AN EXPERIMENTAL USE-WEAR AND FUNCTIONAL ANALYSIS OF GUNFLINTS

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Introduction

There have been relatively few archaeological studies performed on gunflints, and most of those that have been conducted focus on identification of an artifact as a gunflint and the gunflint's country of origin. This study addresses the dearth of information on use-life and use-wear patterns of gunflints. Previous archaeological and experimental research had concluded that unifacial step flaking associated with smoothing of the worked edges is the prototypical gunflint use-wear pattern (Kenmotsu 1990). This pattern is classified as unique to gunflints, allowing archaeologists to categorize artifacts in a collection that exhibited these wear patterns as gunflints, and also estimate its use-life based on the kind and severity of use-wear present.

This research project was designed to evaluate previous gunflint use-wear studies, conducted by Nancy Kenmotsu, and to see if there is indeed a unique use-wear pattern that increases systematically each time the flint strikes the frizzen. These patterns would be observed in a modern sample through experimental research and compared to gunflints from the archaeological collection in order to reconstruct the artifact's use-life. An accurate assessment of use-life will allow for reconstructions of site economics and make it possible to see if gunflints are being used differently in varying spatial and cultural contexts.

Another topic that this study addresses is one that has been overlooked in experimental archaeological literature. Experimental research was conducted to see if differences in raw material and manufacturing processes affected the likelihood of shots being fired. This was measured through a comparison of the numbers of charges lit and the number of times the flint strikes the frizzen. Differences in the numbers of shots fired per gunflint can lead to a more accurate understanding of the best type of gunflint to be using.

Before an evaluation of relative manufacturing techniques and raw material, a review of the history of gunflint manufacturing, materials used, and gunflint use is required. After gathering an adequate amount of background information, an experiment was designed and performed to address the two issues this project raised. The data collected were then interpreted to discover if unique, systematically increasing use-wear patterns existed in gunflints and to evaluate the differences, if any, between manufacturing techniques, raw materials and the effectiveness of the gunflint.

Background

Gunflint production started in the 1600's with the invention of snaphance guns (Lenk 1965). Manufacture of flintlock rifles began in 1650 (Chapel 1962). The gunflint itself was used to produce a spark to ignite the black powder in the frizzen pan of a flintlock rifle (Hamilton 1964). All gunflints were manufactured outside of the United States, mainly in France and England, and then imported (Woodward 1960). Gunflints of French origin were the most common in the United States until 1790, when production of Brandon flint in England began (Kenmotsu 1990). English Brandon flints rapidly replaced French flints as the gunflint of choice for people in the United States. Gunflint manufacturing techniques changed from gunspall production to blade-core production c. 1790, and only recently have gunflints been mass-produced by machine cutting. Native Americans utilized gunflints differently than Europeans in the United States. The Native Americans fired and retouched their gunflints bifacially (Witthoft 1966), while Europeans worked their gunflints unifacially. In the archaeological record, a gunflint worked bifacially most likely has been utilized by Native Americans. Previous research has focused on spatial distribution analyses (Hamilton1960). Nancy Kenmotsu's (1990) research project added a dimension of use-wear analysis to the literature. Kenmotsu microscopically examined 38 gunflints from modern and archaeological contexts and proposed a use-wear pattern for gunflints based on her observations.

Project Design and Methods

The archeological collection used in this study comes from sites excavated by Mark Schurr during the University of Notre Dame Archaeological Field School conducted from 2000 to 2003. Three sites, Bennac Village (12MR231), Pokagon Village (20BE13), and McCartney Cabin (12K0313), date from the Removal Period of the Potawatomi, between 1830 and 1850. These three collections contained a total of seven complete gunflints,

and a number of alleged gunflint fragments. The gunflint fragments were not included in this study due to the inability to ascertain information about the number of worked edges. The gunflints were then categorized, based on a table by Mark Wagner (2001). It was hoped that this data, when compared with the modern gunflints, would aid in reconstructing site economics and individual artifact use-life.

To formulate a modern sample of gunflints for the experimental work, a flintlock rifle and gunflints first had to be attained. Thirty gunflints were purchased for this study: ten English Brandon gunflints manufactured with blade and core technology, ten gunflints machine cut from Brazilian agate, and ten machine cut gunflints made from Arkansas chert. It had been hoped that ten gunflints of French raw material and manufacturing would be used in this study because of the presence of gunflints with a French origin in the archaeological collection. Yet the relatively small number of modernly manufactured gunflints provided a scarcity of resources, and the desired materials were unable to be acquired. As Kenmotsu suggests, a 10-70 power light microscope was used for analysis of the use-wear patterns. Each modern gunflint was examined microscopically and a Lithic Use-Wear Pattern data sheet, modeled on Kenmotsu's and Ahler's (1979) data collection sheet, was completed for each gunflint. The Lithic Use-Wear Pattern data sheet examined the presence or absence of blunting, smoothing, polishing, step-fracturing, crushing, flat flaking, striations, and residue on the edges of the gunflints. The definition of these use-wear terms was taken from Ahler (1979).

First, a gunflint was fitted into the cock. The frizzen pan was then loaded with a small amount of black powder. Then the frizzen pan was covered with the frizzen, the cock was pulled back, and the trigger was pulled. This action created sparks which had the opportunity to light the black powder in the frizzen pan. A successful shot is attained when the sparks produced from the flint striking the frizzen ignite the black powder in the frizzen pan. In use, this ignition would then light black powder in the barrel, firing the round. For this experiment, the barrel was not loaded with powder or a round because a lighting of the frizzen pan's black powder almost assuredly would guarantee a shot to be fired. Each flint was used for a specific number of shots. Six flints from each raw material (English, Arkansas, and Brazil) were used. One flint of each material was not shot to provide a control specimen. The other five flints struck the frizzen 10 times, 20 times, 50 times, and 100 times. Each time, it was recorded whether the sparks produced by the flint striking the frizzen resulted in a successful shot.

Use-Wear Expectations

Based on previous studies, this project expected to find a number of characteristics of the gunflints that would signify uniform use-wear. First, it was expected that use-wear patterns would become more severe as use-life increased. Severity of gunflint use-wear patterns would be indicated by macroscopic observation and by high levels of step fracturing, blunting, and polishing on the working surface. It was also expected that the use-life of the gunflints, specifically the number of times it has been fired, could be determined through microscopic analysis. In Kenmotsu's research, 100 percent of the working edges of the gunflints exhibited step fracturing. It was expected that this work would reflect her data, and that all worked edges would have step fractures. Finally, in Kenmotsu's study, analysis of use-wear was not limited to gunflint edges that had been used to strike the frizzen. She included all edges that exhibited use-wear, not differentiating between firing use-wear and manufacturing use-wear. In this study, the number of edges used and which edges struck the frizzen is known. It was expected that the used edges would have more severe use-wear patterns than the unused edges, especially in blunting, crushing, and step-fracturing.

Firing Expectations

First, it was expected that the reliability of the gunflints would decrease with an increase in the number of times the flint struck the frizzen. Second, drawing upon U.S. military records, it was expected that a gunflint edge would only be reliable for 20 rounds (Chapel 1962). It has been put forth in archaeological literature that light serrations on the working edge produced during the knapping process increase the number of sparks sent into the frizzen pan, resulting in more successful shots (Kenmotsu 1990). It was therefore expected that the English Brandon flint manufactured using the blade-core technology would fire more consistently than the machine cut gunflints. Finally, it was expected that the English Brandon flint would produce a larger number of successful shots because of its popularity for nearly 100 years as the premier gunflint material.

Results

Due to small size, the Arkansas gunflints could not be used in this study.

This left the Brazilian agate and the English Brandon flint as the two comparative materials.

Use-Wear Results

Upon completion of the experimental portion of the project, the gunflints were analyzed under a microscope and data recorded on Lithic Use-Wear Pattern data sheets. The information from the data sheets was then combined into a spreadsheet (table 1). Blunting was found in four (66.7%) of the Brazilian worked edges and two (7.7%) of the English worked edges. There were no recorded instances of smoothing of the edges in this experimental study. Two (33%) of the Brazilian edges, the ones that were fired over 20 times, exhibited polishing while there was no polishing found on the English gunflints. Step-fracturing was found in four (66.7%) Brazilian agates and sixteen (61.5%) English flint edges. Crushing was recorded on 2 (33.3%) of the Brazilian edges and fourteen (53.8%) of the English edges. Four (66.7%) of the Brazilian worked edges had flat flaking, while all 26 (100%) edges of the English flints had flat flakes removed. Striation was non-existent in the Brazilian agate (0%), but it was found on two (7.7%) English gunflint edges. The most common residue found on the gunflints was metal. Metal was found on one (16.7%) Brazilian gunflint and all six (100%) English gunflints. Three (50%) of the Brazilian gunflints had a black residue on the worked edge, though it was not found on the English gunflints.

Analysis of the used edges of the gunflints was also recorded. Four (80%) of the used edges of Brazilian agate had blunting, while there were no occurrences (0%) of blunting on the English Brandon flint. There were two (40%) used edges of the Brazilian gunflints that had polishing and zero (0%) English gunflints exhibited that type of use-wear. The Brazilian agate and Brandon flint both had 3 (60%) used edges that had step-fracturing. One (20%) of the Brazilian gunflints and two (40%) of the English flints had crushing along the used edge. Flat flaking was present on four (80%) of the Brazilian agate used edges and on all 5 (100%) of the Brandon flint used edges. While there were no striations (0%) on the Brazilian gunflint used edges, striations were present on one (20%) of the English gunflint's used edges.

Firing Results

Each time the gunflint struck the frizzen it was noted if that contact produced sparks that ignited the black powder in the frizzen pan. The relative

frequency of successful shots is shown in figure 3. In this chart, the average number of successful firing is computed per five shot increment. The best five shot increment for the Brazilian gunflints produced two successful firings (40%) and it occurred seven times: shots 6 to 10, shots 16 to 20, shots 21 to 25, shots 31 to 35, shots 36 to 40, shots 46 to 50, and shots 81 to 85. The best five shot increment for the English gunflints was from shots 31 to 35 when it averaged 4.5 out of five (90%). On average, at any given five shot increment, it is 80% likely the English Brandon flint is at least equal in reliability, and usually more reliable, than the Brazilian agate. The average number of successful firings per 100 shots for the Brazilian agate was 25.2. Over the same 100 shot period, the English Brandon flint averaged 37.0 successful firings. For the English gunflints, the average number of times the flint has to strike the frizzen to fire 20 rounds is between 30 and 35 times. The Brazilian gunflints, on average, fire 20 rounds in 65 to 70 shots.

Discussion

Use wear

The macroscopic and microscopic analysis revealed no consistent use-wear patterns produced on gunflints. The only use-wear pattern that was found on all used English gunflints is flat flaking, yet this was also found on the English gunflint that was not fired (as a result of the manufacturing process). In Brandon flint, the action of the flint striking the frizzen creates step flaking, crushing, and sometimes striations and blunting. The severity of this use-wear, however, is highly variable, in contrast to the first expectation of use-wear patterns. Upon macroscopic and microscopic analysis, it was clear that the English gunflint that was fired 10 times had a higher severity of step-fractures, crushing, flat flaking, and striation on the used edge than the English gunflint that was fired 100 times. The English gunflint that was fired 100 times had no step fracturing, blunting, crushing, or striations on the worked edge, compared with the gunflint shot 10 times that had crushing, striations, and step fracturing on the working edge. The Brazilian gunflints were even less predictable, as the presence or absence of flat flaking, step-fracturing, crushing, and blunting did not increase systematically. The metal residue that was left on all of the English gunflints yet only one Brazilian gunflint might suggest that the Brandon flint is harder or less brittle than the Brazilian agate. The one type of wear that seems to increase with shots fired is polishing in the Brazilian agate, but Kenmotsu (1990) suggests that polishing in the archaeological record may not be found, as the gunflints are usually discarded or retouched before they develop this severe type of use-

wear. This high variability in the severity of use-wear makes it nearly impossible to determine the number of times a gunflint has been used.

The objective of categorizing the gunflints from the archaeological collection into different degrees of use-wear to reconstruct use-life and site economics was unable to be realized. In addition, it was evident that the gunflints in the archaeological record had been retouched. All of the archaeological gunflints had been pressure flaked bifacially. While this suggests Native American use, it hampers a use-wear analysis. Retouching an edge removes all of the worn material, regenerating that edge for further use. It cannot be determined how many times an edge has been retouched, and in turn, the number of shots fired cannot be calculated. Other factors, such as differences in individual gunflint shape and size and orientation in relation to the frizzen, appear to account for the lack of a uniform use-wear pattern that increases systematically through use.

The expectation of the presence of step-fracturing on all worked edges was also not supported by the data. Only 66.7% of the Brazilian agate edges and 61.5% of the English Brandon flint edges had step-fractures, far below the 100% found in Kenmotsu's project. This is once again evidence that there is no uniform use-wear pattern associated with gunflints. There were differences in the use-wear analysis between the two raw materials and production techniques. The Brazilian agate had much more use-wear in the categories of blunting and polishing, while the Brandon flint had more edges with crushing, flat flaking, and striations. The template for use-wear patterns that Kenmotsu suggests does not take into account raw material. The results from this experiment, however, show that gunflint material and production technique impact the presence or absence of use-wear.

When comparing the percentage of worked edges with particular use-wear patterns to the percentage of used edges with those same patterns, there is no glaring disparity. If use, rather than manufacturing process, is allegedly producing the wear patterns, then it is expected that the used edges would have significantly more wear. That is not the case in this study. For the English gunflints, the presence of use-wear patterns does not appear linked to the edge used. For example, there were two instances in blunting in the English flints, yet neither of them was on a worked edge. Similarly, 53.8% of the worked edges exhibited crushing, but only 40% of the worked edges showed the same. The percentage of step-fracturing was nearly identical. Increasing use-wear patterns along the used edge does not occur.

The presence of residue on the gunflint does not necessarily correlate with use-wear. In the Brazilian agate, not all of the samples had black residue, most likely a result of the powder, and only one had metal on the surface. The lack of consistent residue patterns makes it hard to apply it to an archaeological context. Lack of residue is not an indicator of lack of use. Presence of residue is likewise not an indicator of use. In the English Brandon gunflints, there was metal residue found on the gunflint that was not fired. The residue most likely was a result of the blade-core manufacturing process, and not a result of striking the frizzen.

A problem with a use-wear analysis of gunflints is found from the military literature. Soldiers often fell into the habit of needlessly snapping the cock, which severely shortened the use-life of a flint (Hicks 1937). This activity would undoubtedly leave use-wear on the gunflint. Even if a uniform use-wear pattern were present on gunflints, activities such as this would distort possible site economic reconstructions.

Firing reliability

In tracking the flint's ability to light the black powder in the frizzen pan, it was observed that the peak effectiveness of each material was between shots 10 and 40. After the gunflint had struck the frizzen more than 50 times, it became wholly unreliable. This result supported the first expectation of firing for the project. For example, in shots 1 to 50 of the English gunflint that was fired 100 times, 27 successful firings of the black powder were produced. In contrast, shots 51-100 of that same flint produced only 9 successful firings. It is unlikely that in the practice, gunflint edges would be shot more than fifty times before utilization of another edge or retouching. The average number of times the flint strikes the frizzen in order to produce 20 successful firings is 30 to 35 for English Brandon flints and 65 to 70 for the Brazilian agate. When all of the gunflints in this study are combined, the average number of shots to shoot 20 rounds is around 50. This agrees with the reliability expectation that each gunflint edge only produces quality sparks for the first 50 shots.

The U.S. Army issued one gunflint per 20 rounds in 1846 (Chapel 1962). Interviews with modern flintlock rifle enthusiasts have shown that a single gunflint usually can shoot close to 200 rounds (Kenmotsu 1990). Kenmotsu concludes that modern people using gunflints are able to maintain a longer use-life of their flints than people 150 years ago. I believe that Kenmotsu's conclusion does not take into account other factors. Modern enthusiasts often

have a number of high quality flints in their kits. The mass production of gunflints in the nineteenth century would have limited the quality of individual flints. Low quality flints may not have had alternate edges to be utilized through retouching and flipping the gunflint over. In addition, in a military situation, it is much easier to simply change gunflints than try and rejuvenate them. To retouch a gunflint, the soldier would need to have additional materials in their kit, such as a stone or antler billet. The size and weight of the gunflints would make it much more attractive to carry around many of them than retouching tools. It also takes less time to change a gunflint than to retouch it. In a battle, that may mean the difference between life and death.

Functionality and cultural differences may be reasons for the distinction between military flints and Native American flints from habitation sites. Acculturation is a major issue in Native American sites during the Removal Period. The gunflint collection from Bennac Village, Pokagon Village, and McCartney cabin sites show that the Native Americans were not using gunflints in the same way as Europeans. Technologically, bifacial retouching of European gunflints is an example of Native Americans adopting materials from the foreign influences, yet keeping their own production techniques that were passed down through numerous generations. Functionally, the Native Americans did adopt European guns and gunflints, yet they used them in their own way. Gunflints found at Native American habitation sites were most likely used for hunting, as opposed to the military's use of guns as warring implements. Gunflints are evidence for partial acculturation, yet with many traditional values and practices still being maintained.

The raw material and manufacturing methods played a large role in predicting the success of a shot. The blade-core manufactured English Brandon flint outperformed the machine cut Brazilian agate, often at a successful firing rate of 2:1. This result was as expected, because the light serrations, which are thought to increase the number and quality of sparks, on the working edge that are produced through the knapping process of blade-core technology are absent in the machine cut material. Further investigation, isolating one of the two variables, raw material and manufacturing process, can show to what extent each affects the gunflint's quality.

Conclusion

This research project was designed to evaluate previous gunflint use-wear

studies, conducted by Nancy Kenmotsu, and to see if there is indeed a unique use-wear pattern that increases systematically each time the flint strikes the frizzen. The results that the experimental work provided contradict Kenmotsu's conclusion. Variables, such as raw material, manufacturing process, angle at which the flint strikes the frizzen, and weapon used impede gunflint analysis by affecting the severity of the use-wear and the way in which use-wear is formed.

Due to a lack of systematic use-wear patterns, archaeologists are unable to categorize the use-life of gunflints in the archaeological collection. Conclusions about cultural processes, such as site economics, which had been hoped to be supported by gunflints in the archaeological collection, cannot be made. Gunflint rejuvenation, uneven use-wear, and alternative use-wear forming activities keep archaeologists from knowing how many times a gunflint has been fired. Experimental research showed that gunflint edges are only reliable for about 50 shots, or 20 rounds. This is in line with the historical military documents of the nineteenth century. It was also seen that raw material and manufacturing process dictate how effective a gunflint will be. Gunflints are surprisingly inconsistent, with most gunflints only successfully firing 40% to 60% of the time. There are many questions about gunflints that have yet to be asked or answered. Further study into ideal raw materials and production techniques can be completed in order to find the optimal gunflint morphology. Gunflints, while found on many archaeological sites, have not at this point been examined for their ramifications on cultural processes such as economics and cultural identity, and that step will lead to a better understanding of historical archaeological sites.

References Cited

Ahler, Stanley A.
1979   Functional Analysis of Non-Obsidian Chipped Stone Artifacts: Terms, Variables and Qualification. In *Lithic Use-Wear Analysis*, edited by Brian Hayden, pp. 301-328. Academic Press, New York.

Chapel, Charles Edward
1962   *U.S. Martial and Semi-Martial Single Shot Pistols*. Coward and McCann, Inc., New York.

Hamilton, T. M.
1960   Additional Comments on Gunflints. *The Missouri Archaeologist* 22:73-79.

Hamilton, T. M.
1964   Recent Developments in the Use of Gunflints for Dating and Identification. In *Diving into the Past, Theories, Techniques and Applications of Underwater Archaeology*, edited by June D. Holmquist and Ardis H. Wheeler, pp. 52-58.

Hicks, James E.
1937   United States Military Shoulder Arms, 1795-1935. *The Journal of the American Military History Foundation* 1(1):22-33.

Kenmotsu, Nancy A.
1990   Gunflints: A Study. *Historical Archaeology* 24(2):92-124.

Lenk, T.
1965   *The Flintlock: Its Origin and Development*. Bramball House, New York.

Wagner, Mark J.

2001   *The Windrose Site: An Early Nineteenth-Century Potawatomi*
        Settlement in the Kankakee River Valley of Northeastern Illinois.
        Illinois State Museum.

Witthoft, John
1966   A History of Gunflints. *Pennsylvania Archaeologist* 36:12-49.

Woodward, Arthur
1960   Some Notes on Gunflints. *The Missouri Archaeologist* 22:29-39.