How Chaco Got the Point: Exploring the Technological Transition from Atlatl to Bow

During Basketmaker III at Chaco Canyon, New Mexico

A thesis submitted in partial fulfillment of the requirements

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By

Brittany M. Bankston

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The thesis of Brittany M. Bankston is approved:

__________________________________________  ____________________
Dr. Matthew Des Lauriers                      Date

__________________________________________  ____________________
Dr. Adam Watson                                Date

__________________________________________  ____________________
Dr. James Snead, Chair                         Date

California State University, Northridge
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Abstract

How Chaco Got the Point: Exploring the Technological Transition from Atlatl to Bow during Basketmaker III at Chaco Canyon, New Mexico

By
Brittany M. Bankston

Master of Arts in Anthropology, Public Archaeology

Studies of technological changes within cultures is a major focus of archaeological scholarship. In particular, the introduction and diffusion of the bow and arrow have attracted considerable attention. Investigations of how bow technology was introduced into Chaco Canyon, New Mexico during the Basketmaker III time period, however, have previously been overlooked. A study into the transition from atlatl to bow technology at Chaco Canyon, can provide insight into the flow of information between groups, responses to new technology, as well as the historical processes that led to the development of a distinctive Chacoan culture beginning in Pueblo I.

For this study, the projectile points from Basketmaker III sites at Chaco Canyon were examined by using the dart-arrow index to identify evidence of the two technologies. A study in variability on the arrow points, through statistics and the identification of point forms, were used to discern how bow technology was introduced into Chaco Canyon through the theoretical perspective of cultural transmission. Comparative projectile point studies from the Four Corners region, including southern Colorado, the Chuska Valley, and Jemez Mountains, were examined to understand the arrow point morphologies observed at Chaco Canyon after the adoption of bow technology within the context of broader, regional, trends.
The conclusions established by this research lay the foundations for future studies regarding projectile point technology and the diffusion of information across the Four Corners area of the Southwest. Questions pertaining to the socio-political effects of new technology can be used to further understand the later developments of Chaco Canyon into the regional center for Ancestral Puebloans.
Chapter 1: Introduction

Isolated from modern civilization, with the nearest town roughly 50 miles away, Chaco Culture National Historical Park is reached only by dirt roads that can easily become impassable during the summer and winter months due to rain and snow. With the relative inconveniences of travel imposed on perspective visitors, Chaco remains one of the few parks in North America to retain a sense of detachment from the technologies of the current world. There is no cell phone service in the canyon, but spotty reception can be found on top of the mesas that are accessible only by hiking. Walking through this world, once populated by the Ancestral Puebloans, one can easily get lost in awe amongst the ruins of the great houses that dot the landscape.

Chaco Canyon, as the center of a regional interaction sphere between AD 1020 and 1150 (Kantner and Kintigh 2006:155), has been the setting for considerable research on regional interaction and population movement. These discussions have been predominantly framed within aspects of trade or population migrations into and out of the American Southwest. However, such exchanges concern not only tangible materials (i.e. pottery, wood, shell, turquoise) but intangible concepts (knowledge and information) that may be reflected within the tangible. Thus, there is an important opportunity in this case to examine the introduction of new information, particularly regarding technological change.

Questions regarding how and why technologies within cultures change over time has long been an interest for North American archaeologists, specifically regarding the introduction of the bow and arrow. The diffusion and adoption of this new technology was based on the transmission and spread of information. The diffusion of new
technological knowledge has implications in how archaeologists interpret the lifeways of people in the past regarding how information is transmitted through social interaction spheres and movement of people.

The history of archaeological research at Chaco Canyon makes it opportune for a study of technological change. More than a century of research has provided crucial information regarding the occupation of the Ancestral Puebloans. However, this work has predominantly pertained to the socio-economic, ideological, and environmental aspects of the time periods of the great houses, the initial expansion of Chacoan influence, and the beginning its influential decline (Mills 2002:66). However, information about earlier occupations in the canyon is available. One such time period is the Basketmaker III era, from AD 500 to 700 (Lekson 2006:7). Ancestral Puebloan society underwent dramatic changes in this era but has received considerably less study compared to other time periods. In general, the Basketmaker III period is characterized by increasing sedentism within the canyon, greater adoption of ceramic technology, increasing reliance upon plant domesticates, increasing architecture complexity, and the adoption of bow and arrow technology. This time period is “perceived as a pivotal transition in the region’s culture history” (Wills et al. 2012:329).

The goals of this thesis are to explore technological change during Basketmaker III at Chaco Canyon via projectile points as evidence for the shift from the atlatl to the bow with the aim of better understanding the adoption and transition by Basketmaker groups. Identifying the persistence of atlatl use co-occurring with the bow has a wide variety of implications such as how the technology was introduced and subsistence choices. The morphology of dart and arrow points can indicate how bow technology was
obtained (Bettinger and Eerkins 1999), and the use of both technologies can elucidate subsistence (Tomka 2012) or defense and deterrence strategies (Bingham et al 2013, Reed and Geib 2013).

This study tested the following hypotheses: 1) Bow technology did not immediately replace the atlatl, thus use of the two technologies will be observable. 2) Dart and arrow points can be determined with some relative degree of success by using the dart-arrow index. 3) Evidence of a technological transition from the atlatl to the bow will be reflected in the projectile points with the presence of larger arrow points and smaller dart points. 4) Morphological variability reflects a broader trend in how bow technology is introduced. 5) Trends in point morphology and variability can be explained through a larger regional perspective.

Theory

The theory of cultural transmission was used in this study to formulate hypotheses that will frame my perspective on how bow technology diffused across the Western United States and how it was introduced and adopted at Chaco Canyon. This theory explains how information was transmitted between people and how it can be observed within the archaeological record.

Background

This study examines questions pertaining to a specific location during a specific time. As a result, the setting will be established with information regarding the Basketmaker III time period across the Southwest and at Chaco Canyon. Additionally, previous research regarding projectile point technology and the introduction of the bow and arrow in the Southwest will be examined.
Methods

Multiple methods of data collection were employed to answer my hypotheses about the introduction of bow technology at Chaco Canyon. Projectile points from four sites at Chaco Canyon dating to Basketmaker III were analyzed with data collection pertaining to measurements, material, and point form. The dart-arrow index was used to distinguish between dart and arrow points, and Simpson’s Diversity Index was adapted to quantify variability within the projectile point assemblage.

Analysis and Results

Basic statistics were used on the projectile point measurements to derive morphological and variable information that included minimum and maximum extents, average, standard deviation, and variation of point attributes. The distribution of projectile point material was analyzed, and the points were identified based on type, or form.

Discussion

I will discuss of the results of my hypotheses within a wider regional context to include data from prominent regions surrounding Chaco Canyon. The data from Southern Colorado, the Chuska Valley, and Jemez Mountains all derived from different cultural resource management reports generated as part of larger data recovery initiatives that included Basketmaker III sites.

The data provided in these reports were compared with Chaco Canyon to determine morphological similarities of projectile points and material types to determine patterns of information exchange. This provided insight into greater technology trends.
throughout the region in addition to events occurring at Chaco Canyon with population aggregations and increasing sedentism (Wills and Windes 1989).

Conclusion

The final thoughts on this study will include a brief reiteration of the theoretical perspective and methods that were used to obtain the results. I will discuss the implications of the results and how this new insight into Basketmaker III contributes to the story of the development and establishment of Chacoan culture in later centuries.
Figure 1.1: Map of the Four Corners Region.
Chapter 2: Theory

The ways in which archaeologists examine variability within and between cultures has ranged from markers of chronological sequences (Bettinger et al. 1991, Koerper et al. 1996), to aspects of function (Beck 1995), and traits of different group identities (Judd 1954). Variation describes how different objects are, such as ceramics, projectile points, and other artifacts, and how objects can be used to examine changes in culture over time.

Cultural Transmission as Explaining Variability

Cultural transmission theory has been used by archaeologists to explain and account for variability within material assemblages and is “the idea that similarity in behavior and artifacts may be caused by the exchange of information using a non-genetic mechanism” (Eerkins and Lipo 2007:240). Cultural transmission is based on how culture and information is passed on through social learning lineages as opposed to biological reproductive lineages; i.e. inherited traits (Bettinger and Eerkins 1999, Boyd and Richerson 1985, Eerkins and Lipo 2007, Lyman and O’Brien 2003). Inherited traits that can be observed within the archaeological record derive from material culture (Schiffer 2008). The material aspect of variability and culture have been observed and studied by previous anthropologists such as Boas, Kroeber, and Sapir, however, they were more interested in what changed and why as opposed to how (Eerkins and Lipo 2007, Lyman 2008).

Through cultural transmission, hypotheses regarding how information was transferred between individuals and groups can be tested within the archaeological record and can indicate how people and groups interacted and exchanged information (Eerkins
Cultural transmission seeks to “explain variation, similarity, and relatedness” (Eerkins and Lipo 2007: 240).

The theoretical perspective of cultural transmission follows a series of hypotheses. 1) Cultural transmission, following biological evolutionary processes, will create artifact lineages or traditions (Lyman et al. 2008, 2009). 2) Artifact classes that persist through time will show a degree of heritability (Lyman et al. 2009). 3) Variation can be explained through copying errors or intentional modification (Eerkins and Lipo 2005). 4) Variation will decrease over-time through selective processes (VanPool 2003). However, cultural transmission does not always suggest that new behavior enhances fitness but acknowledges that variation can be neutral (Lyman and O’Brien 2003, Smith 2013:111).

When discussing the transfer of information between groups and individuals the social relationships of those who are teaching and those who are learning is an important aspect as it shows the direction of information movement (Mills 2008). The two main directions of transmission are vertical and horizontal. Vertical transmission occurs with the passing of information from parent, guardian, or teacher to child, while, horizontal transmission occurs when information is transmitted between individuals within the same generation (Cavalli-Sforza et al. 1982:20, Mills 2008:247).

Cultural transmission explains variability through two main models: guided variation and biased transmission. Guided variation is the process of learning, modifying what was learned based on different factors such as the environment or a learned misunderstanding, and subsequently teaching the modified version (Boyd and Richerson 1985, Bettinger and Eerkins 1999, Eerkins and Lipo 2005). Biased transmission has three
types: direct bias, indirect bias, and frequency-dependent bias. Direct bias is when an individual tries different ways of learning a behavior and chooses the method that seems to work best. Indirect bias is when an individual learns a new behavior by modeling after the most successful individual in that behavior. Frequency-dependent bias is when a specific method of behavior is chosen by an individual because that is the same method as most other individuals practicing that behavior (Boyd and Richerson 1985). Each type results in a different outcome based on the decision of the individual learning but is compounded with exposure to multiple variants (Bettinger and Eerkins 1999, Boyd and Richerson 1985).

Cultural Transmission and the Introduction of the Bow and Arrow

The diffusion of bow and arrow technology across North America represents the adoption of new technology through information transfer and the process of learning. Despite the flaws inherent in the use of projectile point types as short-term temporal markers (Flenniken and Wilke 1989), well defined and established typologies can be reliable indicators of major technological shifts, such as the transition from the atlatl to the bow and arrow (Koerper et al. 1996).

Variation, in projectile points after the introduction of the bow and arrow into an area are seen as evolutionary processes by which technology changed and adapted to different groups and environments (Bettinger and Eerkins 1999, Hildebrandt and King 2002, Hughes 1998). According to Hughes, “evolution is a two-step process: (1) the creation of variation and (2) the differential persistence of that variation” (1998: 347). Variation within projectile point assemblages can be observed metrically (length, width, thickness) and/or morphologically (corner-notched, stemmed, side-notched) (Lyman et al. 2008:2807) and can be either stylistic or functional (Shott 2008, VanPool 2003).
Projectile point variation occurs through either function, such as hafting method, or styles and forms that “develop within given regions of a culture area and persisted for varying periods of time” (Moore 1981:14).

Predictions can be proposed when examining the adoption and responses of new technology within the archaeological record. Before the introduction of the bow, dart points will exhibit limited variability due to selective processes for effective points (Lyman et al. 2008). For the introduction of the bow and arrow it can be expected that high levels of arrow point variability equate to the development of bow technology through trial-and-error, with decreasing variability over time as variations are “winnowed out” (Bettinger and Eerkins 1999, Eerkins and Lipo 2005, Lyman et al. 2008:2807). However, “the diffusion of a more or less perfected technology into a new area will likely be accompanied by minimal variation” (Lyman et al. 2008:2806). For bow adoption through trial-and-error first attempts at arrow point manufacture may be modeled after and closely resemble dart points. Thus creating arrow points that are morphologically and metrically similar to established dart forms (Koerper et al. 1996, Kennett et al. 2013, Lyman et al. 2008).

Specific characteristics of artifacts can affect variability. According to VanPool (2003) performance characteristics can be identified as either functional or stylistic, and can play important roles in variability and future selection. Behavioral characteristics “refer to the behavioral capacity of an artifact” (VanPool 2003:86). VanPool identifies three types of performance characteristics in artifacts. 1) Performance characteristics that allow or increase human reproductive success rate are functional aspects of technology. 2) Performance characteristics that do not allow or increase reproductive success are
3) Characteristics that are not performance based are stylistic (2003:88). Emphasizing metric and qualitative variation of point attributes as opposed to aspects of function and style, patterns of selection can be observed regarding the introduction and adoption of bow and arrow technology (Lyman et al. 2008). However, by emphasizing the role of functional attributes other variables such as social change, pressure, and agency are not often accounted (Pauketat 2010).

Bettinger and Eerkins (1999) used cultural transmission theory to account for observed projectile point variability between sites in California and the Great Basin. They argue that different processes of bow adoption occurred at these sites. The Rosegate points from the Nevada site show a correlation between basal width and weight, suggesting that these attributes were acquired as a “package deal” (1999:237). They propose that transmission of indirect bias was occurring. In contrast, the Rosegate points from California show a lack of correlation between basal width and weight, suggesting that transmission from guided variation took place.

Eerkins and Lipo (2005) conducted a study of projectile points in the Owens Valley, California. Measuring attributes from Rose Spring points they determined that variation of point basal width decreased over time as point thickness increased over time. The refinement of basal width in conjunction with copying errors in point thickness suggest that high levels of experimentation where occurring with new technology. Eerkins and Lipo suggest that since thickness was less of a factor for the proper function of a projectile point “copying errors in thickness could have been tolerated” (2005:327). This means that there was less selective pressure to refine and limit variability in point thickness.
VanPool (2003) analyzed the projectile points from Ventana Cave, Arizona with an evolutionary perspective based on the reproductive success and selective pressures of point attributes. His results showed that stemmed atlatl and arrow points were selectively favored throughout occupation of the cave with “limited selection for triangular and corner notched points in the later occupations” (VanPool 2003: 322). VanPool noted that the use of atlatl technology was still occurring after bow technology was introduced into the area even with the latter’s seeming superiority in efficiency. It was hypothesized that the atlatl’s continued use of at Ventana Cave was due to its superiority for hunting large game due to the higher levels of kinetic energy when compared with the bow (VanPool 2003).

Roth and colleagues (2011) examined the technological transition from the atlatl to the bow in the Mimbres Mogollon region of southwestern New Mexico during the Late Pithouse period. They observed that variation present in the arrow point assemblages, along with decreased variability over time, suggested that guided variation was the mechanism for the introduction of bow technology into the region. They suggest that the reason for the adoption of bow technology was due to “increased technological efficiency of the bow that allowed for groups to obtain meat with less time and effort” (2011:105). The timing of the adoption of bow technology in the area coincides with agricultural intensification throughout the region as groups shifted in primary subsistence from meat to plant crops.

**Conclusion**

Cultural transmission theory and evolutionary studies of projectile points have been used in areas across the Great Basin and Southwest regions to understand how bow
technology was adopted and the local responses that ensued. This thesis will use the main ideas of cultural transmission theory to explain observed levels in arrow point morphology and variation after the introduction of bow technology at Chaco Canyon. I hypothesize that high levels in arrow point morphology will suggest an adoption based on trial and error. In contrast, relatively minimal variation can be suggested that bow technology was copied from an ideal model.
Chapter 3: Background

Cultural transmission will serve as the theoretical approach for this study, framed within the temporal setting of Chaco Canyon during Basketmaker III to understand how the bow and arrow was introduced. A review of previous research into Chaco Canyon, the Basketmaker III time period, and the introduction of the bow and arrow into the Southwest will place this study into its proper context.

Chronology of Chaco Canyon

Human occupation of the San Juan Basin was suggested to have begun around 10,000 years ago with the discovery of Folsom projectile points on Chacra Mesa and other areas surrounding the canyon (Mathien 2005:64). Projectile points belonging to defined temporal classifications were identified at Chaco Canyon and included the Early, Middle, and Late Archaic, and Basketmaker II eras. Archaic sites within Chaco Canyon were predominantly temporary encampments (Mathien 2005). The Basketmaker II era saw the use of ceramic gray and brownwares, with Basketmaker III (AD 500-700) continuing grayware use with new additions such as Lino Gray and La Plata Black with White (Lekson 2006:7). Additionally, Basketmaker III pithouses became more structured than compared to Basketmaker II pithouses (Mathien 2005).

Pueblo I (AD 700-850) saw the transition from subterranean pithouses to above-ground structures, with construction beginning on the first great houses around AD 1000. The canyon experienced a major population increase during Pueblo II, from approximately AD 850 to 1110. This time period encompasses Early and Classic Bonito eras of Chaco Canyon when major great house construction efforts were done (Lekson
Classic Bonito (AD 1040-1110) and Late Bonito eras (AD 1090-1140) saw population fluctuations until the eventual mass de-population and abandonment of the canyon occurring from AD 1140 to 1200 (Judge 1991, Lekson 2006).

![Figure 3.1: Chronology showing Pecos, Chaco Canyon, and Dolores Archaeological Project Phases, adapted from Lekson (2006) and Robinson et al. (1986).](image-url)
The Environment at Chaco Canyon

The environment of the San Juan Basin is characterized as semiarid, with low humidity, and rainfall occurring during the summer monsoon months from local thunderstorms (Murrell 2014: 17, Reed and Ponczynski 2002:10). Temperatures are variable depending upon elevation with the warmest occurring in late June to July and the coldest in January (Murrell 2014: 17).

Within Chaco Canyon, the amount of rainfall and runoff can vary (Vivian et al. 2006:49), resulting in an unpredictable reliance upon agriculture. The period encompassing late Basketmaker III and Pueblo I at Chaco Canyon would have been the most suitable area for agriculture due to increased precipitation and water runoff during the spring and summer months. This has been suggested to have led to population aggregation and increasing sedentism within the canyon (Vivian 1991:59, Vivian et al. 2006: 52). In addition to runoff from surrounding mesa tops, the Chaco Wash provided water supply and the capacity for floodplain farming during the monsoon season (Vivian et al. 2006). The geology that created Chaco Canyon’s east-west orientation allowed for the canyon’s south-side bottom to be exposed to the sun for longer periods of farming throughout the year. In conjunction with longer sun exposure, the construction of water flow control mechanisms through utilization of rincons to channel water run-off from mesa tops to the canyon bottom allowed for agriculture to be practiced. (Judge and Cordell 2006:191).

History of Archaeology at Chaco Canyon

The first historical documentation of the architecture at Chaco Canyon came from Lieutenant James Simpson in 1849, followed by William Jackson in 1877 (Judge 1991,
Lister and Lister 1981). The first archaeological expedition to Chaco Canyon was the Hyde Exploring Expedition in 1896, under the supervision of George Pepper, with Richard Wetherill in tow. The excavations of Pueblo Bonito, despite being “collections-oriented” provided a wealth of information about the Ancestral Puebloans and the Southwest in general (Snead 2001:40)

Twenty years after the last excavations from the Hyde Expedition, the National Geographic Society Expedition sent Neil Judd (1954) to resume excavation of Pueblo Bonito and to begin research on Pueblo del Arroyo. While at Chaco Canyon with Judd, Frank H. H. Roberts (1929) excavated the Basketmaker III site of Shabik’eshchee.

The most comprehensive field undertaking at Chaco Canyon was conducted from the 1970s to the early 1980s by a cooperative effort of the National Park Service and the University of New Mexico known as the Chaco Project (Mathien 2005). To this day, the Chaco Project remains the most extensive field work conducted at Chaco Canyon. In contrast to previous fieldwork, the approach toward surveys, excavations, and research was fundamentally different in that it provided systematic methods for new research techniques involving data recovery, analysis, curation, and “dissemination of results” (Mathien 2005:8).

Chaco Canyon was established as a national monument in 1907 (Judd 1952). It was not until 1980, as a result of the work from the Chaco Project that Chaco Canyon was designated a National Historical Park, with it being designated as an UNESCO World Heritage Site in 1987 (Mathien 2005). Presently, field work is uncommon at Chaco Canyon with most research re-visiting existing collections and data to provide new insight and perspective (Mills 2002:70, Plog 2015:3).
**Basketmaker III**

Classic characteristics of Basketmaker III included large pit house structures with storage pits, two-handed manos and trough metates for plant processing, and distinctive ceramic styles such as gray ware and early unslipped white and red wares (Reed 2000). The abandonment of the atlatl for a wider implementation of the bow and arrow occurred during this time, as well as the adoption of bean cultigens in addition to maize agriculture, and turkey husbandry (Reed and Geib 2013).

Basketmaker III, was originally seen as the last stage in Pre-Ancestral Puebloan development before the arrival of traditional Ancestral Puebloan culture in Pueblo I (AD 700-950) (Lekson 2006, Reed 2000, Windes 2015). During the infancy of archaeology in the Southwest, the people and culture of the Archaic and Basketmaker eras were considered to have been a cultural dead-end, and not the predecessors to the Ancestral Puebloans (Roberts 1929). This was, in part, due to the seemingly distinctive characteristics of the cultural material between the Basketmaker and Pueblo periods, mainly in architectural differences (Roberts 1929, Reed 2000). This distinction was disregarded with additional research (Judd 1954, Reed 2000).

There are considerable differences within Basketmaker groups throughout the Southwest. Geib and Spurr (2000) caution against using indicators such as the use of cultigens and semi-sedentary occupation sites for identifying Basketmaker III sites as those characteristics have been observed in Basketmaker II sites on Black Mesa, Cedar Mesa, and the Rainbow Plateau in Arizona. Additionally, other markers such as bow and arrow technology, pottery, and turkey husbandry were not all adapted as a “‘suite’” at a single point in time, nor were these items equally adopted by all contemporaneous
households” (Geib and Spurr 2000:175). Hence, understanding regional variability and cultural heterogeneity are aspects that needs to be considered in understanding the lifeways of the people who lived during that time (Vivian 2000:252).

The first extensive research into the Basketmaker III period at Chaco Canyon was done by Frank H. H. Roberts from 1926 to 1927 with the excavation of Shabik’eshchee (Roberts 1929, Windes 2015). Wills and Windes revisited the interpretations of Shabik’eshchee with a discussion of site occupation and sedentism. Building upon Robert’s work with additional evidence from storage pits and locally seasonal resources such as pinon nuts, Wills and Windes (1989) concluded that the extensive nature of Shabik’eshchee was due to episodic occupations and not one long and continuous occupation as originally thought.

A study conducted by Wills and colleagues (2012) revisited the work of Wills and Windes (1989) to further address the conclusion that Shabik’eshchee was seasonally occupied. With documentation of over 100 Basketmaker III sites located along the canyon bottom near tributaries, Wills and colleagues suggested that mesa-top sites such as Shabik’eshchee and 29SJ423 are not separate “villages” but merely represent the occupational extents of Basketmaker III communities at Chaco Canyon, with site occupation being fluid among members of the canyon community (Wills et al. 2012).

Numerous additional sites of this time period have been documented at Chaco Canyon. The Hayes Survey identified approximately 70 preceramic sites and observed that most were situated along the southern side of the canyon under mesas (Hayes 1981:24). Due to the various ways in which pre-great house occupations (Archaic, Basketmaker II, and Basketmaker III) could be covered, such as alluvial deposits and
multiple time period occupations, the actual number recorded sites are “unquestionably much lower than their actual occurrence” (Hayes 1981:24). Thus, at least as many as 150 Basketmaker III sites that may be buried under the floodplain of the canyon.

A synthesis of data from the Chaco Project of the 1970s and 1980s showed that a combination of hunting and agriculture was used by the Basketmaker III communities at Chaco Canyon (Mathien 2005). The faunal remains suggest that smaller mammal species were dominant in Basketmaker III contexts, with larger species less frequently hunted during this time. Of these, pronghorn antelope, a species hunted communally, were more common than mule deer or bighorn sheep. This pattern suggests a procurement strategy around garden hunting (Mathien 2005: 114, Watson 2011).

As evident from the results of the Hayes survey (1981) and excavations from Shabik’eshchee and 29SJ423, a substantial population occupied Chaco Canyon during Basketmaker III. The foundations of Chacoan culture can be seen in the lifeways of the people during Basketmaker III through agriculture, ceramics, and architecture that suggests that “communal ritual and the concepts of sacred geography, cyclical renewal, social memory, and possible dualism were present or developing” (Van Dyke 2007:63).

*Previous Research into Lithic Studies at Chaco Canyon and the Four Corners Region*

Understanding the geologic origins of non-local materials found at Chaco Canyon give insight into the patterns of procurement or trade throughout the Ancestral Puebloan occupation. Procurement and trade patterns can assist with understanding the transmission and flow of new ideas and technology. The Four Corners region contains numerous sources for various types of quality raw stone material used to manufacture various tools. Within 10 to 20 km around Chaco Canyon are scattered sources of
silicified wood, chert, chalcedony, and quartzite. These materials are considered local as they can be obtained within a day’s range of activities. In which the procurement of these materials likely occurred during other activities such as hunting and gathering or the collecting of other materials like clay or wood (Cameron 2001:81).

Recent studies by Duff and colleagues (2012) using XRF analysis reveal that the obsidian recovered from Basketmaker III contexts at Chaco Canyon were procured from Mount Taylor, approximately 100 km south, and the Jemez Mountains, roughly 150 km southeast (Duff et al. 2012). Also found within lithic assemblages at Chaco Canyon is Narbona Pass chert, formerly known as Washington Pass chert. This material was sourced to the Chuska Mountains, approximately 75 to 80 km west of Chaco Canyon (Cameron 2001, Toll 1991). From an early period of occupation within Chaco Canyon, raw materials from as distant as 150 km were being transported into the canyon.

Local materials of chert, chalcedony, petrified and siliceous woods were used for tools all throughout the occupation of Chaco Canyon. Obsidian was a common non-local material during Basketmaker III, and other non-local materials such as Narbona Pass chert, Morrison Formation materials such as Brushy Basin chert, and yellow-spotted chert from Zuni are present in the debitage assemblages but in small quantities (Cameron 2001:85). Later, during the height of great house construction, Narbona Pass chert becomes the most common material type, surpassing even local material. It has been hypothesized that the Chuska Mountains was the most likely source for the wooden roof beams needed for great house construction and Narbona Pass chert was entering Chaco Canyon as “partially processed cores or flakes” as result of that connection (Cameron 2001: 85).
The most extensive research into lithics from Chaco Canyon has primarily been completed by Cameron (1985, 1997, 2001) whose analysis of the chipped stone from the Chaco Project (1997) provided a temporal perspective of material, debitage, and tools throughout Ancestral Puebloan occupation of the canyon. Her analysis showed preferential use of local materials for both formal and informal tools during Basketmaker III, in which the primary technology was “informal and expedient” with projectile points being the most common formal tool (Cameron 2001:79).

Lekson (1997) provided a more detailed analysis of the formal tools from the Chaco Project, focusing on projectile points, knives, and drills. His analysis of the projectile points focused on arrow points, in which were shown to have temporal changes in morphology. Stemmed points were the predominant type during Basketmaker III and early Pueblo I, corner-notched during early Pueblo II, and side-notched in late Pueblo II (Lekson 1997). According to Lekson (1997), most of the smaller and medium-sized knives may have been projectile point preforms from Archaic or Basketmaker contexts.

The chipped stone lithics recovered at Shabik’eshchee were described by Roberts (1929) as including “scrapers, knife blades, spearheads, and arrowheads” that contained a high degree of morphological variability (1929: 136). Roberts described the assemblage has having varying degrees in the quality of tool manufacture and craftsmanship, with obsidian and chalcedony as the prevailing material types for the projectile points.

Outside of Chaco Canyon, Torres (2000) analyzed the chipped stone lithic material from Basketmaker II to Pueblo III sites across the Cove-Redrock Valley in northeastern Arizona as part of the Cove-Redrock Valley Archaeology Project. His analysis showed distinctive changes in technological production from Basketmaker II to
Basketmaker III that included decreases in average flake tool mass and length as the shift to bow and arrow technology from atlatl technology was occurring. The debitage showed a similar pattern of changing technology with a shift in material procurement strategies from wide ranging to predominantly local sources. Torres notes that the important distinction between Basketmaker II and Basketmaker III dart points are the objective piece of manufacture. Basketmaker II dart points were made from “large biface thinning flakes” and Basketmaker III dart points were “made from cobble core flakes” (Torres 2000:227). This shift of material procurement strategies has been debated as to reflect either changes in mobility with increasing sedentism or as a result from the adoption of bow and arrow technology (Railey 2010).

Changes in stone tool technology across the Southwest from a formal technology based on biface manufacture to expedient, flake based technologies has been suggested to be temporally correlated with the introduction of the bow and arrow (Railey 2010). This is in contrast to arguments that suggest the technological shifts in stone technologies occurred as a result of increasing sedentism and farming. According to Railey, Parry and Kelly noted this technological shift occurring around AD 600 despite that maize was first introduced into the Southwest around 2100 BC and that pit houses are seen as early as Basketmaker II (Railey 2010:262).

Railey argues that the introduction of the bow and arrow carried aspects of production and maintenance that was fundamentally different than the dart and atlatl. Arrow points can be manufactured from flake blanks that are smaller than those for manufacturing dart points. Less high quality raw material is needed for arrow points and would allow for a wider range of material exploitation. This is in contrast to dart points
that require greater quantities of higher quality material due to the manufacture of larger points. Additionally, chipped stone assemblages should therefore have distinctive characteristics stemming from atlatl or bow technologies. This includes higher frequencies of flakes and bifaces made from finer-grained material in assemblages that pre-date the bow (Railey 2010:266-267). However, based on evidence from the Northern Rio Grande, Vierra observed a shift in “flake-based projectile point technologies… associated with the use of Middle and Late Archaic darts, and not arrowpoints” (2013:152). Flake-based projectile point manufacture has been observed elsewhere in the Southwest and is an often overlooked aspect in regard to chipped stone assemblages (Whittaker 1987).

Previous Research into Atlatl to Bow Transition in Southwest

The introduction of the bow into North America from Asia was first seen in the Arctic around 3000 BC and diffused across the continent (Blitz 1988). Different areas responded differently to the adoption of bow technology. Some replaced the dart and atlatl quickly while others may have used the atlatl and bow as “part of a single arsenal for quite some time” (Tomka 2013:553). The presence of bow technology, seen at around AD 500, was used as one of the classifying traits of Basketmaker III culture. However, with the development and refinement of absolute dating methods and an increase of excavation projects in the Southwest region, dates for the initial introduction of the bow have been cited as early as AD 100 at Glen Canyon, Utah. A wider, regional, adoption is suggested to have occurred in between AD 500 and AD 600 in areas of northern Arizona and New Mexico (Blitz 1988, Reed and Geib 2013, Torres 2000).
The primary reason for the assumption of a swift adoption of bow technology is the superiority in hunting and interpersonal conflict over the atlatl. Comparatively, the atlatl requires a closer range to the target and more space for throwing, as opposed to the bow that has a longer range, can be used in a tighter space, and has a greater accuracy (Blitz 1988, Bettinger 2013, Reed and Geib 2013, Whittaker 2013). Arrows have a lighter mass and thus are able to obtain a higher velocity, and are smaller and lighter compared to their dart counterparts and are easier for transportation (VanPool 2006).

The technological superiority of the bow over the atlatl for both hunting and for use in conflict is often the evolutionary explanation for the rapid diffusion and replacement of the atlatl across North America (Blitz 1988, Tomka 2013). However, despite this prevailing notion, the atlatl was not completely replaced and existed as a part of a continuum with bow technology for some time in some areas in North America (Justice 2002, Roth et al. 2011, Shott 1996, VanPool 2006).

VanPool (2006) examined projectile point technology from Ventana Cave, Arizona and Paquimé, Chihuahua, Mexico and found indications of atlatl use well into AD 800 and beyond. VanPool cites three potential reasons for the continued use of atlatl technology despite the wide use of the bow: 1) symbolic meaning of the atlatl, 2) the dart’s heavier mass and penetration capabilities, and 3) the ability to use with one hand (2006:434).

Additional evidence suggests an overlap of technologies. Atlatl technology was observed to have been used by the Aztecs during Spanish contact, with the bow hardly used. Additionally, pictographs from the Great Basin and the Southwest show both atlatl and bow technology being used at the same time (Justice 2002).
According to experimental studies by Tomka (2013), the effectiveness of bow and arrow technology in hunting was restricted to small and medium sized animals due to a lighter weapon system compared to the atlatl. When hunting larger species such as bison, the bow failed to deliver a lethal wound. However, because of the “greater kinetic energy and momentum” the atlatl would have had the penetration capacity to deliver a lethal wound in ways that the bow could not (Tomka 2013: 562). Tomka concludes that hunting strategies would have had to change with the adoption of bow and arrow technology because of the bow’s inefficiency at killing larger prey. However, due to the arrow being a lighter and more accurate weapon system, gains in hunting small and medium sized animals would have increased. Retaining dart and atlatl technology with bow and arrow technology would have “allowed hunters to broaden their hunting capacity and retain a flexible subsistence strategy” (Tomka 2013: 564).

In the Mimbres Mogollon region, bow technology likely diffused into the southern Southwest from the Great Basin via the northern Southwest (Roth et al. 2011). The timing of this introduction was dated to approximately AD 500 to 600 along with a period of co-occurrence with atlatl technology. Roth and colleagues suggest that the probable reason for the adoption of bow and arrow technology was related to subsistence strategies “where the efficiency of the bow and arrow allowed for groups to obtain meat with less time and effort” (2011:105).

Interested in the socio-political effects of new technology, Bingham and colleagues (2013) proposed two theories upon the local adoption of the bow. Social coercion theory predicts that the use of bow technology will increase “social scale and economic intensification” while also providing a weaponized means against non-kin
“freeloaders” (2013:82). Warfare theory predicts that the adoption of the bow will follow with increases in “warfare” and intergroup conflict. This increase in conflict will led to increased “social complexity and economic intensification resulting from the demands or effects of increased warfare” (2013:82).

The theories proposed by Bingham and colleagues were tested (Reed and Geib 2013, VanPool and O’Brien 2013) and concluded that no evidence to support warfare theory was found after the introduction of the bow and arrow in the Southwest. Incidents of violence rise during the late AD 600s to late 700s, well after the adoption of the bow and arrow (Reed and Geib 2013:109). Instead, evidence to support social coercion theory is substantiated with a period of delay in violence followed by a rapid increase of social complexity. Reed and Geib conclude that the adoption of bow technology across the Southwest provided an advantage in social interaction through defense and offense. The advantage of bow technology resulted in groups adopting the technology out of competition with other groups or as defense from “tit-for-tat” raiding (Reed and Geib 2013:109, VanPool and O’Brien 2013:115).

*Point Typologies*

Early attempts at discerning sequence typologies were pre-occupied with the use of ceramics for defining temporal sequences in the Southwest. In contrast to the Great Basin where projectile points are used as temporal markers (Bettinger et al. 1991, Fauvelle et al. 2012, Flenniken and Wilke 1989), the Southwest was characterized by the wide use of ceramics as defining temporal sequences; for preceramic sites, dart points were used. As a result, arrow points were left to be under-examined in the archaeological
record, resulting with minimal investigations that did not produce widely applicable typologies (Phagan and Vierra 1984, Smiley 1995:33).

In the Southwest, Irwin-Williams defined the Oshara Tradition as the “unbroken sequence of preceramic cultural development beginning in the sixth millennium before Christ and culminating in the early phases of the local Anasazi-Pueblo culture” (1973:2). The Oshara Tradition contains technological phases of toolkits dating to specific eras that occur across the Four Corners region. The Jay, Bajada, San Jose, and Armjio phases cover the Archaic time period. The En Medio Phase (800 BC-AD 400) occurs during Basketmaker II with the Trujillo Phase (AD 400-600) following in Basketmaker III. According to Irwin-Williams, the material culture of the Trujillo phase “represent continuous trends established in the En Medio” with the introduction of arrow points “made like miniatures of En Medio dart points” (1973:13). Irwin-Williams’ work laid the foundation for point types and their temporal associations across the San Juan Basin and Colorado Plateau areas of the Southwest, however, descriptions of the extent of metric and morphological variation within the defined traditions were relatively minimal (Kearns and Silcock 1999).

Conclusion

In summary, bow technology is seen widely across the Southwest around AD 500 and is considered to be one of the characteristics of the Basketmaker III time period. Sites dating to the Archaic and Basketmaker II have been documented at Chaco Canyon, but the Basketmaker III time period represented the first sedentary occupation (Hayes et al. 1981) that laid the cultural foundation for the subsequent Pueblo I time period (Van Dyke 2007). With the technological transition from the atlatl to the bow occurring during this
time, Basketmaker III sites at Chaco Canyon provide the opportunity to examine the mechanics of this transition and how it may have played a role in the proceeding developments leading to the establishment of Chacoan culture seen in the Bonito Phases.
Chapter 4: Methods

While cultural transmission will serve as the theoretical lens from which to frame and formulate questions that can be addressed, with Chaco Canyon serving as the case study, a variety of methods were employed to obtain the data necessary for this study. Perishable objects such as wood and sinew rarely preserve in the archaeological record, with exceptions to dry and arid regions, such as the Southwest. However, recoveries of the entire technological composite of the atlatl and bow is rare, leaving studies regarding projectile point technology to rely on the stone points (Reed and Geib 2013). I used projectile points from four different sites dating to Basketmaker III at Chaco Canyon to test my hypotheses regarding the technological transition from atlatl to bow. These sites were selected based on the availability of excavated assemblages.

Overview of Study Sites in Chaco Canyon

29SJ299 (299) is a small Basketmaker II site located near Fajada Butte that was first excavated by Richard Loose in 1973. Excavations revealed two burnt pithouses, a ramada, and numerous storage cysts. Occupation of the site was determined to have been relatively brief and may have been limited to one or two families. Architectural observations for the pithouses were identified as being similar to the patterns from the western extent of the San Juan Basin from around AD 600 (Windes 2015:88).

29SJ423 (423) is an early Basketmaker III site located near Peñasco Blanco on West Mesa, near the confluence of the Chaco and Escavada washes. 423 was originally recorded during the 1972 survey and was observed to have numerous pit houses in addition to a great kiva, suggesting the site was comparable to Shabik’eshchée (Mathien 2005:101, Windes 2015:119). Turquoise and shell caches were recovered from the kiva,
“suggesting and early establishment of a practice that is well documented during the later Chaco florescence” (Mathien 2005:106). According to Windes, the initial settlement of 423 occurred during the late AD 400s with the kiva constructions occurring during an unusually wet period that ranged from the early AD 500s into the 520s (2015:118). This would have increased the potential for small scale horticulture and agriculture in the area, attracting populations to settle. Site occupation was estimated to have ended in the late AD 500s to early 600s.

29SJ519 (519) was discovered in 2010, while replacing a water pump in the south end of the NPS maintenance yard. The site is located on the north side of the canyon “near the base of a talus slope” to the west of Gallo Wash (CCNHP Site 29SJ 519 Draft Report 2010:1). Excavations were conducted by NPS staff archaeologists, who uncovered five pit house structures, a possible ceramic kiln, and ceramic and lithic artifact scatters. The site was dated from AD 550 to 650 and was interpreted to be a seasonal occupation of a relatively brief time span, perhaps as long as 15 years (CCNHP Site 29SJ 519 Draft Report 2010, Watson 2011). The relatively brief time of occupation of 519 provides a “snap shot” that will avoid issues of temporal mixing.

29SJ1659 (1659), also known as Shabik’eshchee was first excavated by Frank H.H. Roberts in 1927. The site was discovered in 1926 during the National Geographic Society’s Pueblo Bonito Expedition (Roberts 1929). Wills and Windes (1989) reassessed Shabik’eshchee, and the broader Basketmaker III settlement patterns in Chaco Canyon. Windes suggests that 423 and Shabik’eshchee represent a cultural continuity, present in Basketmaker III, which developed into the classic characteristics of Chacoan life later in the AD 800s (2015:118).
Methods

The projectile points that were recovered from the described sites were analyzed for this study. Projectile point is a general term that encompasses dart and arrow points. The term dart point is used to describe a projectile point hafted onto a shaft used in conjunction with an atlatl. These points are typically larger in neck width, thickness, shoulder width, and neck width than arrow points (Thomas 1978, Shott 1997). Arrow point is used to describe a projectile point hafted onto a shaft to be shot with a bow and are typically smaller than dart points.

Length, width, and thickness were the basic measurements taken for all points, regardless of condition, and represent the maximum extent. Blade length was measured from the tip of the point to the tip of the shoulder. Neck width was measured from the edges of the neck, just below the blade. Base width was measured between the lateral margins of the base. The measurement of corner to shoulder was only taken if the base of the point was stemmed, corner or side-notched. This measures from the bottom of the shoulder to the corner of the point base.

In order to statistically determine degrees of variability, or how the projectile points are similar or different in morphology, the standard deviation and variation for the measurements were calculated. Length, width, thickness, blade length, neck width, base width, and shoulder to corner were represented by the minimum and maximum values, the mean, standard deviation, and variance.
Figure 4.1: Projectile point measurements used in this study for stemmed and corner-notched points, adapted from Andrefsky (2005) and Phagan (1988).

The material of the projectile points was also noted. This was an important aspect of analysis because the material of point manufacture can indicate the locality and source; thus inferring patterns of procurement or trade. An important distinction made within the material types was discerning if a material was local or non-local. Local material is defined as obtainability within the “daily range of activities”, approximately 10 to 20 km away from Chaco Canyon (Cameron 2001:81). Local materials include various cherts, chalcedonies, quartzites, and siliceous woods from around the San Juan Basin. Non-local
materials are defined as material sources that are greater than 20 km away from Chaco Canyon and include obsidian, Narbona Pass chert, Morrison Formation cherts, and Zuni yellow-spotted chert.

The dart-arrow index was used to distinguish between dart and arrow points. This index requires measurements of the neck width and the maximum thickness of the point because these elements are less likely to be affected by point reworking and rejuvenation (Hildebrandt and King 2012). These measurements added together will produce an index number that can determine if a point falls within the acceptable range for arrow points or dart points. The index number proposed by Hildebrandt and King was approximately 11.3 mm as the threshold between dart and arrow points. In this study, neck width and thickness were plotted against each other to achieve the same results. For the points that have notching, the measurement of the width of the neck was taken, and for points that did not have a neck, the maximum thickness was measured to compare with point other thicknesses from the assemblage.
To examine the nature of the technological transition a morphological analysis was used on the arrow points to determine the extent of information transmission. Morphology is defined as “the nature of the shape and structure” of the points (Andrefsky 2005:258). By examining dart points and their morphology it can be determined if dart styles transitioned to arrow point styles. This was observed in the Great Basin with the Elko dart points and their smaller versions, known as Rosegate arrow points (Bettinger and Eerkins 1999).

According to Eerkins and Lipo, cultural transmission can be used to explain “variation, similarity, and relatedness” in the archaeological record because “similarity in artifact form may be a product of information ultimately coming from the same source” (2007:241). To determine morphological variability, the different point forms based on hafting element (the section of the point that was attached to the arrow shaft) such as...
stemmed, corner-notched, or side-notched was distinguished. Broken points were
classified as a fragment, with the point segment (base, tip, mid-section) identified, and
were considered for analysis on a case-by-case basis.

To further understand the different levels of variability between the projectile
points at Chaco Canyon, the points were placed into distinctive forms, or types. The term
“form” is used in this thesis to describe a specific point morphology, synonymous to the
term “type”. This was done to avoid confusion from describing material type and point
type. “Type”, and hereby “Form”, is defined as:

“artifacts that demonstrate a simultaneous morphological, temporal, and
geographic congruence rather than a general, and possibly coincidental, similarity
across large areas or different time periods. This, in turn, is taken to reflect a
shared mental template, which encompasses commonality in thought, a standard
set of techniques for translating a design canon to material culture, and a
commonly held understanding of technology and technical expression.” (Sliva
2015:5)

The arrow points were assigned a typological form based existing typologies
from the Four Corners region. This was done through either the use of metrics, such as
thickness and Notch Opening Index, or through intuitive methods. The Notch Opening
Index is the degree of notching between the stem and shoulder edge (Brown et al. 1993:
385, Thomas 1981: 14). Replicating the methods of how the points were typed was
attempted, but was not able to be done for some of the comparative typologies. This was
when intuitive methods where used. Intuitive typologies are defined as types that were
developed in a “subjective manner by placing observationally “similar” items together”
(Phagan 1988b:88).

This thesis adapted the Simpson’s Diversity Index, commonly used to describe
species variability within faunal assemblages, to quantitatively describe variability within
the arrow point assemblage at Chaco Canyon. Simpson’s index of diversity calculates the
probability that two individuals that are drawn at random from an “infinitely large community” will belong to the same species (Magurran 2004: 114). Adapting this for projectile point forms, this calculation hypothetically predicts the probability of two arrow points drawn at random from an assemblage will belong to the same point form. The higher the probability is the lower the diversity. $D$ is representative of diversity with $P_i$ as the proportion of arrow points in the $i$th form. Diversity of the index is expressed as $1-D$ and gives the percentage of assemblage diversity (Magurran 2004:114).

$$D = \sum P_i$$

In order to understand the point forms and variability observed at Chaco Canyon, comparative points from different areas surrounding Chaco Canyon were used. These areas include Southern Colorado, the Chuska Valley, and Jemez Mountains and were chosen based upon the availability of data for Basketmaker III sites. Data from Grants Ridge and areas to the south of Chaco Canyon were not able to be obtained in time inclusion in this study. The addition of a regional perspective was done as an attempt to place the points from Chaco Canyon within the greater context of the Four Corners region.
Chapter 5: Analysis and Results

The data from 519 was collected at Chaco Culture National Historical Park during the month of July, 2015. The data from sites 299, 423, and 1659 were collected at the Hibben Center in Albuquerque, NM during July 2015. Most of the points included in this study were first examined by Cameron (1997) and Lekson (1997). There had been no previous examination of the artifacts from 519. In total, 63 projectile points were analyzed.

<table>
<thead>
<tr>
<th>Site</th>
<th>Most Complete</th>
<th>Fragments</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>299</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>423</td>
<td>17</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>519</td>
<td>5</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>1659</td>
<td>9</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>29</td>
<td>63</td>
</tr>
</tbody>
</table>

Table 5.1: Projectile point counts from Basketmaker III sites at Chaco Canyon.

29SJ299

Three projectile points in the assemblage were recovered from 299. The low sample size may have been affected by the Basketmaker III components not being screened, thus limiting the total number of recovered lithics (Cameron 1980). Site 299 had evidence of Basketmaker III and Pueblo I occupations, however the projectile points were recovered from Basketmaker III contexts (Cameron 1980).

Two projectile points were manufactured from obsidian and one from chalcedony. One is a dart point and the other two are arrow points. One of the arrow points was complete and the other had the shoulders and tip missing; both manufactured from flake blanks. The appearance of the dart point indicates that it was extensively reworked,
however submission for obsidian hydration testing and measurement of the hydration rims (Yohe 1992) would indicate if this point was from Basketmaker III or earlier.

<table>
<thead>
<tr>
<th></th>
<th>Min. Value</th>
<th>Max. Value</th>
<th>Mean Value</th>
<th>Standard Deviation</th>
<th>Variance</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td>17.0</td>
<td>20.0</td>
<td>18.5</td>
<td>2.1</td>
<td>54.3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Width</strong></td>
<td>11.0</td>
<td>12.0</td>
<td>11.5</td>
<td>0.7</td>
<td>52.3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>2.4</td>
<td>3.6</td>
<td>3.0</td>
<td>0.8</td>
<td>4.2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Neck Width</strong></td>
<td>4.6</td>
<td>4.6</td>
<td>4.6</td>
<td>7.2</td>
<td>61.0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Blade Length</strong></td>
<td>12.8</td>
<td>16.0</td>
<td>14.4</td>
<td>2.3</td>
<td>40.0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Haft Length</strong></td>
<td>3.8</td>
<td>5.0</td>
<td>4.4</td>
<td>0.6</td>
<td>0.4</td>
<td>3</td>
</tr>
<tr>
<td><strong>NOI</strong></td>
<td>50</td>
<td>120</td>
<td>76.7</td>
<td>37.9</td>
<td>1433.3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Base Width</strong></td>
<td>5.3</td>
<td>5.6</td>
<td>5.5</td>
<td>0.2</td>
<td>44.5</td>
<td>2</td>
</tr>
<tr>
<td><strong>Shoulder to Corner</strong></td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5.2: *29SJ299* projectile point measurements.

**29SJ423**

A total of 30 projectile points were examined from 423 and 18 were complete enough for statistical analyses. Local materials, such as silicified wood, chalcedony, and chert, were the primary materials for points. Obsidian is the dominant non-local material. One archaic Bajada dart point, made from chert, was recovered, and noted to have been reworked. The greatest variation within the points was in total length, and blade length, and base width with the lowest variation in thickness.
### Table 5.3: 29SJ423 projectile point measurements.

29SJ519

A total of 12 arrow points and points fragments were recovered from 519. No dart points were recovered. No fully intact arrow points were recovered with the most complete intact points missing elements that made a study of morphological variability difficult. Only 3 points were complete enough to derive morphological information. The projectile point dating to Pueblo 1 context was ignored for analyses of variability. Of the remaining projectile points, the highest levels of variability occurred in overall length, width, blade length, and blade width. One of the pit structures at was interpreted to have been used as a ceramic kiln, suggesting the occupants were manufacturing their own ceramics (CHCU 519 draft report). It is possible that they were trading ceramics for stone material, or finished tools. 2 of the 4 finished Basketmaker III projectile points were manufactured out of obsidian and were more than likely not traded as finished points.
<table>
<thead>
<tr>
<th></th>
<th>Min. Value</th>
<th>Max. Value</th>
<th>Mean Value</th>
<th>Standard Deviation</th>
<th>Variance</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>13.0</td>
<td>33.0</td>
<td>22.0</td>
<td>10.1</td>
<td>103.0</td>
<td>3</td>
</tr>
<tr>
<td>Width</td>
<td>10.0</td>
<td>13.0</td>
<td>11.0</td>
<td>1.7</td>
<td>3.0</td>
<td>3</td>
</tr>
<tr>
<td>Thickness</td>
<td>2.0</td>
<td>3.0</td>
<td>2.7</td>
<td>0.6</td>
<td>0.3</td>
<td>3</td>
</tr>
<tr>
<td>Neck Width</td>
<td>5.0</td>
<td>7.0</td>
<td>6.0</td>
<td>1.4</td>
<td>2.0</td>
<td>2</td>
</tr>
<tr>
<td>Blade Length</td>
<td>20.0</td>
<td>30.0</td>
<td>25.0</td>
<td>7.1</td>
<td>50.0</td>
<td>2</td>
</tr>
<tr>
<td>Haft Length</td>
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<td>4.0</td>
<td>4.0</td>
<td>0.0</td>
<td>0.0</td>
<td>2</td>
</tr>
<tr>
<td>NOI</td>
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<td>80.0</td>
<td>75.0</td>
<td>7.1</td>
<td>50.0</td>
<td>2</td>
</tr>
<tr>
<td>Base Width</td>
<td>7.0</td>
<td>9.0</td>
<td>8.0</td>
<td>1.4</td>
<td>2.0</td>
<td>2</td>
</tr>
<tr>
<td>Shoulder to Corner</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>0.0</td>
<td>0.0</td>
<td>2</td>
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</tbody>
</table>

Table 5.4: 29SJ519 projectile point measurements.

29SJ1659 (*Shabik’eshchee*)

A total of 11 out of 14 points recovered from 1659 during the Chaco Project were from surface contexts, leaving only 3 points in this sample with well documented proveniences. The projectile points recovered by Roberts were also not included in this analysis. Results from 1659 that were produced during this study should be considered preliminary until a more extensive study that unites all of the points from 1659 into one analysis can be conducted.

A total of 13 projectile points were analyzed from 1659 with 13 complete enough for a metric analysis. Local materials such as chalcedony, chert, and silicified wood were dominate local types, with obsidian being the dominant non-local type. A large, orthoquartzite, dart point was recovered from a well-established provenience.
<table>
<thead>
<tr>
<th>1659 Projectile Points</th>
<th>Min. Value</th>
<th>Max. Value</th>
<th>Mean Value</th>
<th>Standard Deviation</th>
<th>Variance</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>11.5</td>
<td>67.4</td>
<td>24.2</td>
<td>14.2</td>
<td>200.6</td>
<td>13</td>
</tr>
<tr>
<td>Width</td>
<td>7.7</td>
<td>26.0</td>
<td>13.7</td>
<td>4.9</td>
<td>23.8</td>
<td>13</td>
</tr>
<tr>
<td>Thickness</td>
<td>1.6</td>
<td>6.2</td>
<td>3.2</td>
<td>1.3</td>
<td>1.7</td>
<td>13</td>
</tr>
<tr>
<td>Neck Width</td>
<td>3.2</td>
<td>14.6</td>
<td>5.8</td>
<td>3.5</td>
<td>12.2</td>
<td>9</td>
</tr>
<tr>
<td>Blade Length</td>
<td>7.7</td>
<td>56.6</td>
<td>22.4</td>
<td>16.3</td>
<td>265.0</td>
<td>7</td>
</tr>
<tr>
<td>Haft Length</td>
<td>2.9</td>
<td>9.9</td>
<td>4.8</td>
<td>2.5</td>
<td>6.0</td>
<td>7</td>
</tr>
<tr>
<td>NOI</td>
<td>60.0</td>
<td>140.0</td>
<td>80.7</td>
<td>27.8</td>
<td>770.2</td>
<td>7</td>
</tr>
<tr>
<td>Base Width</td>
<td>3.1</td>
<td>22.5</td>
<td>7.5</td>
<td>6.4</td>
<td>40.6</td>
<td>8</td>
</tr>
<tr>
<td>Shoulder to Corner</td>
<td>3.2</td>
<td>10.2</td>
<td>5.6</td>
<td>2.3</td>
<td>5.2</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 5.5: 29SJ1659 projectile point measurements.

**Material Types**

Local materials dominated the assemblage for dart and arrow points. Obsidian was the only distinctive non-local material observed for point manufacture and suggests that trade connections existed between the groups at Chaco Canyon, Grants Ridge, and Jemez. Site 519 had the highest quantity of obsidian projectile points despite a relatively short occupation while 423 and 1659 had greater quantities of points manufactured from local material.
A total of 28 points with measurements for both neck width and thickness were used to plot the dart-arrow index. The plotted distribution (Figure 5.2) shows a prominent gap between dart and arrow points. The identification of the dart points had been done prior and were not a result of this study. The substantial gap between the arrow and dart points suggest that the technological transition from atlatl to the bow had already occurred and perhaps took place prior to settlement at Chaco Canyon.

Figure 5.1: Material types of projectile points from Basketmaker III sites at Chaco Canyon.
Figure 5.2: Dart-arrow index of Basketmaker III projectile points.

Discriminant analyses utilize numerous aspects of morphology to quantify variability between projectile points and to distinguish between arrow and dart points. Breaking down the attributes of thickness and neck width, used in the dart-arrow index, (Figures 5.3 and 5.4) suggest that the distributions of these measurements are enough to distinguish between dart and arrow points for the assemblage at Chaco Canyon during Basketmaker III. This trend may be due to the small sample size of dart points, however, the 2 mm gap between arrow and dart point thicknesses and the 5 mm gap between arrow and dart neck widths concludes a lack of transitional points from dart to arrow at sites 299, 423, 519, and 1659.
Figure 5.3: Thickness of DAI projectile points from Chaco Canyon
Figure 5.4: Neck width of DAI projectile points from Chaco Canyon.
Thickness and neck width are vital features for projectile points because they directly affect how the point will be hafted to the foreshaft, thus affecting projectile efficiency (Parry and Christenson 1987:147, VanPool 2003:248). A neck width for the point is created from notching the basal corner or sides to assist with hafting and to control where the point will break as a result from impact. A notched point will most often break where there is the least amount of structural integrity, which is through the notched area, the shoulders, or basal corners. After a break through the notched area, the blade will likely remain intact with enough material remaining to rejuvenate the point, thus affecting morphological features and associated metric attributes such as weight, length, and width (Flenniken and Wilke 1989:151). The measurements of thickness and neck width are less likely to be affected by point rejuvenation because hafting to the foreshaft and thus are more reliable indicators in distinguishing between dart and arrow points (Hildebrandt and King 2012:791).

Roth and colleagues’ (2011) study into the transition from atlatl to bow technology in the Mimbres Mogollon region showed evidence of point experimentation in thickness and neck width attributes. Their study showed that at the site La Gila Encantada, a “number of both dart and arrow points fall within the 2.5 to 4 mm range” (Roth et al. 2011:98). This is contrasted with the distribution of thickness for the points from Chaco Canyon, as shown in Figure 5.3.

It is unclear if the dart points recovered from 299 and 1659 resulted from scavenging points from earlier time periods or if dart technology was still minimally curated by groups at Chaco Canyon. The point from 423 suggests a degree of scavenging, however, projectile points manufactured during earlier time periods have been observed
at Chaco Canyon, with some found in Basketmaker III contexts. Hayes (1981) noted 23
dart points from preceramic sites during the Hayes Survey that included Folsom, Jay,
Pinto Basin, San Jose, and Basketmaker II; Basketmaker II points were noted at
Basketmaker III sites, providing additional evidence of point scavenging (Hayes et al.

Obsidian hydration of the obsidian dart point from 299 would determine if the
point had been scavenged and reworked but the orthoquartzite dart point from 1659
would not. An analysis of biface thinning flakes may shed light on the status of dart
points in Chaco Canyon. Biface thinning flakes were identified and examined for 519.
However, this specific type of debitage was not identified in the Chaco Project analysis
(Cameron 1997) and future research would be required to re-examine the debitage from
299, 423, and 1659.

**Point Forms at Chaco Canyon**

The projectile points from the Basketmaker III sites at Chaco Canyon were typed
in order to understand projectile point technology at Chaco within the wider region. This
was done by tracing and linking projectile point forms and morphologies observed at
Chaco Canyon to other regions that have similar point forms. Unfortunately, a systematic
and unified typology for projectile points dating to Basketmaker III does not exist, and as
a result, numerous typologies were used.

**Dart Points**

The dart point from 423 was identified as an Archaic, late Bajada point. Irwin-
Williams (1973) defined the Bajada Phase as occurring between 4800 BC – 3200 BC and
are described as “long straight stems with weak shoulders and a concave base” (Justice
Bajada points were observed to have changed in morphology over time and are distinguished by early and late Bajada. Morphological changes for late Bajada points include greater defined shoulders and a decrease in overall length (Irwin-Williams 1973:7, Justice 2002:124).

The dart point identified from 1659, while not an exact match, was typed as Basketmaker White Dog based on the description provided by Sliva (2015:79). This type is identified by Justice as Black Mesa Narrow Neck (2002:213). The Basketmaker White Dog point type has been observed across Black Mesa, in northern Kayenta Arizona and southeastern Utah, and southern Arizona Mogollon Rim (Sliva 2015:80-81). Sliva mentions that similar points to Basketmaker White Dog have been found in the eastern Chuska Mountains of northwest New Mexico but have slightly different notching characteristics that are “not precise matches for White Dog” (2015:81). However, for the purposes of this study, White Dog was used since no alternative designation for this variant was proposed. Sliva dates White Dog points to approximately AD 50-300, comfortably within Basketmaker II (2015:78), while Justice places Black Mesa Narrow Neck to approximately AD 1 – 800 (2002:215).

The obsidian dart point from site 299 was not able to be typed due to extensive reworking. However, based on the attempted rejuvenation of the base, the point may have been a long stemmed point that obtained a bending fracture during manufacture.
Chaco Canyon Dart Points

Figure 5.5: Illustrations of dart points from Chaco Canyon. A) C13699, B) C10729, C) C30588.
Arrow Points

Arrow points dating to Basketmaker III have not been typologically defined as well as the dart points from Archaic and Basketmaker II. Previously, Basketmaker III point types have been defined based on specific projects (Brown et al. 1993, Kearns and Silcock 1999, Moore 1981) or by general morphology of the hafting element (Lekson 1997). The most comprehensive attempt at unifying point types in the Southwest comes from Justice (2002), however, Sliva critiques the use of those typologies “due to his often questionable grouping of only superficially similar artifacts from disparate regions and times into clusters, and his occasional inaccurate chronological assignments.” (2015:8)

Lekson distinguished three arrow point forms for the projectile point analysis of the Chaco Project: stemmed, corner-notched, and side-notched. Stemmed points were defined as the “hafting element is a parallel-sided or slightly expanding stem below the blade” (Lekson 1980:59). Corner-notched points were defined as having the “hafting element formed by notching originating at the point of juncture of the blade edges and the base”, and side-notched points were defined as the “hafting element formed by notching originating above (distally) the juncture of the blade edges and the base” (Lekson 1980:59). Stemmed points were the most common point form during Basketmaker III with some corner-notched points.
Figure 5.6: Arrow point forms, adapted from Lekson (1997).

Figure 5.7: Arrow Point Forms from Chaco Canyon Basketmaker III, adapted from Lekson (1997).
Stemmed points were the most common point form that was observed in the assemblage from Chaco Canyon. Corner-notched points were also identified but were only observed at sites 519 and 1659. Side-notched points were not identified in this assemblage. A total of 40 points were classified as “Indeterminate” due to being too fragmented.

The lowest levels of variability based on the standard deviation of stemmed and corner-notched arrow point forms were observed in thickness and the hafting features. Hafting features provide the most reliable indication for measuring variation because they are relatively stable attributes and are less likely to be affected by reworking like length and width (Thomas 1981:15). The statistics for corner-notched points should be considered preliminary data considering the small sample size of that point form that was included in this study.

<table>
<thead>
<tr>
<th>Stemmed Arrow Points</th>
<th>Min. Value</th>
<th>Max. Value</th>
<th>Mean Value</th>
<th>Standard Deviation</th>
<th>Variance</th>
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</thead>
<tbody>
<tr>
<td>Length</td>
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<tr>
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<td>17</td>
</tr>
<tr>
<td>Thickness</td>
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<td>2.9</td>
<td>0.6</td>
<td>0.4</td>
<td>17</td>
</tr>
<tr>
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<td>4.6</td>
<td>1.1</td>
<td>1.1</td>
<td>16</td>
</tr>
<tr>
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<td>6.5</td>
<td>41.7</td>
<td>12</td>
</tr>
<tr>
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<td>3.8</td>
<td>0.8</td>
<td>0.7</td>
<td>15</td>
</tr>
<tr>
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<td>69.3</td>
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<td>15</td>
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<td>1.1</td>
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</tr>
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<td>Shoulder to Corner</td>
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<td>1.0</td>
<td>1.0</td>
<td>15</td>
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</table>

Table 5.6: Stemmed arrow point metrics.
Table 5.7: Corner-notch arrow point metrics.

The projectile points at Chaco Canyon show relatively high levels of variability in length, width, blade length, and notch opening index, however, all of these variables can be affected by point breakage and rejuvenation. Overall, thickness had the lowest levels of variability, suggesting an established method of flake reduction and manufacture across the sites at Chaco Canyon. The standard deviations for the measurements of neck width and haft length also show low levels of variability.

Typologies based on general morphology of the base, such as stemmed, corner-notched, and side-notched, have limited potential for fully examining variability. To further evaluate variability, arrow points from Chaco Canyon were identified based on the typology developed by Kearns and Silcock (1999) for the southern Chuska Valley. This typology was used because it adequately accounted for the point morphology and variability that is seen with the points at Chaco Canyon.
Sites 423 and 1659 had the highest number of points that were able to be typed. The arrow points from 299 were both typed as one form, and the arrow points from 519 were typed as two different forms. Sites 299 and 519 had small sample sizes that was potentially reflected in the limited distribution of point forms.

Four arrow points were identified as 2201. This form is characterized by relatively high levels of variability. The stem may be broad or narrow with broad and deep corner notches, and blade can appear triangular or slightly curved (Kearns and Silcock 1999:6-13). One point within this type from site 519 also fits the defined morphological characteristics of Moore’s Type 3D which has been observed in southwest Colorado in Pueblo II sites. This form is characterized by a long blade with shallow side-notching to produce a short and slender stem (1981:29).
Two points were assigned form 2202 and both were from site 299. This form is a variant of 2201 with “generally straight to slightly acute shoulder angles, and short, straight to slightly contracting stems” (Kearns and Silcock 1999: 6-13).

Four points were identified as 2301, three from 423 and one from 1659. The defining characteristics for this type are “deep, corner or basal notches that create accentuated barbs, and narrow, slightly expanding stems” with straight bases and triangular blades (Kearns and Silcock 1999:6-13).

Five points were identified as form 2401. The form is represented by corner-notched points with “moderate to broad, deep notches, acute shoulders with accentuated barbs, and triangular blades”. The base of the point is narrow with expanding stems (Kearns and Silcock 1999:6-13).

One point from site 519 and 1659 was identified as form 2402. The characteristics for this point form are corner-notched with “narrow, moderately deep notches, acute shoulder angles, and triangular to slightly excurvate blades. The necks are narrow and expand into wide, triangular stems with straight to slightly convex bases” (Kearns and Silcock 1999:6-13-6-14).
### Baskemaker III Chaco Canyon Arrow Point Metrics

<table>
<thead>
<tr>
<th></th>
<th>Min Value</th>
<th>Max Value</th>
<th>Mean Value</th>
<th>Standard Deviation</th>
<th>Variance</th>
<th>n</th>
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<td>4</td>
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<td>NOI (degrees)</td>
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</tr>
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</tr>
<tr>
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<td>3</td>
</tr>
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<td>13.9</td>
<td>11.9</td>
<td>1.8</td>
<td>3.1</td>
<td>3</td>
</tr>
<tr>
<td>Thickness</td>
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<td>3.4</td>
<td>3.0</td>
<td>0.3</td>
<td>0.1</td>
<td>3</td>
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<td>0.9</td>
<td>0.8</td>
<td>3</td>
</tr>
<tr>
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<td>4.1</td>
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<td>0.9</td>
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</tr>
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<td>0.3</td>
<td>0.1</td>
<td>3</td>
</tr>
<tr>
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<td>13.2</td>
<td>175.0</td>
<td>3</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
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<td>6.23</td>
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<td>3</td>
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<tr>
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<td>53.33</td>
<td>5.77</td>
<td>33.33</td>
<td>3</td>
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</table>
Table 5.8: Arrow point metrics and statistics from Chaco Canyon using typology from Kearns and Silcock (1999). Form 2302 were not statistically analyzed due to sample size.
Chaco Canyon Arrow Points

Figure 5.9: Illustrations of select arrow points from Chaco Canyon.
**Simpson’s Diversity Index**

The point forms used to calculate the index of diversity derived from the typology developed by Kearns and Silcock (1999). The probability that two arrow points randomly drawn from the Chaco Canyon assemblage will be of the same point form was calculated to be approximately 18 percent. The representation of diversity of the assemblage ($1-D$) was approximately 81 percent. This determined the overall representation of the arrow point assemblage to be relatively diverse in point forms.

**Conclusion**

The Basketmaker III projectile point assemblage at Chaco Canyon presented both dart and arrow points, however, there is reason to suspect that the dart points were manufactured during earlier time periods, discarded, and scavenged considered the well-provenience contexts of their recovery. The standard deviation and variance statistics for the arrow points showed high variability in measurements of length, width, stem length, and notch opening index, with minimal variability in thickness, neck width, and haft length. The distribution of the dart-arrow index, thickness, and neck width measurements show a lack of transitional and distinctively identify dart points versus arrow points. Simpson’s Diversity Index showed relatively high levels of diversity in arrow point forms for the Chaco Canyon assemblage.
Chapter 6: Discussion

*Technological Transition from Atlatl to the Bow*

This analysis has demonstrated that there is no evidence for the transition from the atlatl to the bow at Chaco Canyon. According to the data presented by the dart-arrow index on the projectile points from sites 299, 423, 519, and 1659, there is a prominent gap in between arrow and dart points. The gap is also observed in the distributions of thickness and neck width, suggesting a lack of transitional points from dart to arrow technology. The low levels of variability in arrow point thickness, neck width, and base width suggests that arrow technology was well established by early Basketmaker III, in that there was little to no experimentation with the hafting and delivery system. However, high variability in point forms suggests possible experimentation with style. It is possible that bow technology was adopted throughout the area prior to the settlement of Chaco Canyon, thus leaving no evidence of a transitory period between atlatl and bow technology.

In contrast, data from the Great Basin does show a transition from larger Elko dart points to smaller Rosegate arrow points in which the dart-arrow point indexes were scatter as opposed to clustered (Hildebrandt and King 2002). Vierra and colleague’s (2014) projectile point analysis from the Chuska Valley included a dart-arrow index study. The results showed a clear distinction between arrow and dart points but a less dramatic gap between the two point technologies than what is observed at Chaco Canyon (2014:378).

The lack of evidence regarding a technological transition from the atlatl to the bow at Chaco Canyon presents an interesting discussion concerning information diffusion
and population dynamics. To further investigate this conclusion, comparative data from across the region was examined.

*Arrow Point Morphology and the Diffusion of Information*

The Basketmaker III time period at Chaco Canyon experienced a population influx with sites 423 and 1659 as an ““integrative” focal point for the canyon population”, and represent the boundary extents for settlement (Wills et al. 2012:328). To understand the diffusion of information and how bow technology came to Chaco Canyon, projectile point forms from around the region were analyzed. These samples include Southwest Colorado, Chuska Valley, and Jemez Mountains.

**Southwestern Colorado**

The data for examining projectile point trends in southwestern Colorado came from the Dolores Archaeological Project (DAP). In the late 1970s The DAP was developed in response to needed mitigation work for a water retaining project. The fieldwork was conducted by the University of Colorado under contract by the Bureau of Reclamation, and was completed in the early 1980s (Robinson et al. 1986). The project was located near Dolores, Colorado, north of Mesa Verde, and investigated several sites spanning from the Paleoindian to Historic.

Over 1,500 projectile points were recovered with the analysis was headed by Phagan (1988a, 1988b) who developed different typologies using discriminate analysis and intuitive methods. The statistical typology was based on discriminant function analysis that grouped points together based on an extensive collection of metric data. The ““intuitive” typology was developed for more “traditional, intuitive procedures” that often involved visual comparisons (Phagan 1988b:87).
The data that was necessary to examine statistical variation for the projectile points analyzed by Phagan was not able to be obtained for this study. As a result, defining patterns between the projectile points from Chaco Canyon and the Dolores Archaeological Project were intuitively based on visual characteristics and should be considered preliminary. This study used Phagan’s statistical S-Typology (1988a) for connecting points from the DAP to Chaco due to biases detailed in his intuitive typological study (1988b). Of the 20 arrow points originally classified from Chaco Canyon only 11 were placed within the DAP point typology. The points that were able to be typed included forms S-1, S-3, and S-4.

According to Phagan, S-1 is characterized as having a narrow and straight, slightly contracting, or slightly expanding base with a low notch angle produced by a “pronounced overlap of the blade and stem” with long and straight blade margins (1988a:40). S-3 is characterized as a long and narrow shape with a moderately wide notch opening angle. S-4 had few distinguishing morphological traits, but is characterized by lower “production-input” and “lower plan symmetry… than the other [forms]” (Phagan 1988a:41).
Projectile Points from the DAP

Figure 6.1: Points S-1 and S-3 from Phagan (1988).
Figure 6.2: Points S-41 and S-45 from Phagan 1988.
**Chuska Valley**

Data from the Chuska Valley came from different cultural resource management reports. The first one was from the El Paso Natural Gas North System Expansion Project that encompassed the western San Juan Basin/Chuska Valley and eastern Arizona. The project was conducted by Western Cultural Resource Management, Inc. from 1990-1993. The data presented in the report was from testing and recovery phases with the majority of cultural resources coming from the Southern Chuska Valley (Kearns 1999).

In total, 320 projectile points were recovered and analyzed from the El Paso Natural Gas Company North System Expansion Project, with 144 complete enough for statistical analyses (Kearns and Silcock 1999). Kearns and Silcock (1999) developed the typology for the projectile points based on discriminant analysis of the recovered points. 119 points identified as arrow were from Basketmaker III to Pueblo III contexts. 38 Archaic and Basketmaker II points were recovered from ceramic contexts, suggesting a high level of scavenging of larger dart points in later time periods.

Kearns and Silcock note that there was a temporal gap of occupational sites in the study area between late Basketmaker II and early Basketmaker III, around AD 500, which is when they suggest that the transition between the bow occurred (1999:6-18). It was observed that predominantly stemmed points dated to Basketmaker III contexts with corner-notched points became preferred during Pueblo I times (Kearns and Silcock 1999: 6-18).
Out of 16 different arrow point forms from Kearns and Silcock’s typology only 6 of those forms appear at Chaco Canyon during Basketmaker III. These forms were identified based on visual and descriptive intuitive methods. The distribution of standard deviations based on measurements of length, width, thickness, neck width, base width, stem (haft) length, and notch opening index show similar and diverging patterns to the points from Chaco Canyon. Length, and notch opening index show the highest levels of variability, with neck width higher compared to the Chaco assemblage. Width, thickness, base width, and haft length show relatively low levels of variability, similar to Chaco. Additionally, thickness consistently showed to have the lowest variations.

Further insight into projectile point technology from the Southern Chuska Valley was provided by Vierra and colleagues (2014) for the New Mexico Department of Transportation project in the southern Chuska Valley. The report showed that high siliceous material, such as chalcedony, petrified wood, chert, and obsidian, were predominantly used to manufacture knives and projectile points. Local chert, notably Chuska chert or Narbona Pass chert, and chalcedonies were the preferred material for the manufacture of projectile points with finished obsidian points being traded (Vierra et al. 2014:378).

Stone material from the Southern Chuska Valley, Chuska chert or Narbona Pass chert, were not substantially represented in the lithic assemblages at Chaco Canyon. None of the observed points from Chaco were made from Narbona Pass chert during Basketmaker III, contrast to later time periods (Cameron 2001). However, obsidian recovered from Basketmaker III sites in the Chuska Valley were sourced primarily to Mount Taylor and Jemez (Kearns and Silcock 1999, Vierra et al. 2014). This is also seen
at Chaco Canyon during this time, with most obsidian originating from Mount Taylor and Jemez (Duff et al. 2012).

### Basketmaker III Arrow Points from the Chuska Valley

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Basketmaker III Arrow Points from the Chuska Valley Cont.

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Table 6.1: Arrow points from the Chuska Valley, adapted from Kearns and Silcock (1999)
Arrow Points from the Chuska Valley

Figure 6.3: Arrow points from the Chuska Valley. A) Basketmaker III corner-notched arrow points, from Vierra et al. 2014. B) Basketmaker III/Pueblo I arrow points, from Vierra et al. 2014. 2201 arrow points from Kearns and Silcock 1999.
Arrow Points from the Chuska Valley Cont.

Figure 6.4: 2202, 2203, 2301, and 2302 arrow points from Kearns and Silcock (1999).
Arrow Points from the Chuska Valley Cont.

Figure 6.5: 2401 and 2402 arrow points from Kearns and Silcock (1999).
Jemez Mountains

The data for the Jemez Mountains comes from the cultural resources report for the Ojo Line Extension transmission line (OLE). The project identified 161 archaeological sites that ranged in dates from the Archaic to Historic, with the highest frequency dating to the late Archaic and Basketmaker time periods (Acklen 1993:3).

A total of 119 projectile points were analyzed with most manufacture from obsidian with few from chert, basalt, and quartzite (Brown et. al 1993:367). The points were identified based on the definitions and criteria as established by Irwin-Williams for the Oshara Tradition with supplementation of Great Basin types. According to Brown and colleagues, approximately to 80% of the recovered projectile points were identified as dart points, with 20% identified as arrow points. The small number of recovered arrow points from the OLE project suggests an occupational gap in the area after Basketmaker II. Recovered arrow points from Basketmaker III contexts were identified as either Trujillo or Rosegate points. Trujillo points are considered a morphological continuation of En Medio dart points but only smaller (Brown et. al 1993:406, Irwin-Williams 1973:13). The use of Rosegate as a point form was necessary in order to distinguish between the “shallow-notched” Trujillo points from deeper-notched points (Brown et al. 1993: 406).

Brown and colleagues observed that the arrow points show “considerable diversity of the projectile point forms” (1993: 406) despite having a small sample size. The statistics from the arrow points from the Jemez Mountains may represent a small sample, however, the pattern of standard deviations follow similar trends to those of Chaco Canyon and the Chuska Valley. Length was the measurement of greatest
variability and thickness was the lowest variability. Neck width had similar levels of variability as the Chuska assemblage, which is higher than Chaco. The Rosesgate point was not included in the statistical analysis because of the sample size of one. Despite the observable trends in this study, further investigations with a larger sample size will be needed before drawing any definitive conclusions regarding projectile point patterns at Jemez.

**Basketmaker III Arrow Points from the Jemez Mountains**

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<th>Trujillo Corner-notched &quot;A&quot;</th>
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<th>Standard Deviation</th>
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**Table 6.2**: Trujillo Corner-notched metrics and statistics, adapted from Brown et al. (1993).

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**Table 6.3**: Trujillo Side-notched metrics and statistics, adapted from Brown et al. (1993).
Conclusion

Point typologies in the Southwest were constructed based on large-scale projects in specific areas, as observed with the comparative point forms used in this study. The DAP and Chuska Pipeline projects used a variety of statistical methods to develop their own typologies that resulted in numerous “types” and “subtypes” (Phagan 1988, Kearns and Silcock 1999). The OLE project used a combination of metrics and descriptive morphology to assign point forms (Brown et al. 1993).

Arrow point forms observed at Chaco Canyon are found throughout the Four Corners area during Basketmaker III and Pueblo I. Overall, the point forms from Chaco were observed to be most similar to those from the Chuska Mountains with some similarity to the points from southern Colorado and Jemez (see Appendix B). Statistical analyses showed high variability in length, low variability in thickness, and different levels of variability in neck width. Higher variability in neck width for the Chuska and Jemez assemblages may indicate experimentation with the delivery system of bow technology during Basketmaker III. This may indicate that the bow was introduced into these areas via guided variation. However, this assessment should be considered preliminary until a study including additional arrow point data from the Jemez Mountains and from the Grants Ridge can be conducted.

Later Trends in Projectile Point Morphology at Chaco Canyon

Based on Lekson’s (1997) analysis of the projectile points from the Chaco Project, the predominant form shifted through time. As stated earlier, stemmed points were the most prominent in Basketmaker III and early Pueblo I times, with corner-notched points becoming prominent in late Pueblo I, and side-notched points during early
Pueblo II. This pattern was also observed by Kearns and Silcock (1999) in the southern Chuska Valley, and Railey and Erhardt (2009) in southern Colorado. The shift from corner-notched points to side-notched points is noteworthy because it suggests a technological shift in point hafting techniques (Beck 1995:203). Lekson suggests that the changes in point types at Chaco Canyon “may be evidence of gradual, internal development in Anasazi point styles” (1997:665).

Conclusion

Evidence of dart technology at Chaco Canyon during Basketmaker III is relatively minimal. A total of three dart points were recovered from well-provenience, Basketmaker III contexts, suggesting scavenging earlier points for reuse. This was observed in surface contexts at Chaco Canyon (Hayes 1981), and in the Chuska Valley (Kearns and Silcock 1999, Vierra et al. 2014) where dart points were mainly found in ritual contexts, calling into question their functional use.

The data presented by the dart-arrow index suggests that despite the presence of dart points in Basketmaker III contexts, there is limited evidence to support a continuation of atlatl use in Chaco Canyon at that time. If bow technology was directly introduced into Chaco Canyon while atlatl technology was still in use there would be evidence of 1) transitional points that would be difficult to identify as either dart or arrow points (Hildebrandt and King 2002, Railey and Erhardt 2009) and 2) experimentation that resulted in high levels of variability in the arrow points (Lyman et al. 2008). Such indicators would be reflected in the projectile points as either small dart points or large arrow points.
The manufacture of arrow points based on the morphology of dart points has been observed during times of experimentation with bow technology after its adoption (Eerkins and Lipo 2007, Lyman et al. 2008). According to Railey and Erhardt, “there is little overall change in shape between the latest dart points and the earliest arrow points, as the latter appear to be simply smaller versions of the typical notched/expanded stem Basketmaker II points...[with] some overlap in key metric measurements used to distinguish between dart and arrow points.” (2009:168)

Based on the wide separation of arrow and dart points according to the dart-arrow index (Figure 5.2), it can be suggested that bow technology was well established by early Basketmaker III at Chaco Canyon. With no evidence showing a transition between atlatl and bow technology it seems probable that the initial adoption of bow technology occurred outside the canyon with the occupants bringing with them bow technology upon settlement at Chaco. Considering the different point forms observed, this may reflect the area of origination of the settling occupants. It is plausible that some variability within the projectile point assemblages may have resulted from occupants bringing into the canyon their own learned method or experimentation with arrow styles as reflected in point length, width, and NOI. Most of the point forms from Chaco Canyon are common forms observed across northwest New Mexico, eastern Arizona, and the southern Colorado areas, suggesting a dynamic landscape of people communicating and transmitting ideas.

According to the data, differing levels of variability characterize the projectile points from sites 299, 423, 519, and 1659 at Chaco Canyon. Stemmed points were the preferred point type at Chaco Canyon during Basketmaker III with some corner-notched points. The overall statistical trend of limited variation in thickness and neck width did
not change between the lumped point forms, such as stemmed and corner-notched, and more defined forms, as seen with the Kearns and Silcock (1999) typology.

The material of the arrow points provided crucial information regarding trade and contacts within the greater region. The predominant use of local chalcedony, chert, and silicified woods suggests a localized exploitation of material. The use of obsidian from Grants Ridge and Jemez is evidence of trade connections and ties with those regions, but the small quantities of Narbona Pass chert from Basketmaker III contexts suggests limited connections with the Chuska valley and mountain groups. This is in contrast to later time periods as Narbona Pass chert becomes the preferred material type for formal tools at Chaco Canyon, including arrow points (Cameron 2001).

Copying errors and experimentation throughout the region, outside of Chaco Canyon, created different forms within the arrow points in such that variability was possibly transferred to Chaco Canyon during population influxes beginning in Basketmaker III. As a common Chacoan identity formed among the occupants of the canyon, point morphology would have changed over time to reflect that newly established tradition that led to different point forms (Lekson 1997:665). This common point tradition would have led to a winnowing of point variability in morphology as certain traits were selected out (Lyman et al. 2008). While it is beyond the scope of this thesis to apply cultural transmission theory to later changes in point morphology, a future study could potentially examine variability and morphological changes in projectile points over time at Chaco Canyon.
Chapter 7: Conclusion

The point of this thesis has been to understand how the technological shift from the atlatl to the bow occurred at Chaco Canyon, New Mexico. Through an examination of the literature it became apparent that atlatl technology co-existed with bow technology well past AD 500 in some areas of the Southwest (Roth et al. 2011, VanPool 2006) and that the use of both technologies may have provided a distinctive advantage in hunting practice (Tomka 2012). Considering that the earliest settlement sites at Chaco Canyon dated to early Basketmaker III (AD 450 or 500), when bow technology was becoming widely adopted, I hypothesized that evidence of the transition from the atlatl would be observable. Evidence of such a technological change would have been noted through the presence of dart and arrow points with overlapping attributes found at Basketmaker III sites.

This study used the theory of cultural transmission to explain how bow technology would have been introduced into Chaco Canyon. This theory explained morphologic and metric variability observed within arrow point assemblages, after the introduction of bow technology through guided variation and indirect bias.

Through the use of the dart-arrow index, developed by Hildebrandt and King (2012), it became apparent that the technological transition from the atlatl to the bow did not occur at Chaco Canyon. No evidence of transitional projectile points were observed with arrow and dart points congregated into distinct and separate clusters in the dart-arrow index (Figure 5.2).

The results of this study suggest that bow technology was introduced into Chaco Canyon after the transition between atlatl and bow occurred for the initial settling groups.
It is difficult to determine if the initial group or groups obtained bow technology through guided variation or indirect bias because of the small sample size and lack of transitional evidence from dart to arrow. However, it can be stated that the arrow forms observed at Chaco Canyon are common throughout the region, with greatest similarities to the arrow forms from the Chuska Valley.

One potential explanation for why the Ancestral Puebloans at Chaco Canyon did not curate atlatl technology with bow technology, despite this occurring in different areas across the Southwest, are hunting strategies and preferences in a primarily agricultural society. Faunal studies from Basketmaker III sites at Chaco show a high preference for garden hunting (Mathien 2005, Watson 2011). The need for large game packages would have decreased as a reliance on agriculture increased, with garden hunting used as a supplement. With a decreasing reliance in large game hunting, atlatl technology would have had less utility and the more accurate and lighter bow would have become preferred (Tomka 2012). This was a similar conclusion made by Roth and colleagues (2011:105-106) in the Mogollon region after the bow was introduced.

Alternatively, bow and arrow technology would have provided an advantage in defense and deterrence for violence within aggregate communities, as suggested by Bingham and colleagues’ (2013) social coercion theory. High levels of violence have been documented in the northern San Juan Basin during Basketmaker III (Chenault and Mostinger 2000) but very little evidence suggests similar events at Chaco Canyon (Wills et al. 2012:344). Bettinger (2013) suggests that the introduction of bow technology can be considered an “equalizer” (2013:118) that made individual defense more effective. Scattered wild resources around the canyon, in conjunction with a high potential for
floodplain agriculture, and the adoption of bow technology all perhaps played a role in low levels of violence during Basketmaker III (Wills et al. 2012:344) that allowed for more permanent settlements, culminating in the construction of the great houses (VanPool and O’Brien 2013).

Avenues of potential research for the future include an examination of the biface thinning flakes from 299, 423, 1659 and other Basketmaker III sites for evidence of dart manufacture, as detailed by Yohe (1992). Additionally, future research would include more comparative data, including a sample of the projectile points from Grants Ridge and the Mount Taylor area. Lastly, an investigation into the mechanics of change in point forms over time may provide additional information regarding Chaco’s role in the surrounding region, and would elucidate if it was at the epicenter of that change or was responding to external pressures from the surrounding region.
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Yohe, Robert M. II
## Appendix A: Chaco Canyon Projectile Point Catalog

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Appendix C: Chaco Canyon Projectile Point Pictures from 29SJ299, 29SJ423, 29SJ519, and 29SJ1659

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Projectile points from 29SJ423: (top row, left to right) C14229, C13962, C14232, C14553, C14198; (middle row) C13982, C14196, C141219, C14197, C14214; (bottom row) C13966, C14205, C14215, C14227.
Projectile points from 29SJ519: (top row, left to right) FS 85.6, FS 142.1, FS 443.1; (bottom row) FS 800.4, FS 959.1.
Projectile Points from 29SJ1659: (top row, left to right) C18436, C18442, C18445; (middle row) C18446, C18437, C18455; (bottom) C30588.