Optimized Arrow Vane for Broadhead Archery

IRON WILL

Mechanical Engineering
UNIVERSITY OF COLORADO **BOULDER**

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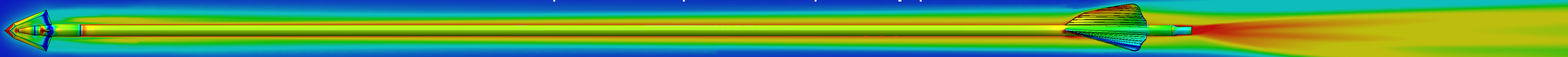
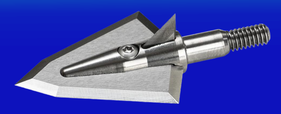


Background/Motivation

- Designed an arrow vane which maximizes stability yet minimizes drag and sound for use with a broadhead point
- Benchmark testing of commercially available vanes and CFD modeling provided insight of flight characteristics
- Prototypes designed based on testing results and optimized for best performance



Iron Will Broadhead **(BH)** ✖

Iron Will Field Point **(FP)** ●

A-G - commercial vanes (dashed lines)
Proto (1-4) – prototype vane profile (solid lines) tested with various materials

Prototyping

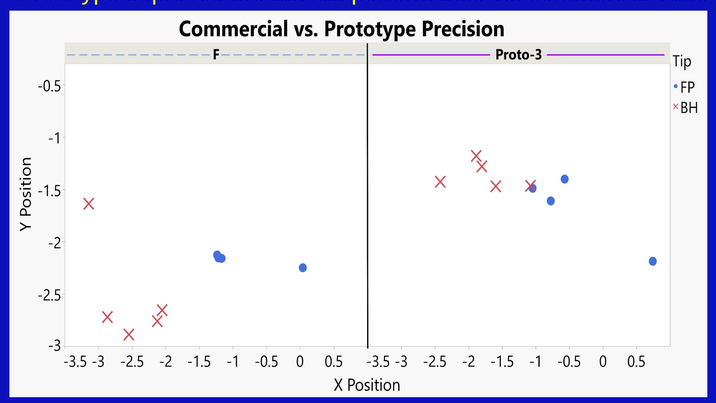
- Prototype vanes were cut from extruded vane ribbon material
- Laser cutting provided best dimensional accuracy and leading-edge surface finish
- Same profile cut on various ribbon types to determine material effects on flight performance

Testing Results

Accuracy

- Shooting machine fired arrows at a target from 40 yards away
- Laser sight and spotting scope ensured consistent targeting
- Measured the deviation from horizontal and vertical axes

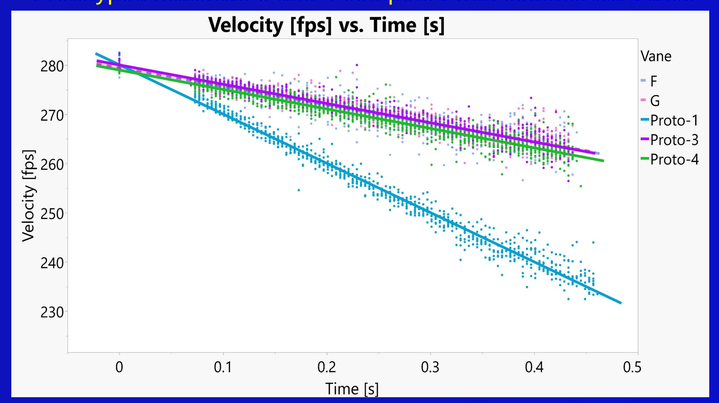
Prototype improved broadhead performance vs. commercial vane



Drag/Velocity Data

- Velocity measured with LabRadar chronograph
- Deceleration calculated using linear regression of velocity points
- Drag force also calculated to account for differing vane masses

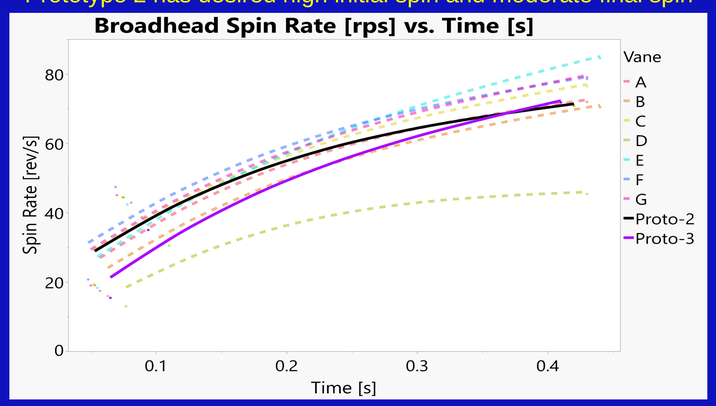
Prototyped materials 3 and 4 competed with commercial vanes



Spin-Up Rates

- Arrow spin balances out asymmetries in flight
- Recorded in 1280 x 720 resolution at 1200 frames per second
- Used High Speed Camera to determine spin rate at 3 points
  - 1st revolution
  - 2nd revolution
  - Final revolution

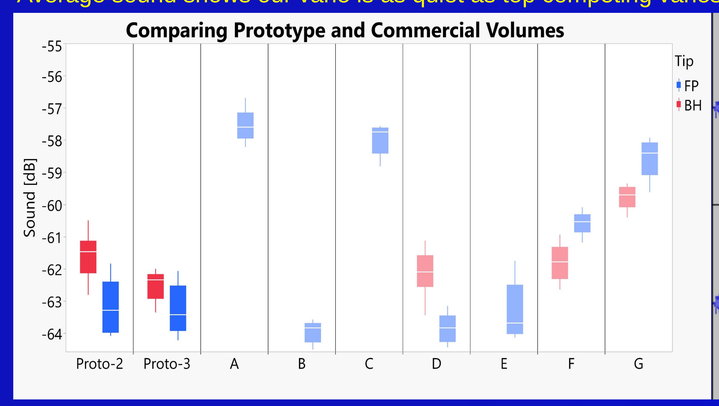
Prototype 2 has desired high initial spin and moderate final spin

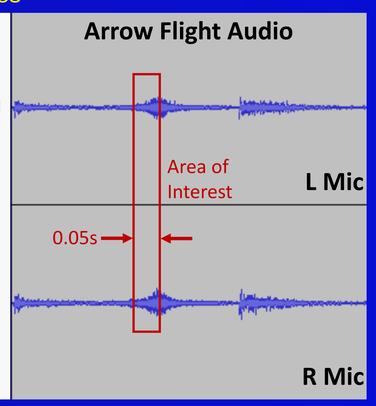


Sound Data

- 0.05s audio sample collected using a Zoom H6 2020 audio recorder, ending at audio peak
- Audio sample undergoes a Fourier Transform to reveal frequencies and their amplitude
- Average amplitude of frequencies in a deer's most sensitive hearing range (4-8kHz) were compared between vanes

Average sound shows our vane is as quiet as top competing vanes





Computational Fluid Dynamic Modeling

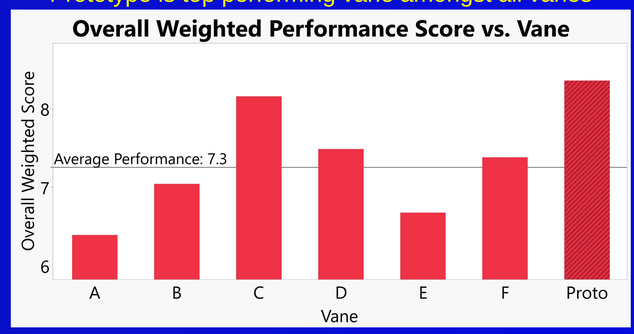
Motivation

- CFD modeling utilized extensively to predict vane performance
- Allowed quick and accurate vane design testing prior to time-consuming manufacturing and experimental testing

Method

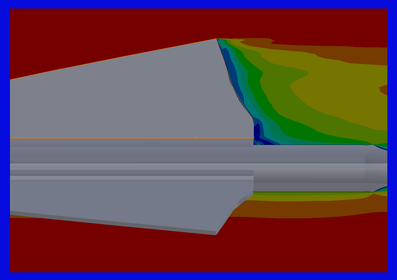
- Simulations included straight and offset fletched:
  - Restoring torque
  - Drag force
  - Spin-up rate
  - Acoustic power level
  - Max spin rate
  - Wind drift
- Simulations used for relative comparisons between vanes
- 3 CFD software packages employed
- 1200+ CPU hours of simulations ran

Prototype is top performing vane amongst all vanes

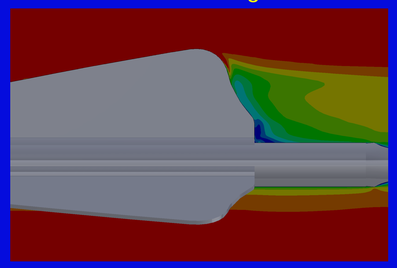


*Spin-up and max spin sims omitted from overall weighted performance score calculation due to results concerns

Sharp corners detach air quickly



Rounded corners allow air to stay attached longer



Project Challenges

- Access and availability of a controlled testing environment
- Consistency and repeatability of shooting machine
- Limited shots per testing session

Future Improvements

- Construct consistent and repeatable shooting machine
- Test for wind drift, stability and at further distances
- Obtain a controlled environment and wind tunnel

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