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Cover: Wahmuza point replicas fractured during breakage pattern study. Specimen in the upper-right corner is approximately 7.2 cm in length. Photo courtesy James C. Woods.

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ARTICLES AND REPORTS

PROJECTILE POINT FRACTURE PATTERNS AND INFERENCES ABOUT TOOL FUNCTION[1]

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INTRODUCTION

Over the past three decades, archaeologists working in the Great Basin have developed and continued to improve ways to classify projectile points according to their shape. It is now generally agreed that projectile point shape evolved through time, and several regional models of this change have been proposed. Within the Great Basin area, most researchers use models reflecting a change from larger to smaller sized projectiles, lanceolate to triangular tool outlines, and stemmed — to indented base — to notched haft elements. When the defined stylistic categories of projectile points are combined with other kinds of archaeological information, it is theoretically possible to begin using the various projectile point forms as chronological markers.

Northern Great Basin models describing morphological variation in projectile point form contain several inconsistencies which remain to be resolved. One such inconsistency concerns the apparent temporal longevity of certain parallel-flaked lanceolate forms, and the resulting overlap with smaller notched varieties employed for much shorter durations. This overlapping has been noted at many locales (see Thomas 1981:37). It has been suggested that certain lanceolate forms cross-cut "temporally sensitive" points because they may have not been projectiles, but instead may have been designed and used as knives (Bettinger 1975, 1978; Davis 1964).

Recent research has raised questions about the entire typological scheme as it is now applied to sites in the Great Basin area (Flenniken 1985; Flenniken and Raymond 1986). While most archaeologists rely on a shape-oriented system to classify comparable finds and use morphological types to date associated materials and features from Great Basin sites (Thomas 1981), there is increasing debate that the various stylistic categories of projectile forms may reflect various stages of rejuvenation as opposed to temporal types (Flenniken 1985; Flenniken and Raymond 1986). While the debate undoubtedly will continue between the morphological typologists and those who suggest "types" result primarily from rejuvenation, it is a necessary prerequisite to determine what factors may have influenced the adoption of different projectile forms. Results of a study designed to differentiate manufacturing from use breakage (Woods 1987) are used here to illustrate one possible explanation for diversity in projectile point style. In addition, this analysis offers a possible explanation for the temporal coexistence of two projectile forms with radically different designs.

TOWARDS UNDERSTANDING STYLISTIC VARIATION

Projectile point stylistic change potentially can be attributed to ethnic, technological, or functional influences. An ethnic influence could be inferred if specific projectile point shapes represent distinct linguistic groups. !Kung Bushmen, for example, reportedly use a combination of projectile shape and arrow decoration to identify the owner of the arrow and/or the owner's dialect group (Wiessner 1983). Therefore, a change or shift in occupation pattern might be represented by a change in tool form. To support this ethnographic example, analyses of projectile points recovered from archaeological sites have suggested that some prehistoric ethnic groups may have manufactured and used specific shapes of projectile points (Fawcett 1980; Greaves 1982; Reed 1985).

A technological influence on projectile point stylistic change may result in the alteration of manufacturing technology. Examples include the discovery of new material sources, the development of techniques which increase the viability of existing sources (Bonnichsen 1977:185-188), and the introduction of different manufacturing techniques altogether.

A functional influence on projectile point stylistic change can result from a change in use. For example, it is now generally agreed that larger point styles were used on the ends of spear or dart shafts where smaller points were used on the tips of arrows (Fenenga 1953; Frison 1978:224; Thomas 1978). It also has been suggested that larger lanceolate points were manufactured in response to the size of the prey (Wormington 1944:9), and the extinction of the larger species resulted in the

[1] *This is a revision of a paper presented at the XIVth Annual Conference of the Idaho Archaeological Society, Boise, Idaho, October 10, 1987.*

subsequent development of smaller projectile forms. It is probable that point styles change as a result of some combination of ethnic, technological, and functional influences.

In an attempt to understand why point styles changed, we can start by drawing parallels with evolutionary change in contemporary technological systems. In many modern technological systems, change can be seen as a product of ethnic, technological, or functional influences or various combinations of these factors. In automobile transportation systems, for example, shape change has been influenced by the sharing of ideas from other peoples such as the adoption by American automakers of European and Japanese auto body styles, by the introduction of new construction materials like aluminum and high impact plastics, more efficient propelling technologies such as high compression engines, new system demands including increased speed, increased fuel economy, greater travel distance, and an increased awareness of user comfort and safety. These and similar influences have inspired change in other complex technological systems such as air travel, communication, and information networks. They also can affect change in simple technological systems like clothing manufacturing, plant food processing, pottery manufacturing, or hunting.

With ancient hunting systems, similar ethnic, technological, or functional influences may have inspired changes in projectile point form. As has already been suggested, there is some evidence that projectile point shape was partially dependent on the ethnic or linguistic membership of the maker. If we were to accept this as the sole explanation of projectile form diversity, we might conclude that each change in style represented a major population shift.

One avenue of inquiry which has received little attention concerns the impact of function on projectile point typology. Initial studies attempted to devise a means of differentiating spear and dart points from arrow points (Fenenga 1953; Thomas 1978), yet there has been little work towards understanding the role that intended function played on the design of projectile points. If we can show that function played a major role in determining projectile form, we then can accept the possibility of a stabile, indigenous population responding to environmental change as opposed to population displacement.

A recent paper by Peter Bleed (1986) offers a potential approach to understanding the relationship between projectile point function and form. Bleed proposes that any hunting system must follow several basic design rules in order to be efficient. One specific design rule which can be used to analyze any technological hunting system concerns the system's availability.

Modern design engineers have two different approaches to insure a system's availability—by designing the system to be reliable or by designing the system to be maintainable (see Table I). These two approaches have very different attributes that affect the physical appearance of the system. Like more complex systems, weapons for hunting must be readily accessible and functional when needed. Therefore, designers of prehistoric hunting systems had to make many of the same choices as modern design engineers.

TABLE I
CHARACTERISTICS OF RELIABLE AND MAINTAINABLE SYSTEMS

Reliable Systems:

1. Overdesigned components (parts made stronger than they minimally need to be).
2. Understressed (system used at less than full capacity).
3. Parallel subsystems and components (redundant and standby).
4. Carefully fitted parts and generally good craftsmanship.
5. Generalized repair kit including basic raw materials (to affect any repair).
6. Maintained and used at different times.
7. Maintained and made by a specialist.

Maintainable Systems:

1. Generally light and portable.
2. Subsystems arranged in series (each part has one unique function).
3. Specialized repair kit that includes ready-to-use extra components.
4. Modular design.
5. Design for partial function.
6. Repair and maintenance occur during use.
7. User maintained.
8. Overall easily repaired — "serviceable".

(from Bleed 1986:739)

A reliable hunting system would be designed to be durable and able to withstand stresses well beyond that encountered during normal use. It would have extra parts that could be added if the primary system was damaged. Reliable systems would be well made, usually by a specialist, prepared in advance, and if damaged, repaired at a later time.

In contrast, a maintainable system would be light in weight and constructed so that it could be easily repaired. It would be equipped with spare parts for onsite repair and constructed in sections so if a portion was lost or damaged, partial function still would be possible (Bleed 1986:740).

Both maintainable and reliable hunting systems appear to have appropriate applications for hunting peoples. Bleed (1986) proposes that design variation in ancient hunting systems was the result of producing either reliable or maintainable weapons. I believe that prehistoric hunters could have simultaneously employed two different hunting systems in an effort to use *both* reliable and maintainable systems to maximize the use of diverse resources. I also propose that the evolutionary change in projectile point form was greatly influenced by functional variables.

As evidence of how intended function can influence tool shape, I will refer to an earlier study designed to examine how and where pressure-flaked stone tools break under use-stress (Woods 1987). In this study, it was noted that some tool forms were more resistant to breakage than others. Three varieties of tools were replicated, then experimentally broken by target impact. First, a series of Elko corner-notched points were manufactured, hafted onto darts and propelled by an atlatl, breaking on impact (see Titmus and Woods 1986). Next, a series of lanceolate forms believed to represent knives were manufactured, then broken. One set of these lanceolate forms were hafted onto various knife handles and subjected to the type of stresses encountered during assorted cutting and scraping activities (Figure 1a-l, 2a-b). For comparative purposes, a second set of lanceolate forms were hafted onto dart shafts, then propelled at the same variety of targets as the Elko corner-notched points (Figure 2c-g). Finally,

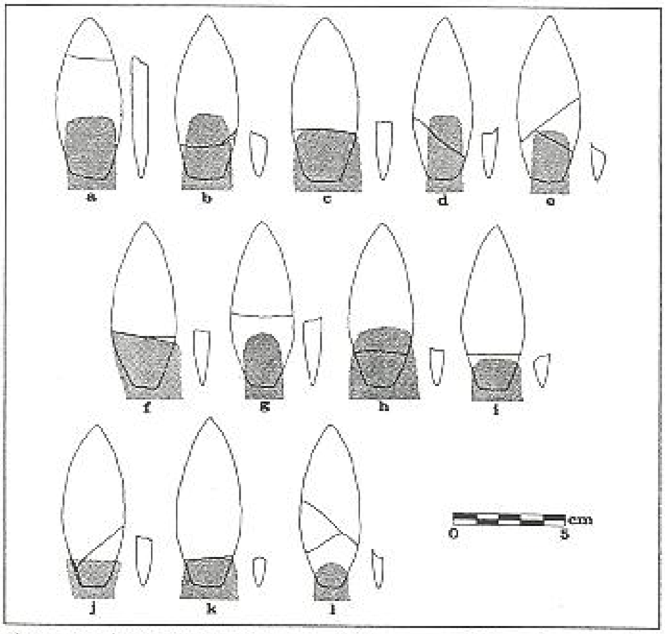

Figure 1. a-l: Fracture patterns on Wahmuza point replicas used as knives. Shaded areas represent shape of handle at haft juncture.

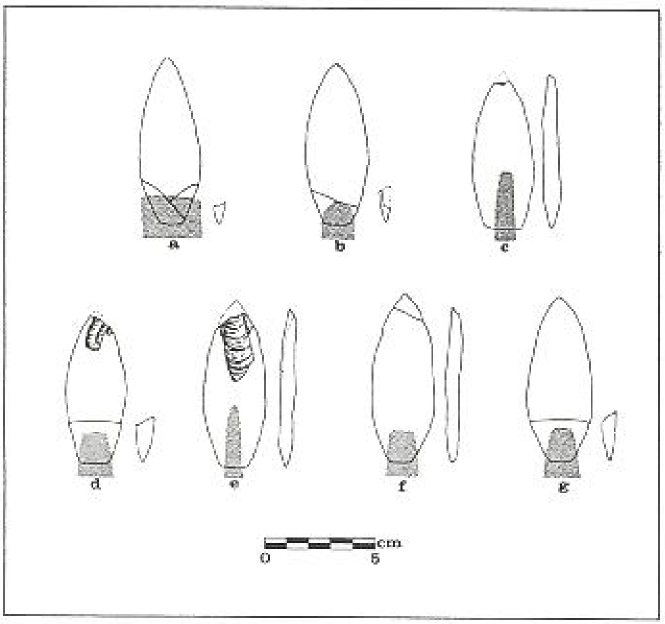

Figure 2. a-b: Fracture patterns on Wahmuza point replicas used as knives; c-g: Wahmuza point replicas used as dart points.

a collection of small basal-notched projectile point replicas were propelled with use of a bow into various targets. Close examination of the breaks on the three varieties of replicas indicated that it was possible to differentiate fractures caused by impact loading, resulting from use as projectiles, from fractures caused by static loading, resulting from cutting, sawing, or scraping activities. As a result, it was suggested that the lanceolate forms previously referred to as Wahmuza knives (Ringe 1985) were in all probability projectiles hafted to darts or spears (Figure 3).

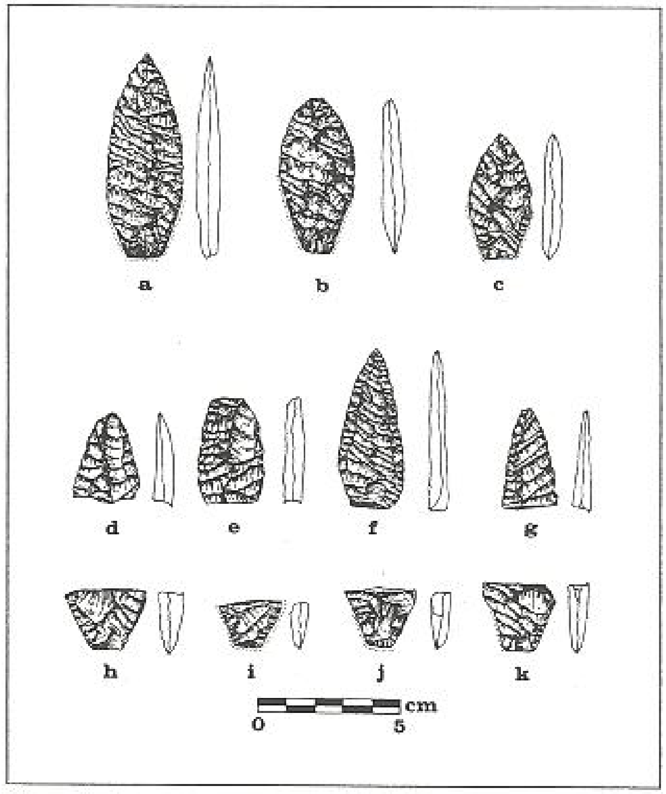

Figure 3. a-k: Wahmuza points from the type site.

This determination created an interpretive problem as the Wahmuza lanceolate tools are commonly found together with Elko series projectile points at the Wahmuza site (Holmer 1985).

WHY TWO TOOL FORMS?

The simultaneous use of two very different projectile forms is a problem that previously has been noted elsewhere. Humboldt and other varieties of lanceolate projectiles often are recovered in context with corner-notched points, and as a result some researchers question the validity of this form as a temporal type (Holmer 1985; Thomas 1981:36). This apparent coexistence of lanceolate and corner-notched projectiles can be variously interpreted. Those who believe that variations in projectile form reflect different ethnic groups might suggest that trade, influence, or shared-residence could explain this phenomenon. However, I suggest that a functional interpretation is justified on the basis of experimental breakage studies and ethnohistoric documentation.

It has been demonstrated that some forms of projectiles were much more resistant to damage from impact than were others, even if used with the same propelling technology. In the breakage pattern study previously mentioned (Woods 1987), 34 corner-notched dart points were propelled at various targets with the intention of forcing breakage. Sixty-seven throws were required to break this collection for an average of 1.97 throws per dart. Using the same propelling technology, the atlatl and dart, six lanceolate forms were propelled at similar targets and a much lower incidence of breakage was recorded. Fifty-one throws were required to break six replicas for an average of 8.5 throws per dart. It is thus suggested that lanceolate forms are much more durable than corner-notched projectiles. Further comparison of the two forms reveals that more time was spent, and greater skill required, in manufacturing the larger lanceolate projectiles. Not only did the lanceolate forms require larger blanks, but the creation of parallel-oblique flaking patterns and abraded basal margins involved additional manufacturing stages, more equipment, and greater flintknapping skill than was required for Elko point replicas. In addition, hafting the lanceolate points to shafts or foreshafts required more time and care than was required to haft the smaller notched projectiles. This is partially due to the larger diameter shafts and deeper notches necessary for the larger projectiles and the greater quantity of sinew and adhesive required to secure the unnotched lanceolate forms. When considering overall size, morphological consistency, careful abrading of the basal margins, and the very low incidence of use-breakage, one might conclude that the Wahmuza and similar lanceolate projectiles represent part of a very reliable hunting system as defined by Bleed (1986). In contrast, the lightweight, random pressure flaking patterns, diversity in morphology, and high incidence of use-breakage suggest notched projectiles are part of a maintainable hunting system.

The suggestion that both Wahmuza lanceolate forms and Elko forms might have been used simultaneously does not create a burdensome interpretive problem. Numerous ethnographic references are available which demonstrate simultaneous reliance on two different projectile forms by hunting-gathering peoples. !Kung Bushmen of the Kalahari Desert use long shafted lances called *assagai* to finish-off animals wounded by small poison-tipped arrows (Marshall 1976:145). Among the Plains Shoshone, lanceolate forms were used on the ends of long-handled lances to dispatch bison after the animals had been wounded by arrows (Ewers 1955:156). Ishi also reportedly used a short obsidian-bladed spear to dispatch animals after they were wounded by arrows (Kroeber 1970:195). Additional examples could be cited, but it suffices to say that the simultaneous use of two different projectile forms among hunter-gatherers appears to have been common.

CONCLUSIONS

Experimental and ethnographic data offer a potential functional explanation of why lanceolate forms and Elko corner-notched projectiles are commonly found in association at Wahmuza and other sites in the Great Basin area. More importantly, since lanceolate forms fit the definition of reliable weapons and the notched varieties can be defined as part of a maintainable system, it is suggested that both maintainable and reliable systems can be, and were, used concurrently. Therefore, Bleed's (1986) recent hypothesis concerning the choice between two different design alternatives can be modified to reflect a simultaneous use of both alternatives in a complete, optimally designed hunting system.

From contextual data at the Wahmuza site (Holmer 1985), it appears that two different chipped-stone tool forms may have been simultaneously employed. Breakage pattern analysis indicates that both forms were used as projectiles. Although numerous factors could lead to the contextual relationship of the two distinct projectile forms, design characteristics of the two forms may justify a functional explanation. As a consequence, caution should be exercised before relying strictly on ethnicity or technology as an explanation for diversity in projectile point form.

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