Quad X Fletching Performance Analysis – Part 3: Velocity loss Study.

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Abstract

This study examines the impact of varying helical offsets on a 4-fletch vane configuration based on arrow velocity loss. Arrows were fletched with 1°, 3°, and 5° helical offsets to assess their influence on velocity loss over 60 yards. Additionally, this study evaluates how helical offset affects arrow rotation (RPS) and whether increased spin introduces meaningful drag. Findings provide practical insights for archers seeking optimal performance with minimal velocity penalties. Results apply to small parabolic vanes similar to the Flex Fletch Quad X, though further testing is needed for broader vane types.

Introduction

Fletching plays a critical role in arrow stabilization, influencing accuracy and consistency. Helical offset determines the spin imparted to an arrow, potentially affecting velocity and stabilization. Traditional assumptions suggest that higher helical angles result in greater velocity loss due to increased drag. However, this study aims to evaluate these claims specifically for **small-profile parabolic vanes**, using the Flex Fletch Quad X as the test model. The primary goal is to determine whether helical offset meaningfully impacts velocity loss and whether the induced arrow spin (RPS) introduces additional drag. This will provide insights into fletching setup optimization.

Methodology

Arrow Build and Setup

- **Shaft:** Black Eagle Carnivore 350/.003 (26.5” carbon to carbon)
- **Nock:** Black Eagle factory nock
- **Insert:** Ethics 25/50 aluminum insert (50gr)
- **Point:** Ethics 100gr bullet point
- **Vanes:** Flex Fletch QUAD X vanes
- F**letching Tool:** Vane Master Pro
- **Total Arrow Weight:** 380.5gr ± 0.9gr
- **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°.
- **Measurement from the pocket of the nock to back of fletching.** 1.125”
- **Forward Of Center (F.O.C.)** 16.5%

Measurement Tools

- **Velocity:** LabRadar Doppler chronograph.
- **Rotation Tracking:** Distance-based rotation calculations from observed data

Environmental Conditions

- **Air Temperature:** 72°F
- **Humidity:** 16%
- **Air Density:** 1.19549 kg/m^3
- **Air Pressure:** 29.98 inHG
- **Wind:** 15 mph (direction: 289° W)
- **Altitude:** 2900 feet
- **Shot Direction:** 139° SE

While environmental variables like wind and air density were noted, their impacts on flight dynamics should be further explored. Crosswinds, in particular, could influence arrow spin and trajectory, offering added insights into real-world performance.

Procedure

Arrows were evaluated over distances up to 60 yards, with velocity recorded at regular intervals. Additionally, rotational speed (RPS) was calculated by tracking the distance per full rotation from observed data.

Rotation Per Second (RPS) Explanation*:* Rotation Per Second (RPS) refers to the number of full rotations an arrow completes in one second of flight. It is influenced by fletching helical offset and directly impacts arrow stabilization. Higher RPS can contribute to increased stability.

The following table and chart compare the RPS for different helical offsets over distance. The following table and chart compare the RPS for different helical offsets over distance.

Results

The average velocity loss data is based on the Quad X 4-fletch vane with a five-shot sequence per degree of helical. The data is shown in Table 1 and Figure 1.

Table 1: Flex Fletch Quad X Helical Offset Velocity Loss Comparison

Table 1	Flex Fletch QUAD X different degree test comparison						Total fps lost in 60 yards	Percent lost in 60 yards
yards	V0	V20	V30	V40	V50	V60		
1°	286.2	277.2	272.8	268.8	264.2	260.0	26.2	-9.15%
3°	287.0	278.0	273.4	268.8	264.4	260.0	27.0	-9.41%
5°	286.0	276.6	272.0	267.6	263.4	259.0	27.0	-9.44%

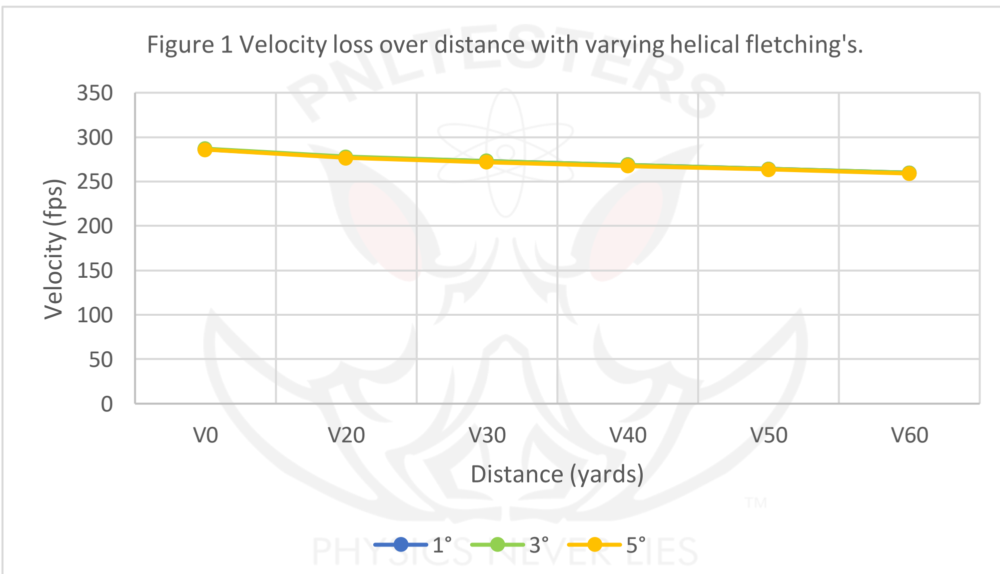
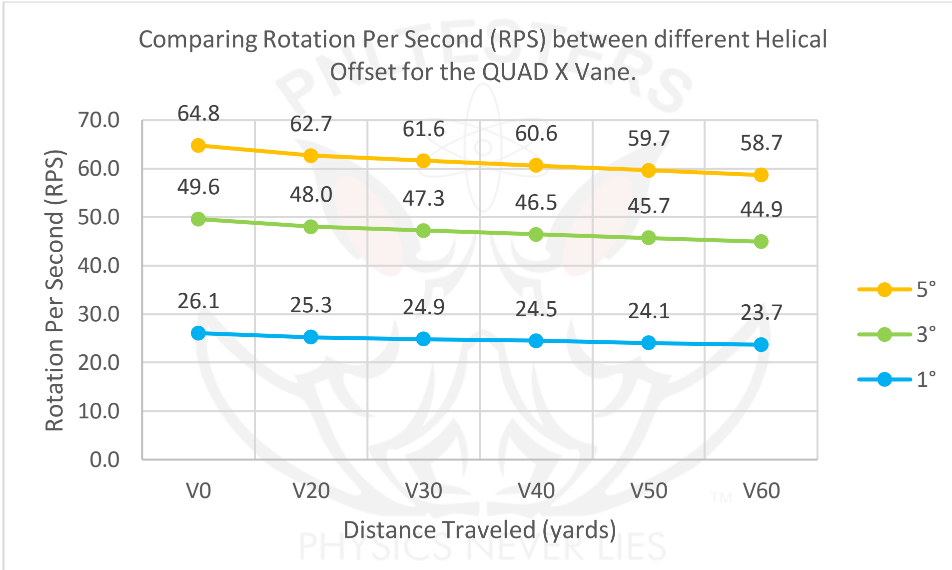
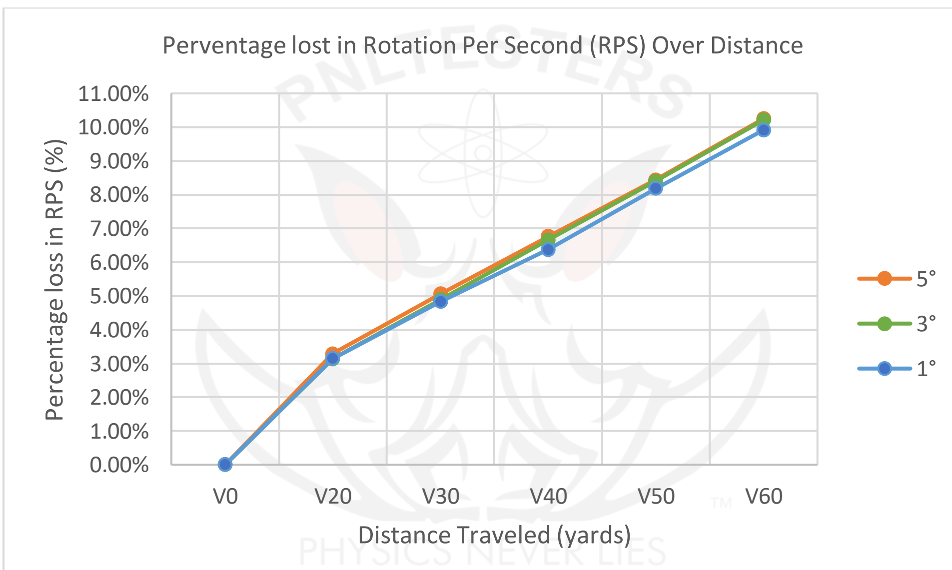


Table 2: Rotation Per Second (RPS) at Different Distances



Percentage Loss in RPS over the distance traveled.



Discussion

Key Findings

- Minimal differences in velocity loss across helical offsets suggest that helical offset alone does not significantly change drag within the tested conditions.
- The RPS data shows a significant difference in initial spin between the different helical offsets. However, despite this increase in spin rate, the velocity loss over 60 yards remained nearly identical across all offsets.

- The percentage loss in RPS follows a nearly identical trend across all offsets, further confirming that higher spin does not introduce significant additional drag.

Implications

- Archers prioritizing stability can use higher helical angles **without significant speed penalties** when using small parabolic vanes.
- The assumption that **higher spin increases drag-related velocity loss is not supported by this data**.
- This data suggests that helical offset can be used for **enhanced stabilization without worrying about a reduction in speed**.

Limitations

- Results are specific to the tested vane design (Quad X) and may not apply to all vane shapes or materials.
- Environmental conditions and distances beyond 60 yards were not evaluated, which may affect generalizability.
- A larger sample size could further confirm statistical consistency.
- The 15 mph wind may have influenced results, though its effect on helical offset was not directly measured.

Part 4 – Helical Angle Effect on Accuracy

The next phase of this research will assess how different helical offsets influence accuracy. By measuring dispersion patterns at varying distances, this study will determine whether a specific helical offset provides a measurable accuracy advantage.

Background Reading

- University of Colorado Boulder, *Drag and Vanes in Archery Hunting*, Senior Design Project, March 25, 2024.
- University of Colorado Boulder, *Restoring Torque and Stability in Arrows*, Senior Design Project, March 25, 2024.
- University of Colorado Boulder, *Vane Height and Its Effects on Performance*, Senior Design Project, March 25, 2024.
- **Dr. James Park.** *Arrows: How to Minimise Drag and Maximise Lift. Bow International*, January 27, 2023. https://www.bow-international.com/features/arrows-how-to-minimise-drag-and-maximise-lift/.

Conclusion

This study shows that **small-profile parabolic vanes, such as the Flex Fletch Quad X, do not suffer significant velocity penalties at higher helical offsets**. Additionally, while higher helical offsets increase arrow spin rate significantly, this does not translate into meaningful added velocity loss. Future research should explore different vane designs, longer distances, and varied environmental conditions to validate these findings.