PHYSICS NEVER LIES

Quad X Fletching Performance Analysis – Part 1: Rotational Behavior Study.

By Eric Newman

Introduction

This paper analyzes the Quad X fletching by Flex Fletch in a 4-fletch right configuration.

This study (**Part 1**) evaluates the rotational behavior of different fletching configurations. Future parts of this research will expand on these findings:

The tested fletching was installed on Black Eagle Carnivore. It examined fletching angles of 1°, 3°, and 5° applied using a Vane Master Pro fletching jig. The tested arrows exhibited a natural left rotation. The fletching's tested were installed with a right helical offset.

Arrow Build

- **Shaft:** Black Eagle Carnivore 350/.003[1] (26.5" carbon to carbon)
- **Nock:** Black Eagle factory nock
- **Insert:** Ethics 25/50 aluminum insert[2]
- **Point:** Ethics 100gr bullet point
- **Vanes:** Flex Fletch QUAD X vanes[3]
- **Vane Master Pro:** fletching jig[4]
- **Measurement from the pocket of the nock to back of fletching.** 1.125"
- **Forward Of Center (F.O.C.)** 16.5%

---

[1] Carnivore Arrows - The best Lightweight shaft in the World
[2] Ethics Archery: Innovative American-Made Archery Components
[3] Flex-Fletch Products, Inc.
[4] Last Chance Archery, LLC

Arrow Data

- **Total Arrow Weight:** 380.5gr ± 0.9gr
- **Total Velocity at launch:** 285.3 fps ± 0.5fps
- **Helical offset tested spin indexer:** 1° tested 1°
- **Helical offset tested spin indexer:** 3° tested 3°
- **Helical offset tested spin indexer:** 5° tested 4.75°

Clocking Arrows Explanation

Clocking arrows refers to determining the natural rotational direction of an arrow as it leaves the bowstring. This process involves shooting an unfletched arrow into a target at a short distance and observing the direction in which it rotates.

Note on Right Helical Offset

I chose to test the right helical offset because most archers build arrows with this offset. This aligns the study with standard archery practices and provides results most applicable to general arrow tuning and performance.

Indexer 5C Explanation

A **single spindle 5C spin indexer** is a precision tool commonly used in machining and indexing applications. It allows for accurate rotation and positioning of cylindrical objects at fixed angular increments. In fletching applications, an indexer such as the 5C enables precise and repeatable settings for helical offsets, ensuring consistent vane placement and spin rate for arrows.

Test Methodology

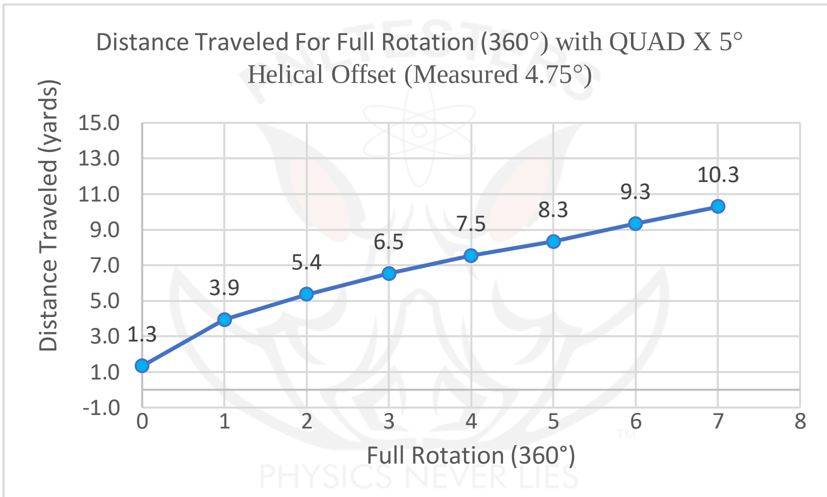
Data was collected by shooting an arrow starting from a position 36 inches from the target. Then, the shooting position was progressively moved back while measuring the distance (in inches) until the arrow returned to zero. Then, continual backing from zero point and the distance to reach a full 360-degree rotation were measured. The procedure was as follows:

1. Identify the arrow's zero point.
2. Measure the distance from the launch position to the first full rotation (360 degrees).
3. Continue backing up and record the distances at each subsequent full rotation.
4. Compare results across different fletching angles to analyze performance differences.
5. Convert measurements from inches to yards.
6. The maximum number of rotations examined in this test was 7.
7. All distance measurements are subject to a ±2-inch margin of error to account for minor testing inconsistencies.

Test Results

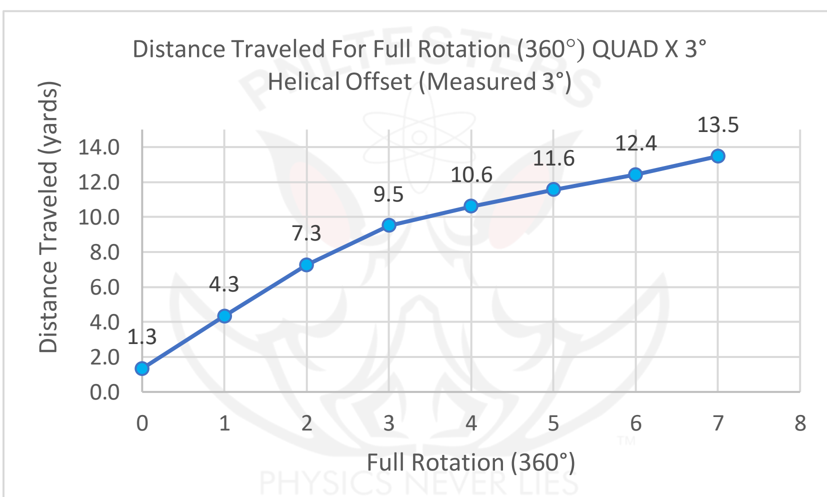
Quad X 5° 4-Fletch Right (Clocked Left, Measured with an Index Circular Degree: 4.75°)

Quad X 5° 4-fletch right (measured 4.75°)								
Full Rotation (360°)	0	1	2	3	4	5	6	7
Distance Traveled (Yards)	1.3	3.9	5.4	6.5	7.5	8.3	9.3	10.3



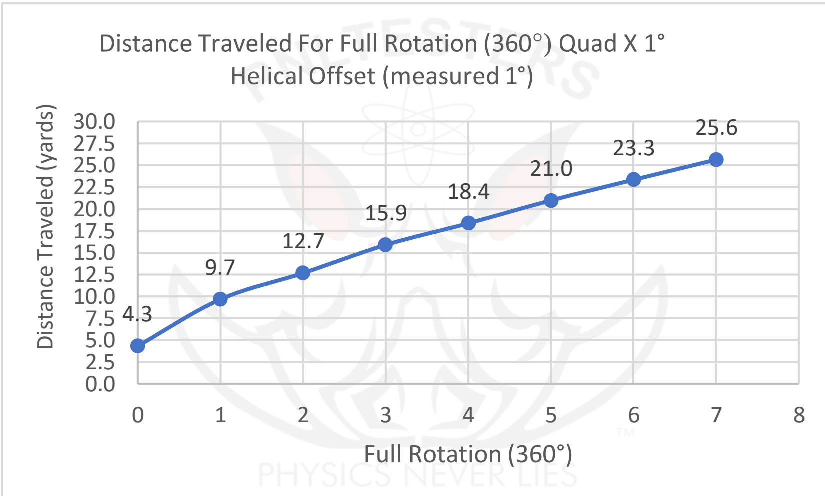
Quad X 3° 4-Fletch Right (Clocked Left, Measured with an Index Circular Degree: 3°)

Quad X 3° 4-fletch right (Measured 3°)								
Full Rotation (360°)	0	1	2	3	4	5	6	7
Distance Traveled (Yards)	1.3	4.3	7.3	9.5	10.6	11.6	12.4	13.5



Quad X 1° 4-Fletch Right (Clocked Left, Measured with an Index Circular Degree: 1°)

Quad X 1° 4-fletch right (measured 1°)								
Full Rotation (360°)	0	1	2	3	4	5	6	7
Distance Traveled (Yards)	4.3	9.7	12.7	15.9	18.4	21.0	23.3	25.6



Analysis and Observations

By comparing the three fletching angles, it is evident that the 5° fletch induces a significantly higher rotation rate than the 3° and the 1° configuration.

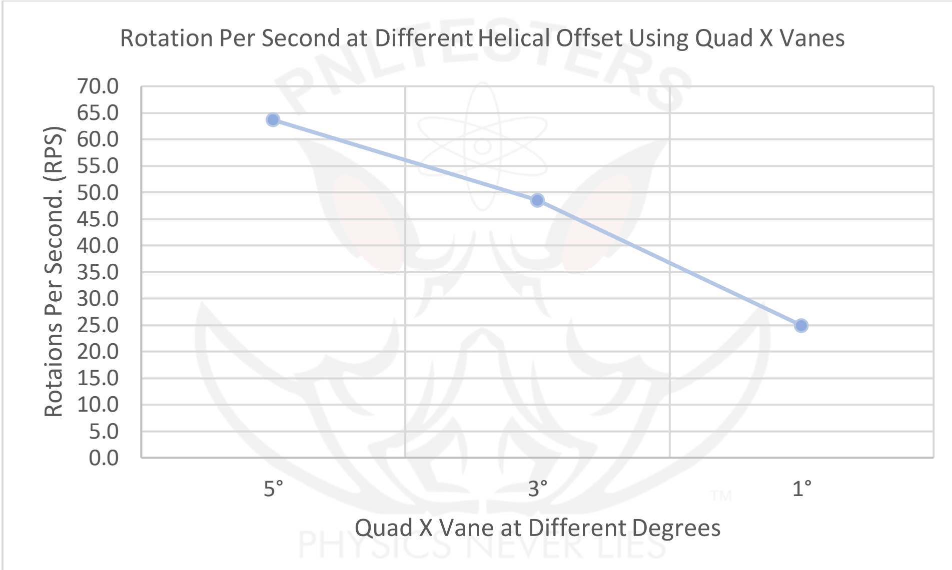
To quantify this effect, we calculated the actual spin rate of the arrows in **rotations per second (RPS)** and **rotations per minute (RPM)**. The results show that increasing fletching offset significantly increases rotational speed, with the 5° offset producing the highest rotation.

Note: While this study demonstrates a clear correlation between fletching offset and spin rate, it is important to note that arrow mass and moment of inertia also may influence rotational behavior.

Spin Rate Analysis

To quantify this effect, we calculated the actual spin rate of the arrows in **rotations per second (RPS)** and **rotations per minute (RPM)**. The results show that increasing fletching offset significantly increases rotational speed:

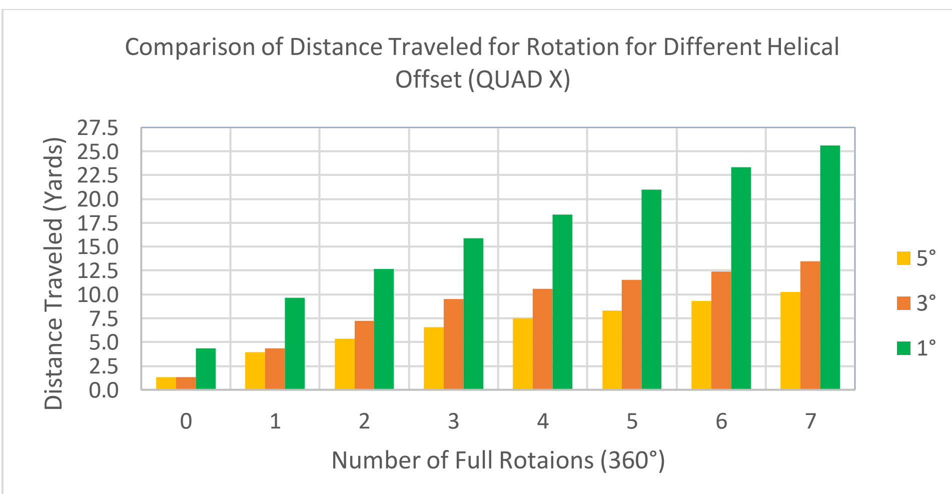
Fletching Offset	Distance for 7 Rotations (yards)	Velocity at listed yards	rotations per yards	RPS	RPM
5°	10.3	281	0.680	63.7	3819.4
3°	13.5	280.8	0.519	48.5	2912.0
1°	25.6	273.5	0.273	24.9	1495.7

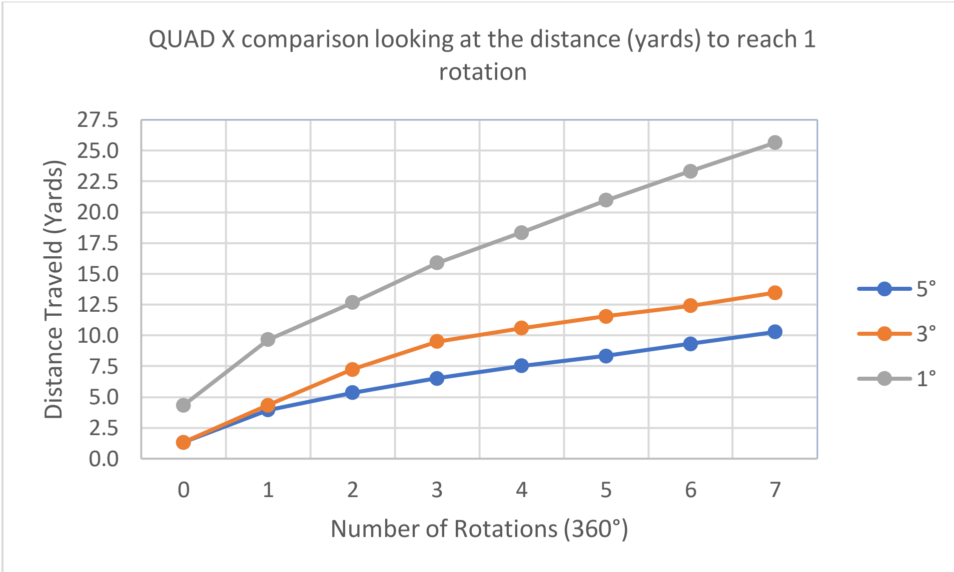


These results indicate a direct correlation between fletching angle and spin rate, with the 5° configuration producing the highest rotation, followed by the 3° and 1°. The increased spin rate could play a significant role in stabilization and aerodynamic efficiency, which will be explored in future research sections.

Comparison of the QUAD X in the 5°, 3°, and 1° Helical Offset.

The data indicates a clear relationship between fletching offset angle and rotational speed, where higher angles induce faster rotation over shorter distances. The 5° configuration reaches complete rotations in the least distance, followed by the 3°, with the 1° requiring the longest distance to complete each full rotation.





Future Research Directions

This study confirms that increasing fletching offset angles enhances an arrow's rotational rate. However, additional research is necessary to understand the full performance implications of these rotational differences.

Part 2 – Stabilization Analysis (Revision 1-February 13, 2025)

The next phase of this research will explore whether a faster-rotating arrow corrects from bad flight more quickly. By analyzing arrow deviation patterns at 5 and 15 yards, this study will determine if higher spin rates help reduce misalignment in flight. If confirmed, this could reinforce the benefits of higher offset angles for archers seeking faster stabilization, particularly in long-range shooting and windy conditions

Part 3 – Velocity Loss Over Distance and Spin Rate

Beyond stability, an important consideration is how increased rotation affects **velocity retention over distance**. A higher spin rate may introduce additional drag, potentially slowing the arrow down at longer ranges. Part 3 will compare velocity retention across different fletching angles, measuring whether increased spin rate causes greater energy loss or whether its aerodynamic benefits offset additional resistance. Understanding this trade-off will help archers balance rotational speed with downrange energy efficiency.

Part 4 – Helical Angle Effect on Accuracy

The final phase of this research will assess how different helical angles influence overall **arrow accuracy**. While a higher helical offset increases spin, its effect on grouping size and shot consistency remains unclear. By measuring dispersion patterns across varying distances, this study will determine whether a specific fletching offset provides a measurable advantage in precision. The findings will offer data-driven insights to help archers optimize their setups for target shooting and hunting applications.

Conclusion

This multi-part study aims to comprehensively understand how fletching offset angles impact rotational characteristics, stabilization, velocity retention, and accuracy. The results of Part 1 establish a clear relationship between fletching angle and spin rate. The subsequent phases will further investigate whether increased spin enhances performance or introduces trade-offs that archers must consider when fine-tuning their arrow setups.

Future studies may further examine how arrow mass interacts with fletching offset to influence rotational performance, as moment of inertia also plays a role in spin-up time and steady-state roll rate.