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Frontier Flintlocks: A Fault Tree Analysis of Firearm Use at Contact Period Sites of the Great Plains

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FRONTIER FLINTLOCKS: A FAULT TREE ANALYSIS OF FIREARM USE AT CONTACT PERIOD SITES OF THE GREAT PLAINS

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Abstract. *Gun part assemblages from several Euroamerican and Native American contact period sites from the Plains are compared as a way of examining how firearms were incorporated into Native technology of the Plains region. These data are interpreted in terms of a "fault tree analysis," an operations research technique that identifies potential points of failure in technical systems in order to study patterns of use, maintenance, and reliability. The analysis indicates distinctively different patterns of gun repair and treatment by Indians and Euroamericans but suggests that Indians were quite capable of repairing firearms and that they systematically reused parts from failed arms.*

The period of initial contact between Euroamerican and Native American societies has attracted the attention of historians, anthropologists, archaeologists, and, of course, the general public. Beyond their intrinsic interest, the dramatic events and romantic objects of the contact period have been studied because they were pivotal to the subsequent history and cultural developments of North America (Billington 1967). As a period of rapid acculturation, the contact period also provides an opportunity to study what happens when radically different cultures are thrown into contact (White 1975).

Contact period sites have attracted the attention of archaeologists and excavations of both Indian and Euroamerican sites have contributed substantially to understanding how the frontier progressed. Archaeological research has shed specific light on the demographic implications of Euroamerican contacts (Ramenovsky 1988) and has shown how materials flowed through the cultural systems that developed as Euroamericans invaded the continent. Detailed analyses of trade goods as diverse as pipe stems (Binford 1961) and buttons (Olsen 1963) have added fine chronological control to investigation of the frontier. Other studies have documented the material culture of frontier societies (Quimby 1966) and isolated distinct ethnic and national spheres of influence (South 1978).

Moving beyond descriptive concerns, archaeologists addressed the processual study of the culture change that marked the frontier (Lewis

1984). At first, contributions in this regard consisted of giving substance to theories drawn from other fields (Ray 1978) or articulating written and material records (Pyszczyk 1989). Increasingly, archaeologists aim at using material records to study the cultural interactions that marked the frontier (Brown 1979; Green 1985). This paper addresses acculturation that occurred on the frontier in strictly archaeological terms. It considers the use and discard patterns of flintlock firearm parts to discuss how Euroamerican goods were accommodated by Indian technology.

Flintlocks have been one of the classic icons of frontier period archaeology and are an appropriate focus for consideration of technological acculturation for several reasons. They have received a great deal of archaeological attention because of their interest to collectors and because they are sensitive chronological and cultural markers. Flintlock firearms were popular and important trade goods, used by Euroamericans and much sought after by Indian hunters and warriors. Historic and ethnographic studies have shown that, after an initially slow accommodation (Babits 1976), flintlock arms were easily incorporated into native economic and social patterns (Secoy 1953). Firearms were, thus, responsible for intensifications of preexisting social and subsistence patterns where they could be accepted without requiring entirely new cultural patterns.

The way firearms were incorporated into Indian technology is less well documented in historical sources, which contain scattered anecdotal references but little systematic information on how Indians handled and treated the guns they obtained through trade. Technologically, flintlock arms were exotic to Indian communities and represented a dramatic break with tradition. Firearms incorporated materials and techniques unknown to stone-age cultures and required maintenance patterns and tools that were very different from those of traditional Indian weapons.

If Indian technological adjustment to firearms is hard to address through historic sources, it can be studied archaeologically because the archaeological record preserves the direct residues and results of gun handling. Moreover, since data are available from both Euroamerican and Indian sites, there is information available on flintlock usage on both sides of the frontier. In this paper, archaeological assemblages of gun parts from contact period Indian and Euroamerican sites of the Great Plains are compared to gain insights on how firearms were incorporated into Indian technologies.

Fault Tree Analysis

To organize the comparisons and focus on the processes that were responsible for the archaeological assemblages considered here, we use

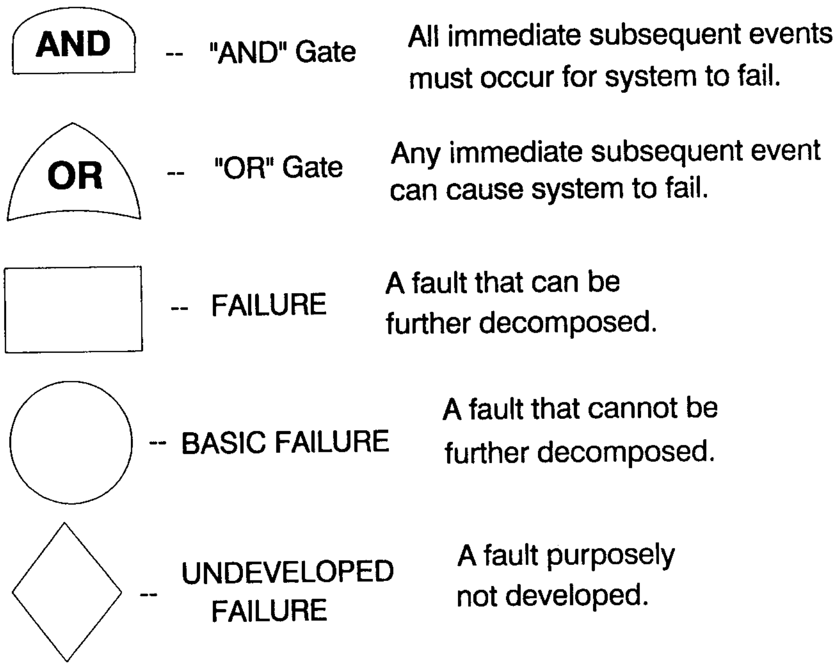

Figure 1. Standard fault tree symbols.

fault tree analysis. This is an operations research technique developed by engineers to determine the array of adverse conditions—or faults—that can cause a technological system to fail (see McNitt 1986; Henley and Kumamoto 1981). Fault trees are dendritic models that present a task's structure by showing how sequences of actions are interconnected. Fault trees focus on the things that can go wrong during the operation of the task.

The central element of analysis is a fault tree model, which lays out the conditions that can result in a system's failure. Virtually any technical or social system can be treated in this way. Fault trees are hierarchical in that they lay out several levels of potential failure. The diagram tree starts with a basic system failure. This "top event" is then decomposed into all of the faults (subevents) that can contribute to it. On the diagram, the alternative faults that can possibly beset a system are logically presented and related to one another and to the top event by means of a series of conventional symbols (Fig. 1). Below the top event, potential intermediate failure events—or those that can be further decomposed into the subevents—are symbolized by rectangles. "Basic failure events," presented in circles, are faults that cannot be further decomposed. They form the bottom of the tree. Diamond shapes indicate failure events that could be further disaggregated but which are not considered in the analysis. Two types of "gates" connect the various kinds of events: "AND" gates connect subevents that can cause failure only when they all occur together; "OR" gates are located between subevents that may independently cause a failure. A fault tree for a complex system with multiple subsystems or built-in redundancies can become complex. The purpose is, however, to lay out in an interpretable order the range of problems a system might encounter. Applied to archaeological materials, a fault tree offers a means of conceptually linking failed residues in the archaeological record to the operation of larger behavioral systems and technical activities (Bleed 1991).

The Flintlock Fault Tree

A standard flintlock firearm is a relatively simple system that can easily be presented as a fault tree (Fig. 2). Most flintlocks consist of three subsystems—the lock, stock, and barrel—that operate in parallel and without backups. If any one of these fail, the gun will not fire. The flintlock fault tree, therefore, starts with a single "OR" gate indicating that a loaded flintlock gun can be inoperable due to failure in one of its subsystems.

The barrel fails through explosion, excessive wear, or if the touch hole at the breech is enlarged. In general, an exploded barrel reflects either misuse of a gun or a manufacturing defect. Worn ("shot out") barrels and enlarged touch holes are results of normal, but very long, use. The wooden stock holds the subsystems together in proper alignment and makes the whole arm manageable. If it breaks through misuse the arm is inoperable. Metal fittings strengthen and decorate the stock, but most are not critical to the operation of the arm.

The lock is the most delicate and complex subsystem within a flintlock and the fault tree clearly shows that it is the subsystem with the most potential for failure (Fig. 3). A worn flint that cannot generate a spark presents a basic failure, but this is one of a number of maintenance problems that can be set right by the operator. Other lock faults require more extensive repairs or adjustments. The cock can break off the gun. The frizzen can be excessively worn so that it will not strike a spark. In some designs, the pan can be separated from the lock plate. The sear can be worn so that the cock is not controllable. Finally, failure of any of the three springs that control lock parts can be considered a basic fault.

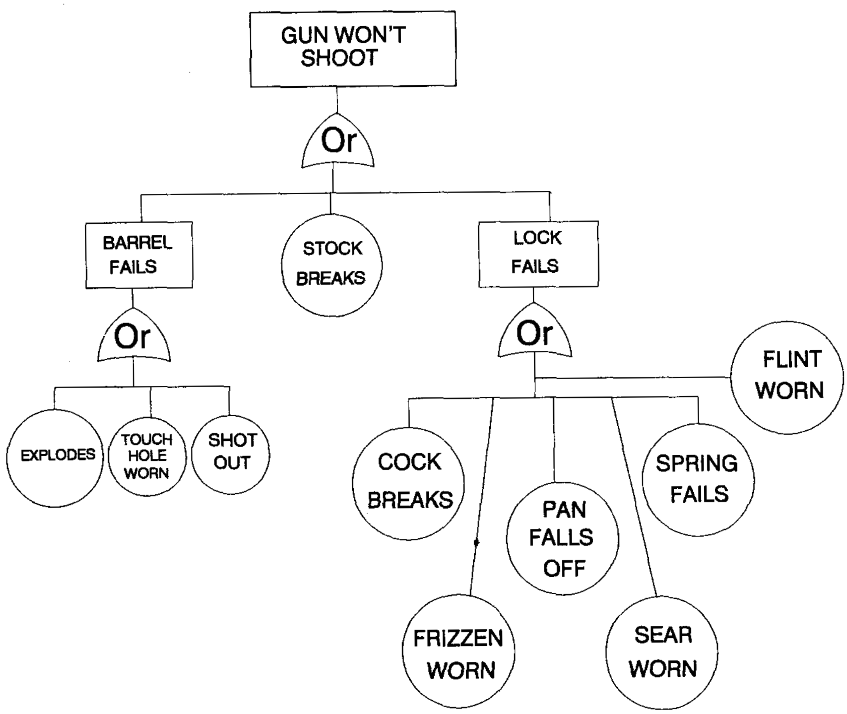

Figure 2. A flintlock fault tree.

By indicating what can go wrong with a flintlock, the fault tree presents a set of expectations about what residues should normally result from flintlock use. Since failure of any subsystem causes total failure, the archeological record should include lock, stock, and barrel parts. Still, the model shows that the lock is the subsystem most prone to failure since it has a large number of critical parts that must operate in precise articulation with one another.

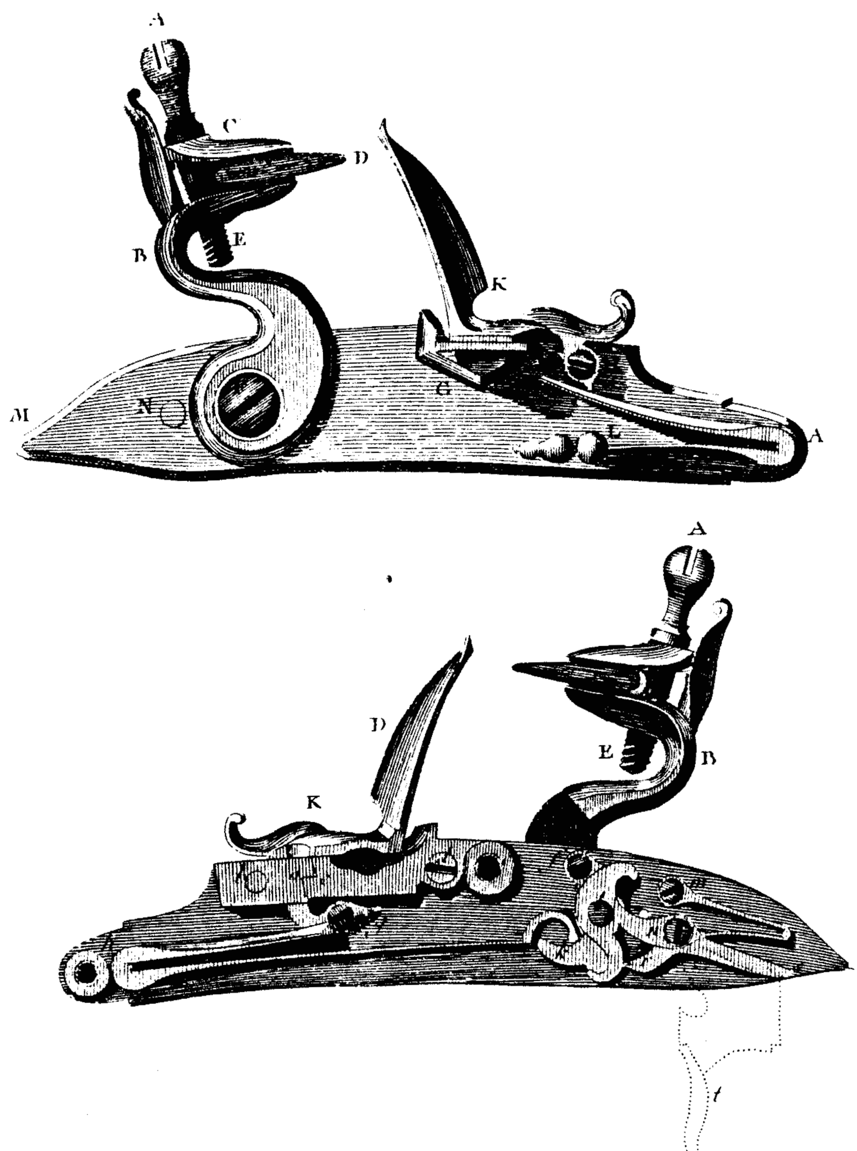

Figure 3. External (top) and internal (bottom) views of a flintlock showing parts subject to failure: D. Flint, B. Cock, K. Frizzen, G. Pan, I. Sear, L., M. and H. Springs. (From Gillispie. 1959: Plate 61).

Flintlocks on the Frontier

To examine the practical realities of gun use on the frontier, published and unpublished data on gun part assemblages from early historic period Euroamerican and Indian sites on the Great Plains were gathered (Table 1, Fig. 4). Contact period assemblages from eastern and southwestern North America and other areas were not considered because they would introduce a wide range of historic and cultural variables. Limiting the scope of the study to the central and northern Plains focuses analysis on an interval and area that experienced a limited range of influences and trends.

To emphasize how guns were used, only materials from domestic residential areas were initially considered. Burial assemblages were not included in the study sample for two reasons. First, culture historic research questions that have dominated Plains research for the past 60 years have made Indian burials more interesting that those of Euroamericans. Data available on non-Indian burials are so limited and widely scattered as to be incomparable to the relatively large body of data available on Indian burials. Second, it seem probable that firearms included with burials reflect less on gun use than on other social patterns. As data collection progressed, however, some burial assemblages clearly became significant in understanding Indian patterns of flintlock usage and are discussed below.

Only the gun parts contained in the collections were considered. No attempt was made to identify the types of guns reflected in the collections. Generally, the sites yielded only flintlock remains, but all of the gun parts present in the assemblages were considered. Contact period sites that yielded no gun parts are, of course, not reflected in the sample. Finally, while gathering data, the focus was on site assemblages. Finer chronological or provenance subdivisions were not considered.

Gun part assemblages from 18 Indian and seven Euroamerican community sites differed markedly (Table 2). Since the fault tree model indicated that potential for flintlock failure is concentrated in the lock, it is not surprising that lock elements account for nearly 40% of the gun parts from Euroamerican domestic sites. The relatively low proportion--about one quarter--of failed lock parts from Indian communities is remarkable. Likewise, the differences in the frequency of barrel fragments is very notable. They are rare in Euroamerican sites, but comprise more than half of the gun parts from the Indian communities. A chi-square test of the distribution of parts in the domestic site assemblages substantiates that the distribution is nonrandom (X^2=76.65, df=2, p=>.0001).

A broader perspective on the domestic site data is provided by three

TABLE 1

ASSEMBLAGES CONSIDERED IN THIS ANALYSIS

Site	Affiliation	Date	# of parts	Reference or location
		Native American Domestic Sites		
Biesterfeld	Cheyenne	ca 1700	1	Wood 1971
32ML2	Hidatsa et al.	1845-1870s	49	Smith 1972
32ME12	Hidatsa et al.	pre-1844	1	Ahler & Swenson 1985
32OL110	Dakota/Arikara	1831-1855?	7	Smith 1986
32ME5	Mandan	1787-1822	32	Lehmer et al. 1978
32ME8	Arikara	1798-1834	6	Lehmer et al. 1978
32ME15	Arikara	ca 1800	2	Lehmer et al. 1978
39BF2	Arikara	mid-1700s	4	Ahler & Toom 1989
39ST6	Arikara	1740-1795	1	Lehmer & Jones 1968
39CO9	Arikara	1800-1823	17	Krause 1972
25NC2	Pawnee	1809-1844	16	NSHS*
25PK1	Pawnee	1823-1846	9	NSHS
25SD2	Pawnee	1852-1859	6	NSHS
25SD1	Pawnee	?	9	NSHS
25GA1	Pawnee	1809?	1	NSHS
25BU1	Pawnee	1750-1809	8	NSHS
25HW1	Pawnee	1770-1844	3	NSHS
25WT1	Pawnee	1775-1809	14	NSHS
25NC7	Pawnee	1842-1847	2	NSHS
25BU4	Pawnee	1750-1770s	7	NSHS
14RP1	Pawnee	1770s	19	Roberts 1978
23SA3	Osage	1730-1775	100	Hamilton 1982a
23VE4	Osage	1775-1815	12	Hamilton 1982a
23VE3	Osage	1775	45	Hamilton 1982a
23VE1	Osage	1790-1815	247	Hamilton 1982a
		Euroamerican		
32WI17	Ft. Union	1829-1867	116	Hunt 1986:125-129
32MN1	Kipp's Post	1820s	1	Woolworth & Wood 1960
32ML2Ft	Berthold I	1845-1862	35	Smith 1972
32ML2	Ft. Berthold II	1851-1870s	17	Smith 1972
39ST217	Ft. Pierre	1859-1863	8	Caldwell 1982
25WN9	Ft. Atkinson	1820-1827	14	NSHS
25SY26	Fontenelle's Post	1822-1842	18	NSHS
		Caches/burials		
25DK2	Omaha	ca 1810	115	UNL**
25PK1	Pawnee	early 1800s	23	NSHS
23SA3a	Osage	ca 1750	108	Hamilton 1982b

* Nebraska State Historical Society

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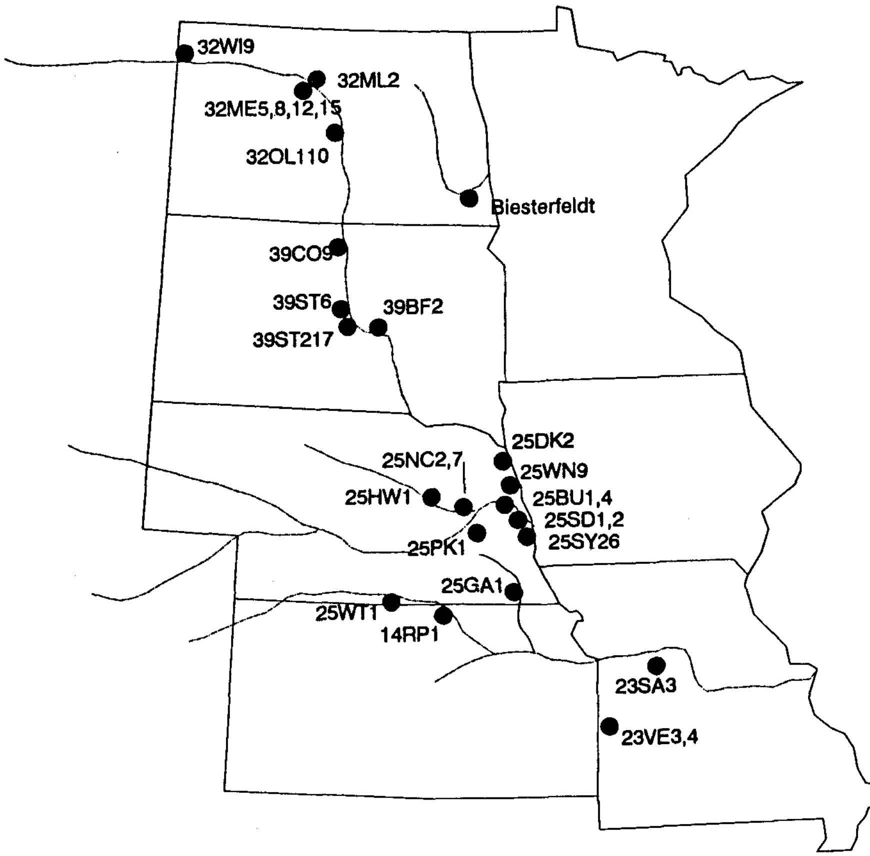

Figure 4. Sites considered in this analysis.

caches of gun parts made by Indians away from their communities. Two of these are from burials, one Pawnee (25PK1) and one Omaha (25DK2). The third is a large cache of parts and tools found in an isolated spot less than one mile from the Little Osage village (23SA3) in western Missouri (Hamilton 1982b). This cache can be assumed to have been made by an Indian, probably an Osage, because of its proximity to the Osage village.

These caches obviously form a small sample, but they markedly amplify the Indian gun part assemblage recovered from domestic sites. The cache assemblages are overwhelmingly composed of lock parts, precisely the parts that appear underrepresented in the domestic assemblages. When

TABLE 2

COMPARISON OF GUN PART ASSEMBLAGES FROM INDIAN AND EUROAMERICAN RESIDENTIAL COMMUNITIES

Communities	Lock	Stock	Barrel	Total
Indian	167	154	297	618
(n=25)	(27.0%)	(24.9%)	(48.1%)	(100.0%)
Euroamerican	81	98	30	209
(n=7)	(38.8%)	(46.9%)	(14.3%)	(100.0%)

the cache assemblages are combined with the domestic totals, the assemblage of gun parts from Indian and Euroamerican sites become more similar (see Table 3). With the cached parts included in the Indian total, barrels and barrel fragments continue to form a relatively large part of Indian assemblages and stock elements still remain relatively rarer than in Euroamerican assemblages. The overall distribution of parts, thus, still shows a statistically significant non-random distribution (X^2=62.818, df=2, p=>.0001). In terms of the proportion of lock parts, however, the assemblages have become markedly similar.

Discussion and Conclusions

The gun part assemblages considered here were unquestionably influenced by factors ranging from the design of flintlock guns to the research strategies of Plains archaeologists. In part, at least, the differences between assemblages from Indian and Euroamerican sites must also reflect that firearms were treated differently by Indians and Euroamericans on the Great Plains frontier. The nature and significance of those differences, however, appear to have been anything but simple.

Gun part assemblages from Indian residential sites include a preponderance of barrels. This high frequency may in part reflect the fact that light-barreled fusils were popular among Indians. These barrels may have had a shorter lifespan than heavier rifle barrels preferred by Euroamericans (Hamilton 1980:7-8). Beyond that potential, many of the barrel fragments found in Indian communities had been reworked into

TABLE 3

COMPARISON OF GUN PART ASSEMBLAGES
FROM INDIAN AND EUROAMERICAN
DOMESTIC SITES AND CACHES

Communities	Lock	Stock	Barrel	Total
All Indian assemblages	400	193	298	891
(n=28)	(44.9%)	(21.7%)	(33.4%)	(100.0%)
Euroamerican	81	98	30	209
(n=7)	(38.8%)	(46.9%)	(14.3%)	(100.0%)

scrapers or other tools. Thus, the high frequency of barrel remnants in Indian sites also probably indicates that they had relatively high scrap value to Indians who used them in ways that allowed them to become part of the domestic residues. In contrast to Euroamerican assemblages, the relatively low proportion of stock parts apparent in Indian domestic assemblages may further reflect regular recycling of the parts of failed guns. Small stock fixtures of brass or other metals turned into ornaments and small tools would have been highly portable. Unlike bulky barrel fragments, such small pieces may have been kept out of the archaeological record, and the study sample, because they could easily be lost or discarded in areas away from residential communities.

The mix of gun parts from Indian communities would also suggest that guns were only irregularly repaired in them. Aside from the preponderance of barrels, Indian community assemblages present a rather even mix of parts from all of the flintlock subsystems. This kind of mix would be consistent with a pattern of rare or irregular gun repair since, if specific faults were not repaired, any failure would result in total discard of the entire arm. In this situation all kinds of parts would appear in the archaeological record. Regular repair, on the other hand, would cause a relatively high archaeological frequency of the specific parts most prone to failure and of those parts least worth preserving for reuse.

Euroamerican sites have yielded the kinds of assemblages consistent with regular firearm repair. Systematic lock repair by individuals expert enough to undertake specific technical repairs of failed systems would result in assemblages like those from Euroamerican sites. The rarity of barrels in those site may further reflect lock repair since a well-maintained, high quality barrel could outlast several locks. Furthermore, with access to blacksmiths, Euroamericans may have been able to recycle barrels as scrap iron or in some other assertive ways that made them unrecognizable in the archaeological record. The high frequency of stock fittings in Euroamerican communities presumably indicates that these parts were of little value once the gun they were on had failed beyond repair. They were not subject to curation and appear instead to have been treated like entirely valueless discardables.

Given only the assemblages from domestic sites, then, it would be tempting to conclude that regular maintenance was more common among Euroamerican frontiersmen than Indians. That conclusion would fit the intuitive expectation that Indians may have had trouble accepting unfamiliar mechanical systems like those of the flintlock. With easier access to both technical experts and spare parts, minor repairs must have been easier in Euroamerican communities where a failed lock could be repaired or still usable parts (like barrels) fitted to other guns and, therefore, kept out of the archaeological record. Domestic site data would appear to indicate that goods spread more rapidly than technical knowledge on the frontier and that technical expertise developed slowly in Indian communities.

Those simple conclusions, however, are cast into considerable doubt by the contents of gun part caches made by Indians away from their residential areas. When the contents of the three known caches are combined with the community assemblages, Indian patterns of flintlock use appear both complex and sophisticated. The high frequency of reused barrel fragments, and perhaps even the relative rarity of stock fixtures, can be seen as evidence that guns parts were highly valued and systematically recycled. Even after they became useless as weapons, Indians appear to have treated their guns as valuable technological resources.

Furthermore, when the caches are included, the similarity in the proportion of lock parts on Indian and Euroamerican sides of the frontier certainly suggests that even during the contact period Indians were quite capable of systematically repairing even the most technically complex and delicate parts of their guns. The fact that the caches represent three different tribes may indicate that the patterns of curation and repair they reflect were widespread among Plains groups.

Archaeology does reveal differences between Indian and Euroamerican patterns of flintlock treatment but those differences do not appear to reflect significantly different levels of skill or understanding. Rather, differential access to resources and different social arrangements are more likely explanations for the variation. Parts from failed guns appear to have been relatively more valuable in Indian communities so that they were systematically recycled and reused. The relatively high value of recycled gun parts may actually have inhibited repairs in Indian communities. Furthermore, if the parts caches from burials were goods interred as the special property of the individuals who had assembled and sorted them, the caches would appear to indicate that technical specialists had begun to develop in Indian communities.

Finally, this research offers two methodological lessons that are worth noting. First, by focusing on the operating processes of technology, fault tree analysis provides an interesting framework for gathering and interpreting archaeological data. Second, the project offers a substantive illustration of the potential importance that archaeological information from burials can have for the full understanding of the human past.

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References

Ahler, S. and D. Toom, eds. 1989. *Archeology of the Medicine Crow Site Complex Buffalo County, South Dakota*. Springfield, IL: Illinois State Museum Society submitted to the Branch of Interagency Archeological Services, Denver, CO: US National Park Service, Rocky Mountain Regional Office.

Ahler, S. and A. A. Swenson 1985. *Test Excavations at Big Hidatsa Village (32ME12) Knife River Indian villages National Historic Site*. Grand Forks, ND: Department of Anthropology, University of North Dakota. Submitted to the Midwest Archeological Center, Lincoln, NE: US National Park Service.

Babits, L. E. 1976. The evolution and adoption of firearm ignition systems in eastern North America: An ethnohistorical approach. *The*

Chesopiean: A Journal of North American Archeology 14:June-August.

Billington, R. A. 1967. The American frontier. In *Beyond the Frontier: Social Process and Cultural Change*, ed. P. Bohannon and F. Plog, 3-24. Garden City, NJ: Natural History Press.

Binford, L. 1961. A new method of calculating dates from kaolin pipe stems. *Southeastern Archaeological Conference Newsletter* 9 No. 1.

Bleed, P. 1991. Operations research and archaeology. *American Antiquity* 56:19-35.

Brown, I. W. 1979. Functional group changes and acculturation: A case study of the French and the Indian in the lower Mississippi Valley. *Mid-Continental Journal of Archaeology* 4:147-65.

Caldwell, W. W. 1982. Relics from Fort Pierre II, Oahe Reservoir, South Dakota. In *Indian Trade Guns*, ed. T. M. Hamilton, 115-26 (reprint of Missouri Archaeologist Vol. 20, 1960) Union City, TN: Pioneer Press.

Gillispie, C. G. ed. 1959. *A Diderot Pictorial Encyclopedia of Trades and Industry*. Dover, NY: Dover Publications.

Green, S. W. and S. M. Perlman. 1985. *The Archaeology of Frontiers and Boundaries*. New York, NY: Academic Press.

Hamilton, T. M. 1980. *Colonial Frontier Guns*. Chadron, NE: The Fur Press.

Hamilton, T. M. 1982a. Relics from 18th century Osage sites. In *Indian Trade Guns,* ed. T. M. Hamilton, 71-105. (reprint of *Missouri Archaeologist* 20:1960) Union City, TN: Pioneer Press.

Hamilton, T. M. 1982b. The gunsmith's cache from Malla Bend, Missouri. In *Indian Trade Guns*, ed. T. M. Hamilton, 29-52. (reprint of *Missouri Archaeologist* 20:1960) Union City, TN: Pioneer Press.

Henley, E. T. and H. Kumamoto. 1981. *Reliability Engineering and Risk Assessment*. Englewood Cliffs, NJ: Prentice Hall.

Hunt, W. 1986. Fort Union Trading Post National Historic Site (32WI17) material culture report, part IV: Firearms, trapping and fishing equipment. Report on file Lincoln, NE: US National Park Service, Midwest Archaeological Center.

Krause, R. 1972. *The Leavenworth Site: Archaeology of An Historic Arikara Community*. Lawrence, KS: Publications in Anthropology, University of Kansas.

Lehmer, D. J. and D. Jones. 1968. *Arikara Archeology: The Bad River Phase*. Lincoln, NE: Smithsonian Institutions River Basin Surveys, Publications in Salvage Archeology, No. 7.

Lehmer, D., W. R. Wood, and C. L. Dill. 1978. The Knife River Phase. Denver, CO: The Interagency Archeological Service, fulfillment of Contract C3537(68).

Lewis, K. 1984. *The American Frontier*. New York, NY: Academic Press.

McNitt, R. P. 1986. Fault tree techniques. In *Failure Analysis in Microscopy, Fractography and Failure Analysis*, ed. M. R. Louthan and T. A. Place, VII, 1-10. Blacksbung, VA: International Metallographic Society, American Society for Metal, Failure Analysis and Prevention Laboratory of Virginia Polytechnic Institute.

Olsen, S. J. 1963. Dating Earl plain buttons by their form. *American Antiquity* 28:551-54.

Pyszczyk, H. 1989. Consumption and ethnicity: An example from the fur trade in western Canada. *Journal of Anthropological Archaeology* 8:213-49.

Quimby, G. 1966. *Indian Culture and European Trade Goods, the Archaeology of the Historic Period in the Western Great Lakes Region*. Madison, WI: University of Wisconsin Press.

Ramenovsky, A. F. 1988. *Vectors of Death: The Archaeology of European Contact*. Albuquerque, NM: University of New Mexico Press.

Ray, A. 1978. History and archaeology of the northern fur trade. *American Antiquity* 34:26-34.

Roberts, R. L. 1978. The archaeology of the Kansas monument site: A study in historical archaeology of the Great Plains. M. A. Thesis, University of Kansas.

Secoy, F. R. 1953. *Changing Military Patterns on the Great Plains*. Locust Valley, NY: Augustin.

Smith, C. S. 1972a. Firearms, gunflints, ammunition and military gear from Like-a-Fishhole Village. In *Like-a-Fishhook Village and Fort Berthold, Garrison Reservoir, North Dakota*, ed. G. H. Smith, 80-88. Washington, DC: US National Park Service, Anthropological Paper No. 2.

Smith, C. S. 1972b. Firearms, ammunition and military gear from Fort Berthold I. In *Like-a-Fishhook Village and Fort Berthold, Garrison Reservoir, North Dakota*, ed. G. H. Smith, 108-10. Washington, DC: US National Park Service, Anthropological Paper No. 2.

Smith, C. S. 1972c. Firearms, gunflints, and ammunition from Fort Berthold II. In *Like-a-Fishhook Village and Fort Berthold, Garrison Reservoir, North Dakota*, ed. G. H. Smith, 163-65. Washington, DC: US National Park Service, Anthropological Paper No. 2.

Smith, C. S. 1986. Euro-American weapons. In *Papers In Northern Plains Prehistory and Ethnohistory: Ice Glider-32OL110*. Sioux Falls, SD: Special Publication of the South Dakota Archaeological, No. 10.

South, S. 1978. Pattern recognition in historic archaeology. *American Antiquity* 43:223-30.

White, J. R. 1975. Historic contact sites as laboratories for the study of culture change. In *The Conference on Historic Site Archaeology Papers*, ed. S. South. Vol. 9, 153-63. Columbia, SC: Institute of Archeology and Anthropology, University of South Carolina.

Wood, W. R. 1971. *Biesterfeldt: A Post Contact Coalescent Site on the Northeastern Plains Contribution to Anthropology* No. 15. Washington, DC: Smithsonian Institution Press.

Woolworth, A. and W. R. Wood. 1960. The archaeology of Kipp's Post (32MN1), River Basin Survey Paper #2, 239-305. *Bureau of American Ethnology,* No. 176. Washington, DC: Smithsonian Institution.