largest remaining piece altered into an end scraper.

this part of the flake regularly has a scalar use-retouch that is not seen on flakes of bifacial retouch and which distinguishes this category of retouch flakes as having been removed from scraping tools.

The fifth category of identifiable retouch flakes includes those used to sharpen end scrapers. These are somewhat similar to side-scraper retouch flakes but are significantly smaller (Fig. 1*d*). Few were recovered at the site due to the mesh size of the screens used in excavation. One series of three overlapping end-scraper retouch flakes was recovered (Fig. 3*c*). One end-scraper retouch flake matches the flake scar on the tool from which it was removed (Fig. 3*f*). In general, end scrapers in this collection were not as thick as the side scrapers; the flakes removed in the sharpening process were narrower and shorter, and they demonstrated smaller striking platforms than the other retouch flakes mentioned. Often a fine scalar retouch is common on the working edges, but wear striations at right angles to the working edges are usually also visible under magnification. It is suggested that most end scrapers were hafted, judging from the polish on ridges between flake scars on the back of the tool. Materials used for manufacture of end scrapers are noticeably superior to those of other tools, and this could reflect different functions and also a greater tool value resulting from the added work of hafting.

The collection of retouch flakes is of a homogeneous nature which suggests several things. There were evidently cycles of use, and resharpening by very stylized processes. With tools of the kind found at the Piney Creek site, a balance must be made between a number of factors. As a tool becomes dull, a point is reached where it is expedient to stop work and sharpen the tool. Stone tools, like any other, reach a point where resharpening no longer renders them functional, and they must be discarded and a new tool selected. Sometimes, as the Piney Creek collection demonstrates, a tool that is no longer of use for one purpose may be altered and used for other purposes. There was undoubtedly a reluctance to shift to a new tool, for adjustments must be made to different physical characteristics of a new tool. There are other considerations also. Working edges must be right for the task at hand. Scraping edges must be different from cutting edges. An edge that is too thin will cut fast but will also nick easily, and then time and material are wasted in restoring the tool to a functional condition. Scraping edges must not be too sharp or they will cut and ruin the hide or other material being worked. In other words, there are strong forces that cause certain attributes of tools to cluster around a central tendency in order to maximize their utility. Maximization of tool use to a high degree is suggested by the Piney Creek material.

The homogeneous nature of the retouch flakes also suggests that some estimate of tool life might be inherent in them. The reduction of the size of a tool is from two causes: removal by wear and removal in the sharpening process. Tool wear was estimated by comparing sharp with dull tools. Removal by sharpening was determined by measuring the striking platforms of retouch flakes. The amount the width of a biface, lenticular in cross section, is reduced in width during one sharpening process is slightly less than the width of the striking platforms of the retouch flakes that were removed (Fig. 1*a*). By actual measurement, 100 flakes of bifacial retouch, all of metamorphosed shales (the most common material at the site), have striking platforms of an average and median width of 2.2 mm. Experiments suggested that about 2.0 mm. was the average width that one edge of a biface tool was reduced through removal of retouch flakes in a single sharpening process. The amount the same edge of the tool was reduced through wear was estimated at from 1.0 to 2.0 mm., which suggests a total of 3.0 to 4.0 mm. that one edge of a biface tool was reduced in width through one cycle of use and resharpening. This can be applied to actual tools from the site. One tool (Fig. 2*g*) was estimated at about 75 to 80 mm. wide at the time it was first broken and 46 mm. wide when broken the last time and discarded. Each blade edge was reduced between 14 and 17 mm., and it is suggested that each edge of the tool may have been resharpened four or five times after it was first broken and before it was finally discarded.

The same figures appear very nearly correct for side scrapers although more of the tool was lost through use and slightly less through resharpening. Striking platforms average slightly narrower on the retouch flakes, and more of the tool is lost through removal of use flakes.

It can be demonstrated (Fig. 1*c*) that removal of a series of flakes from the flat side of side scrapers did not reduce the width of a tool and actually resulted in gaining one cycle in the use

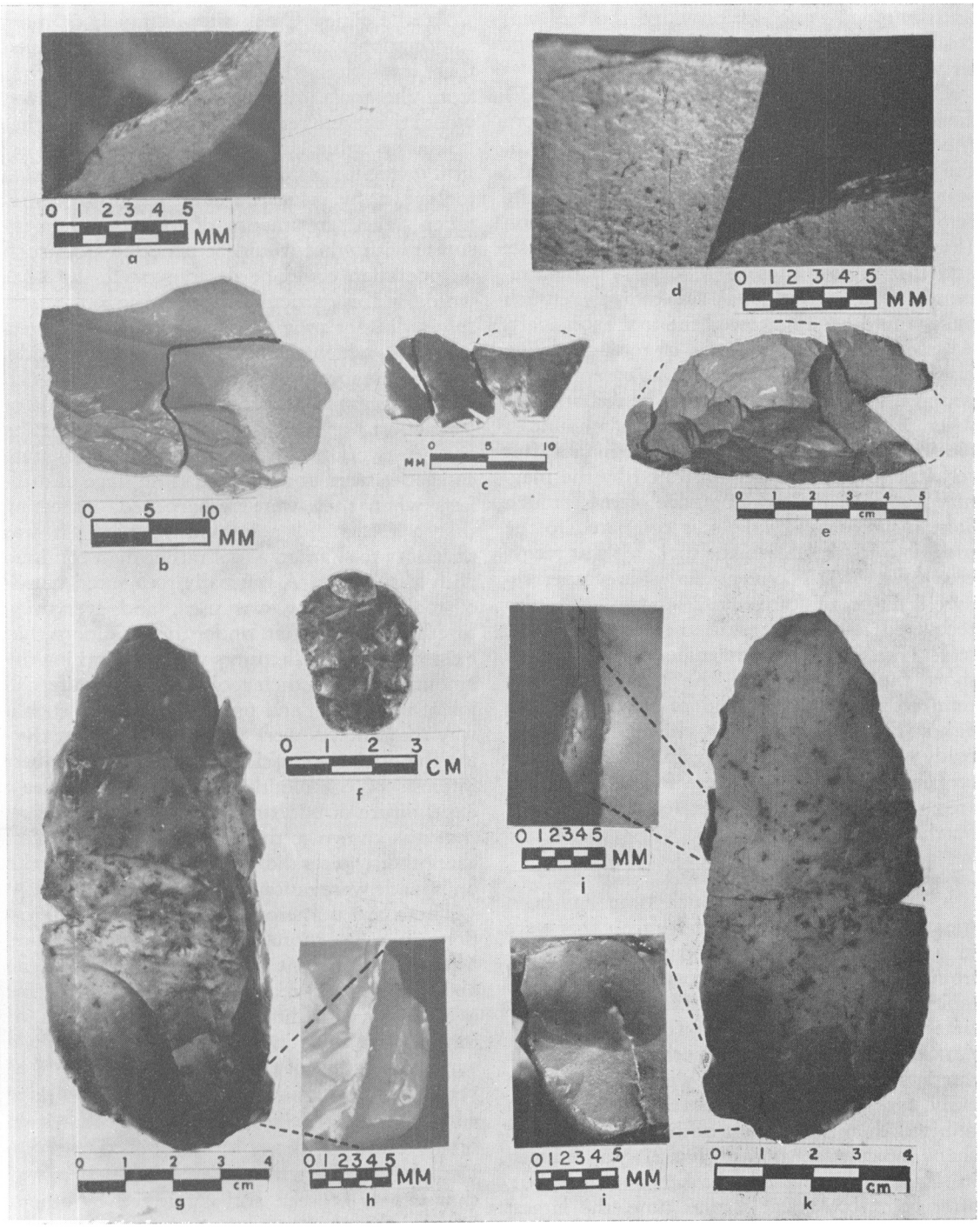

FIG. 3. *a*, enlarged view of striking platform of typical side-scraper retouch flake of category one; *b*, enlarged view of two overlapping side-scraper retouch flakes in the same category, showing scalar retouch; *c*, three overlapping end-scraper retouch flakes; *d*, enlarged view of working edge of (*e*) side scraper, demonstrating different kinds of use at different times on the same tool; *f*, end-scraper retouch flake replaced in flake scar on tool; and *g–k*, side scraper with enlarged views of replaced retouch flakes.

and sharpening process, provided the tool was thick enough to withstand thinning and not be structurally weakened in the process.

One side scraper was recovered (Fig. 3*g*, *k*) from which several flakes were removed from the flat side in the vicinity of one end. One of the flakes was recovered which matches its flake scar on the tool. The working edge of the retouch flake as shown under magnification (Fig. 3*i*) was dulled, apparently through use, and in this case there is a suggestion that removal of a conventional side-scraper retouch flake would have narrowed the tool excessively. After removal of this series of retouch flakes, however, the tool was used to the extent that it was again dull and was ready to be resharpened when it was probably broken. The amount of reduction of the tool width through use after resharpening can be demonstrated by the magnified view of the working edge of the retouch flake in its original flake scar compared to the present working edge of the tool as it was recovered (Fig. 3*h*). Conventional side-scraper retouch flakes of category 2 above were also recovered and replaced in their original flake scars (Fig. 3*g*, *k*). A magnified view of these show the amount that the tool width was reduced after the removal of the sharpening flakes (Fig. 3*j*). Apparently this tool was about ready for resharpening again when it was broken. Retouch flakes were found in the kill area; the broken tool was recovered in the butchering area.

CONCLUSIONS

It would appear that much time has been spent hypothesizing functions for tools that were in a nonfunctional condition when recovered from their archaeological context. The same tool may also appear much different at different times during its lifetime of functional utility. An example is Fig. 2*g*. Two other tools are side scrapers (Fig. 2*i*, *k*) which were broken at an early stage, and continued use and resharpening reduced them in size but with little change in shape indicated. Another (Fig. 2*j*) was reduced in size after having been broken one time; but, after being broken at a later time, the largest piece of the tool was changed into an end scraper. Tool typology must consider these possibilities if typology is to have any value as a temporal, spatial, or functional indicator. Care must be taken to determine whether two or more different-appearing tools are not the same tool, functionally, at different stages of use.

At the Piney Creek site, as much or more information, concerning activities performed there, was derived from the retouch flakes as from the tools. The retouch flakes remained where they were removed as they had no further utilitarian value. In the kill area there was very little evidence of tool use in the form of actual tools, but, by using the evidence from the retouch flakes, an amount of tool use commensurate with what would be expected from such an operation could be demonstrated. In other words, in this particular context, the tools themselves did not provide a basis for a valid interpretation, which the retouch flakes did provide.

The homogeneous nature of the retouch flakes suggests that something of a principle of least effort prevailed during the activities at the site. All working edges of tools in their separate categories were at about the same stage of dullness when they were resharpened, indicating that a recognized point existed when it was necessary to sharpen a tool rather than continue with a dull one. A mutually recognized means of tool sharpening was used, and everything together suggests that, under the conditions that existed, the manufacturers were maximizing the amount of use in their tools and performing the job of butchering and preserving meat in such a way that choices were necessary, at points during the operation, which were made in the best interests of completing the job with the least expenditure of effort at the level of technology that was known to them. This is not to suggest that other choices did not exist but only that the ones made were rational.

There are numerous problems and implications in a functional analysis of this nature. Microscopic analysis is time consuming, and the ability to see and recognize evidence of tool use is acquired with difficulty. Straightforward interpretations may often be shown on only a small percentage of the total specimens. It is as yet difficult to assign tool wear on a working edge to any specific function except within broad limits. Evidence is often difficult to photograph or otherwise preserve in such a way that it may be seen and confirmed by others. To perform such an analysis also requires some background in the mechanics and use of simple tools.

The analysis of the Piney Creek material has left a number of thoughts for future work. With enough care in excavation in a site such as Piney Creek, a tool that is no longer present at the

site could be traced in time and space through its period of functional utility with a possibility of being able to say how it was used along the way. For example, a tool at Piney Creek (Fig. 3*g*, *k*) was recovered in the butchering area, but several of its retouch flakes were found in the kill area. Obviously, speculation such as this could go on indefinitely, but the fact remains that the information offered by retouch flakes can result in better interpretations concerning tool use; and this will undoubtedly have its effects in other areas of interest as well.

There is already some evidence that this type of analysis can be applied to other sites and other time levels. An Early Middle period bison kill in the Powder River Basin of Wyoming produced retouch flakes that gave a more valid interpretation of the activities at the site than the tools were able to offer (Frison 1968).

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BORDES, FRANÇOIS

1961 Typologie du Paléolithique Ancien et Moyen. *Publications de l'Institut de l'Université de Bordeaux, Mémoire* No. 1. Bordeaux.

FRISON, GEORGE C.

1967 The Piney Creek Sites, Wyoming. *University of Wyoming Publications*, Vol. 33, No. 1. Laramie.

1968 Site 48 SH 312: An Early Middle Period Bison Kill in the Powder River Basin of Wyoming. *Plains Anthropologist*, Vol. 13, No. 40. Lincoln.

JELINEK, ARTHUR J.

1965 Lithic Technology Conference, Les Eyzies, France. *American Antiquity*, Vol. 31, No. 2, pp. 277–9. Salt Lake City.

SEMENOV, S. A.

1964 *Prehistoric Technology*, translated by M. W. Thompson. W. and J. Mackay and Company, Chatham, Kent.

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