# A Great Hunter Needs a Great Spear: An Experimental Study of Technological Considerations that Determine the Efficacy of a Hunting Spear


**Jordan Durham, Elizabeth Hagan**

Department of Anthropology, University of Louisville, USA

UNIVERSITY OF LOUISVILLE. CENTER FOR ARCHAEOLOGY & CULTURAL HERITAGE


## Introduction

Projectile technology represents a major cultural innovation in human history. The use of projectile technology allowed prehistoric hunters to successfully acquire prey from a distance with lowered risks. Human innovation and functional necessities facilitated the use of projectile technology, but our knowledge is limited due to the likely material of the shafts creating these composite tools is wood and is perishable in the archaeological record. This research project will investigate the effects of various shaft-lengths at different ranges of distance to determine the efficacy of projectile technology, specifically the effects of shaft-length variation.

**Objectives:**

- **To assess how various shaft-length affects the efficacy of projectile technology**
- **To determine the effects of shaft-length variation upon distance**
- **To understand how shaft-length affects accuracy and total distance achieved of hand-thrown spears**

## Hypotheses

i) Shaft length will negatively affect the efficacy of hand-thrown spears. Shorter shafts will achieve less distance and produce less-successful hits.
ii) Shaft length will positively affect the efficacy of hand-thrown spears. Longer shaft-length spears will have greater distance achieved and yield more-successful hits.
iii) Shaft length has no significant effect upon distance or lethality. Each shaft of varying length will achieve, relatively, the same distance and accuracy - no matter shaft-length.
iv) Total distance achieved and accuracy of hand-thrown spears will be negatively affected by shafts length. Smaller shaft-length will achieve the least distance.

## Material and Methods

**The experiment:** First, we organized materials such as wooden shafts (1m x 1m diameter), hemp-cord, five-minute epoxy, and raw materials of dacite (igneous rock sourced from Oklahoma). We produced 10 stone points from flint-knapping replication and reworking the material. We used a Dremel to grind the shafts of the wooden spear to become suitable for hafting. Once the materials were ready to be made a composite tool, we fastened the point to the shaft and placed epoxy on the inside and wrapped the hafted-point with cordage. More emphasis was placed upon the results from the projectile technology's functionality and less on the exact material available in prehistory to be replicated.

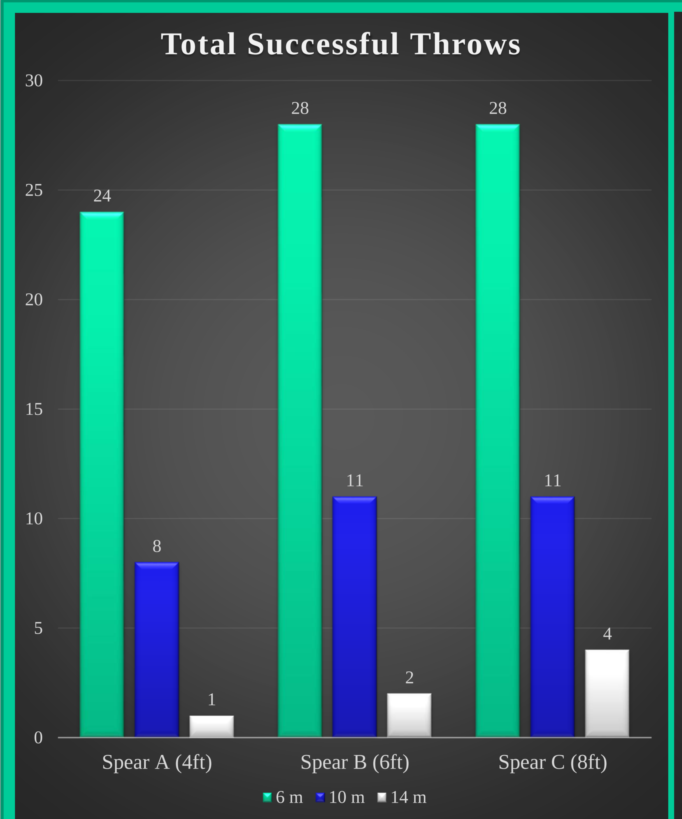
Secondly, we created a 14 x 20m grid with 2 x 2m squares that plot the distribution of participants throws from distance of 6m, 10m, and 14m from the target. Our target used was a model-deer (hunting practice equipment) that was placed on the 7m mark, the halfway point of our X-axis, and was moved after each participant completed 10 throws with the A (4ft), B (6ft), C (8ft) spears at each distance.

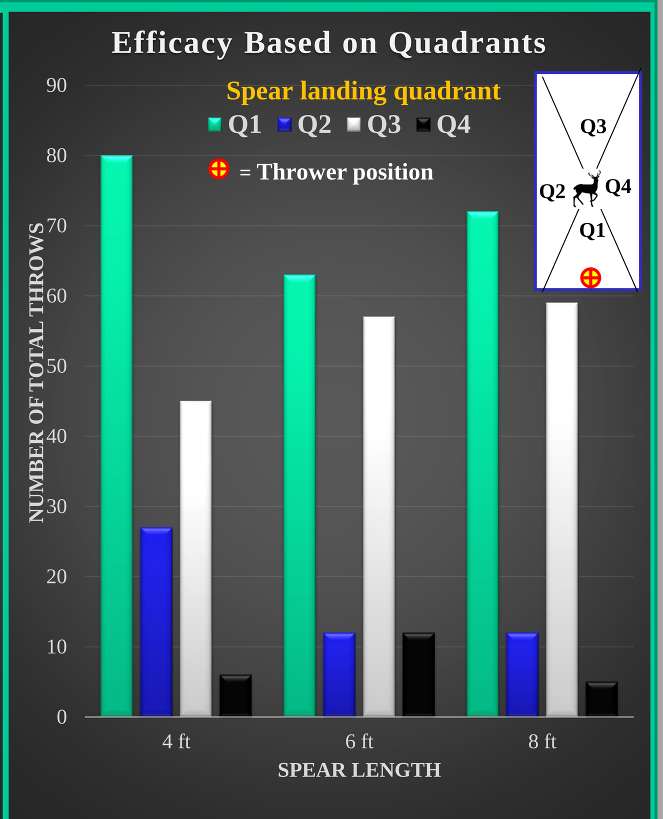
Thirdly, we recorded each participant's height, arm-length, age, sex, and frequency of exercise to understand if any unaccounted variables affected a participant's throwing accuracy, distance, and lethality. Participants threw each spear 10 times from three separate distance and this data was used to plot the distribution of missed throws on our grid to determine how accurate the missed throws of each participant were distributed. This plot of missed throws provided data to assess how accurate and effective individual's throws were with each varying spear shaft-length and distance. Variables of missed throws were recorded using X, Y, Z, intervals that represent how close the spear landed from the target. The X (>10 in. from target), Y (10 – 20 in. from target), and Z (< 20 in from target) intervals will be used to understand that even if a hunter missed their prey the spear still performed adequately in achieving the distance and accuracy needed to successfully hunt and acquire prey. Data produced from missed throws intervals will help explain external effects such as hunters' skill or past experience in physical-hunting strategies that could have affected the results, both positively and negatively.

**Data Processing:** Data was generated from each participant's 90 throws at three various distances and multiple shaft-lengths. Microsoft Excel was used to generate histograms and line plots to represent the efficacy of each spear throw at various distances. We organized the material to reflect the successful number of throws achieved as it relates to the varying shaft-length. Shaft-length and the distance achieved by missed throws will reflect the efficacy of various spears to understand how shaft-length may have a positive or negative effect upon successful throws achieved. Distance achieved by missed throws and the range they were away from the target (X, Y, and Z) will be used to understand the accuracy and effects of shaft-length variation. Understanding the accuracy of missed throws and the percentage of unsuccessful hits that still were rather accurate will help explain the relationship between different shaft-lengths and their effects upon efficacy. Organizing the material to reflect the total successful throws from each spear at each distance will display the best shaft-length to use and at what distance that would be most suited for successful hunting.

Fig. 1. Experiment Area & Technology

Fig. 2. Experimental Throws




### Sample Data

| Participant 3 | 6 (m) A | 6 (m) B | 6 (m) C | 10 (m) A | 10 (m) B | 10 (m) C | 14 (m) A | 14 (m) B | 14 (m) C |
|---|---|---|---|---|---|---|---|---|---|
| Throw 1 | Z | Hit | Hit | Hit | Hit | Hit | Z | Z | Z |
| Throw 2 | Z | Hit | Hit | Z | Z | Z | Z | Z | Z |
| Throw 3 | Y | Hit | Z | Z | Hit | X | Z | Z | Hit |
| Throw 4 | Hit | Y | Hit | Z | Hit | Z | Y | Z | Z |
| Throw 5 | Z | Z | Z | Z | Hit | Z | Z | Z | Z |
| Throw 6 | Z | Hit | Hit | Y | Z | Z | Z | Z | Z |
| Throw 7 | Z | Hit | Z | Z | Z | Z | Z | Z | Z |
| Throw 8 | Hit | Hit | Z | Z | Z | Z | Z | Z | Z |
| Throw 9 | Hit | Hit | Z | Z | Z | Y | Z | Z | Z |
| Throw 10 | Z | Z | Hit | Z | Z | Z | Z | Z | X |

| Total successful throws | A | B | C |
|---|---|---|---|
| Participant 1 | 15 | 13 | 16 |
| Participant 2 | 6 | 6 | 9 |
| Participant 3 | 4 | 11 | 7 |
| Participant 4 | 6 | 7 | 7 |
| Participant 5 | 2 | 4 | 3 |
| Total: | 33 | 41 | 42 |

Key Boxes

| Shaft Length Key |
|---|
| A = 4 (ft) |
| B = 6 (ft) |
| C = 8 (ft) |

| Participant information | Sex | Age | Height | Arm Length | Workout History |
|---|---|---|---|---|---|
| Participant 1 | M | 27 | 5'9 | 2'3 | twice a week |
| Participant 2 | M | 22 | 6'4 | 2'3 | None |
| Participant 3 | F | 30 | 5'8 | 2'2 | three times a week |
| Participant 4 | M | 23 | 6'0 | 2'5 | once a week |
| Participant 5 | F | 20 | 5'5 | 2'2 | twice a week |

| Distance from Target if Missed |
|---|
| X = Unsuccessful under 10 in. |
| Y = Unsuccessful attempt within 10 -20 in. |
| Z = Unsuccessful attempt above 20 inches |

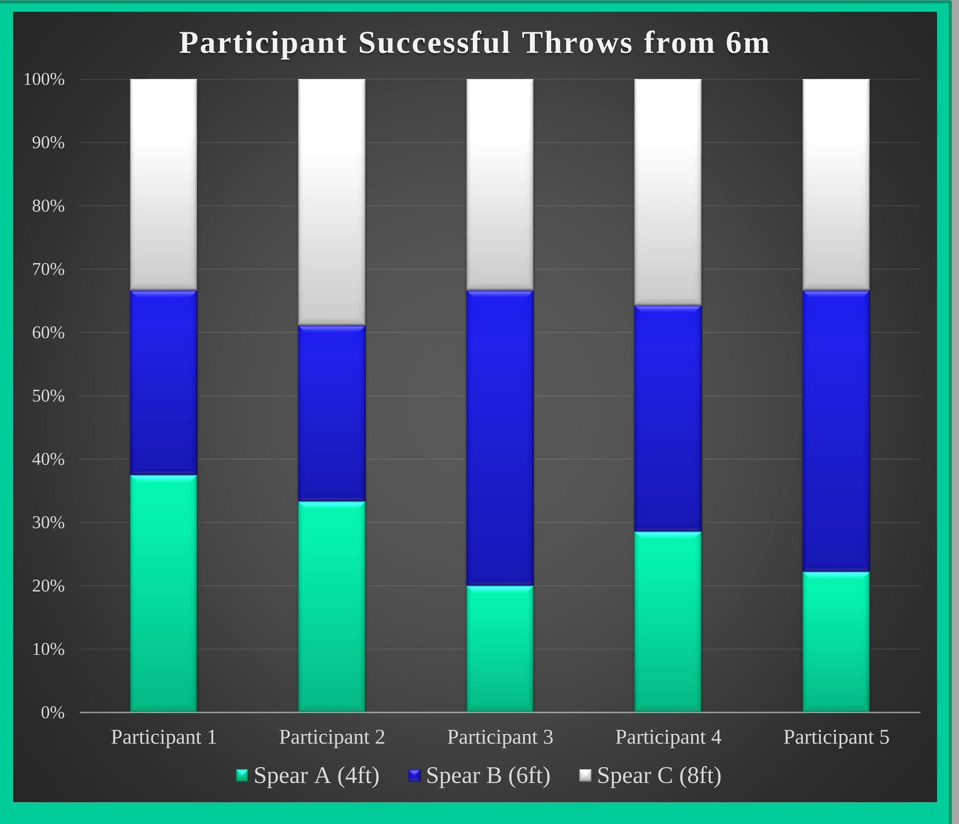
## Results

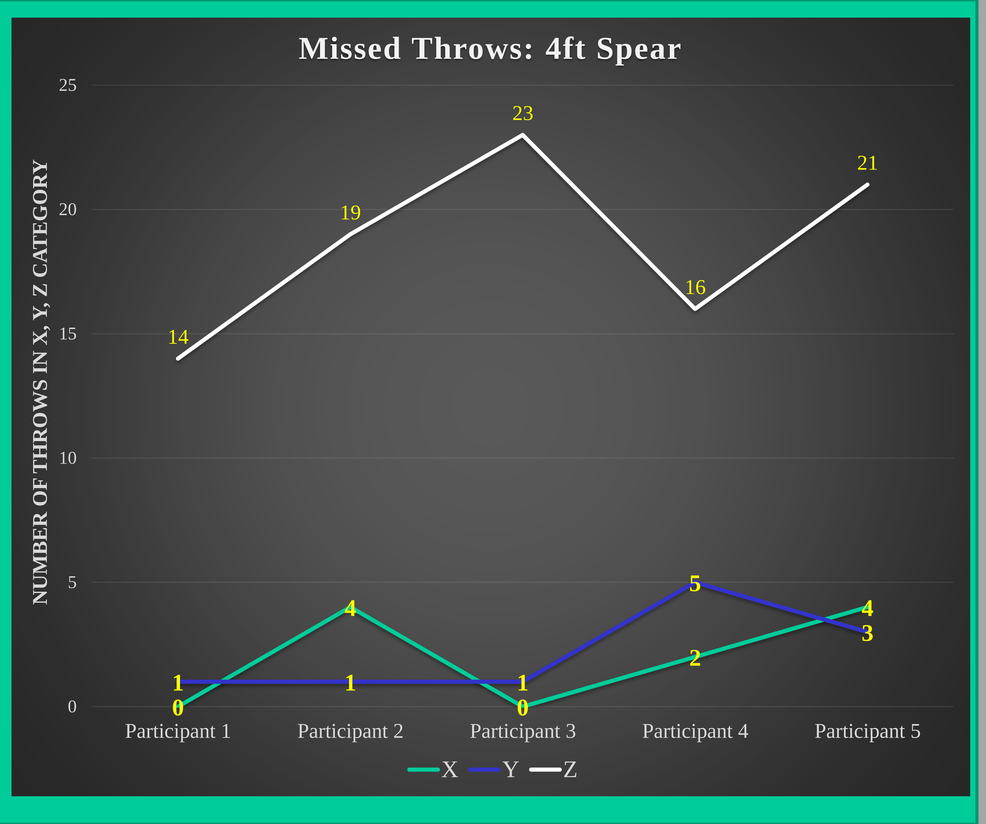
The most successful throws occurred around the 6m mark away from the model-deer across all shaft sizes. This result indicated that no matter the shaft-length, this allows hunters to have better accuracy, precision, and control the closer you are to a target. Nearly all participants achieved throws from 10 m, except participant 5, which displayed how the B & C spear were performing at higher efficacy rates – especially in terms of successful hits. At 14 m, only two participants achieved successful throws with any spear – mainly representative of B & C spears. Evidence from successfully achieved throws as related to shaft-length suggested the B & C spear may perform better as distance increases, while the A spear lacked the precision to achieve greater than 6m hunting distances.

The most successful distance achieved by a hand-thrown spear came from the B spear at the 6m range. Spear B had the highest amount of percentage of throws hit as compared to their throws at the same distance, only being out performed by the C spear at 14m. (suggesting the thrower-height and shaft-size of a hunter may affect efficacy) At 6m and 10m, participants 3 -5 achieved the highest or equal amount of successful throws with 20 % being the lowest. While at the 14m range only the C spear performed successful hits with the highest percentage of any participants being 30 %.

Comparing the number of unsuccessful throws of various shaft-lengths, this data resulted in the participants usually achieving a Z (<20 in from the target), which indicates the probable outcome of someone hit or miss by a larger margin, potentially due to the amount of force required to achieve certain distances. The B and C spears performed the highest from all participants by receiving the most accurate and successful throws – tying at the 6m mark. The only variable between the B and C spear came from Participant 1 with 30 % success rate at the 14m mark, while only one other participant achieved a single successful throw at 14m.

While the results from the majority of missed throws achieved a Z, the patterns from the later participants show increase in X and Y values. However, these accurate throws and representatives of X and Y's on the chart being achieved from a closer range of 6m could impact the efficacy results of the A & B spear and not reflect shaft-length effects, but distance thrown. Although some participants had lower successful hit-ratios, the ability to achieve a short distance from the deer, represented as an X or Y, indicates the spears' effectiveness at hitting the target and overall efficacy in hunting activities.




## Conclusions and Implications of the study

Our results indicate that the efficacy of the B & C spears was relatively the same and performed higher than the A spear at all distances. Conclusions drawn from these results prove that an effective hunting spear is relative to your body height and/or slightly larger than your body height, up to 2 feet. The total number of successful throws revealed that any spear with varying shaft length from 6m will produce higher successful-hit results. The successful throws of the B (6 ft) & C (8 ft) spears indicate the similar effects of shaft lengths equal to or larger than the participant's height performing most-efficiently. If a hunter was hunting at a longer distance range, then a spear of equal or larger body-size would produce the most successful throws. Shaft-lengths larger than the thrower's height by up to two feet provide larger total distance achieved, but any larger could negatively impact accuracy and effectiveness. Shaft length shorter than the participant, Spear A (4ft), would reduce the accuracy and produce less-desirable results as compared to other shaft-lengths of spears. Results from certain participants could reflect the physical dexterity of the individuals and could have produced lower or higher number of successful throws. Participants distribution of unsuccessful throws indicates the higher accuracy levels of spears B & C and reveal how the overall efficacy of the spears was higher. When spears are thrown the most probable scenario is to hit the target or miss by over 20 inches (Z). These results could explain how multiple individualized factors beyond objective qualities of spear throwers could affect the total successful throw results. Quadrant analysis from the experiment revealed that the spear's shaft-length had minimal impact on the accuracy of the throws - due to the high prevalence of Q1 and Q3 (in-front and directly behind the deer) producing impact results. Throwers are most-probable to throw the spear in the flight path of the intended direction and individuals own competence and accuracy skills could affect the successful hit-ratios. In conclusion, shaft-length does affect the efficacy of projectile technology from various ranges. Overall, this experiment can contribute to the broader debate around projectile technology and provide further insight in the preferable shaft-length of composite tools (that is harder to understand due to the absence in the archaeological record) as equivalent to or larger than the thrower's height.


## Acknowledgements

Thanks to all the Anthropology Undergraduate Majors and Minor and Anthropology Graduate Students who helped participate. Special thanks to Dr. Amanuel Beyin and Dr. Jonathan Haws for guidance and assistance throughout the entire project. Thanks to the University of Louisville's Center for Archaeological and Cultural Heritage.


## References cited


Ascher, Robert. 1961. Experimental Archeology. *American Anthropologist*, New Series, Vol. 63, No. 4, 793 – 816.
Milks, Annemieke. 2019. External Ballistics of Pleistocene hand-thrown spears: Experimental performance data and implications for human evolution. *Springer Nature*. www.nature.com/scientific reports
Shea, John J. 2006. The origins of lithic projectile point technology: evidence from Africa, Levant, and Europe. *Journal of Archaeological Science*, 33, 823 – 846.
Pargeter, Justin. 2007. Howiesons Poort Segments as Hunting Weapons: Experiments with Replicated Projectiles. *The South African Archaeological Bulletin*, Vol. 62, No. 186, 147 – 153.