RISE Grant Proposal Essay

STUDENT NAME GRAD YEAR (redacted)

Modeling of Arrow Flight on How Front of Center, Weight Bias, and Spin Affect Arrow Drag

Senior Research

Abstract

Archery is one of the oldest arts still practiced today. The evolution of archery began at the start of mankind's history, and evidence of ancient archers has been found around the world as early as 10,000 years ago. The laws of physics play a critical role in arrow flight. These laws allow an archer to make educated predictions and improvements, but most past progress has been the result of trial and error. Continued study of arrow flight is of interest, but no modeling has been documented.

In this project, I will be modeling arrow flight, not just a simple projectile motion problem with drag, but rather a complex analysis of observations and predictions on how vanes affect the drag process, vane quantity as well as surface area and contact points with the air.

Introduction

My proposed research is modeling arrow flight, not just a simple projectile motion problem with drag, but rather a complex analysis of observations and predictions on how vanes play in the drag process. The vane quantity, size and degree as well as surface area and contact points with the air affect the arrow's drag and acceleration. Larger diameter and heavier arrows will affect the overall weight and model. I will explore the concept of FOC or "front of center" which helps adjust for the added weight bias up front leading the arrow to fall drastically at distance.

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I am an avid archer and outdoorsman. I have been practicing with several models of compound bows during the last 7 years, always having the desire to accurately shoot an arrow. As physics major, the phenomenon of the physics behind the archery has fascinated me and I have postulated theories and effects that have not been documented. I am requesting the RISE Grant for this project and for my Senior Research. If I can prove my ideas are correct, the benefit to the archery community could be substantial. I feel this new path of research is tailored to my expertise and interests and could lead to a career as a designer in the archery field. My career and professional goals are to work in the archery design field with a company such as Mathews, QAD or Tru-Ball.

Background/Studies

I plan to determine how efficiently the arrow spins and what minimizes drag and how the lift of the arrow is also affected by the spin. I plan to perform an analysis of several different diameter arrows including arrows with broadheads or heavier field points. The FOC is the most important part which will affect the drop and tilt of the arrow. I will explore the concept of FOC or "front of center" which helps adjust for the added weight bias up front leading the arrow to fall drastically at distance. Topics generally not considered is air density and how it affects drag and spin. Most of the values for the air density already published will be included in my findings.

The values below will affect the model in the vertical direction.

Arrow weight

GPI "arrow density"

Arrow Velocity

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Surface area of the fletching “preferably measure the surface area of the fletching”

Number and size of fletchings (2” control and test 2”-5”)

Helical of the fletchings (1-4 degrees)

Point weight

Type of broadhead : expandable or fixed blade

Arrow spine “stiffness”

Altitude

Draw length of Bow - brace height “distance the arrow is on the string accelerating”\

The values below will predict the compensation for wind values in the horizontal direction.

Arrow length

Total cross sectional surface area would include fletching dimensions arrow diameter,

Arrow length

Tip profile, if broadhead; select dimensions, if field point select length”

Goals

I will write a math model using Mathematica, Matlab, Java for GUI or possibly Python and adapt for 5 different bow categories (non-efficient cam, dual cam, Solo cam, target, youth). I will develop logarithms for spin and trajectory. With the given inputs from the user, it would use equations to find the distance needed to adjust the hold over on the sight. Then, when the dial is turned it would read out yardage to the 10th or 100th of a yard, depending on user preference.

Model Parameters:

- Arrow spin in relation to lift

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- Fletching orientation
- FOC (Front of Center) Compensation
- Effect of spin on acceleration
- Speed of spin

Modeling these parameters will allow me to predict the drop of an arrow at any yardage and any weather condition. This will revolutionize how archers shoot, and provide a new level of accuracy.