INTRODUCTION

Only a few scientific studies are known on the aerodynamic properties of an arrow, although they have dominant effects on down-range velocity and also on its drift in wind (Okawa, Komori, Miyazaki, Taguchi, & Sugihara, 2013).

**Objectives**
The objectives of this project are:

- To design and develop arrowheads for archery.
- To perform testing and analyse the arrow drag force by using high speed camera.

**Scopes**
- 3 types of arrowhead performance to be compared: Bullet point, 3D shaped point and cone shaped point.
- The arrowhead material is stainless steel.
- 240 fps digital camera used to capture arrow shooting.
- Arrow shaft to be use is carbon shaft of 5.46mm outer diameter and 7mm fiberglass and carbon fiber shaft.
- Plastic fletcher is used.

LITERATURE REVIEW

**Arrow**
- A good arrows must be able to bend at certain degree as the arrow will not be able to shot if the shaft is too stiff (Leach, 2014).
- The common arrowhead shape are as shown below.

- The common shaft materials are carbon, aluminium, fiberglass and wood (Barton et al., 2011).

Front of Center
- The range of FOC recommended for varies archery are: 11% to 16% for FITA (Olympic style), 6% to 12% for 3-D archery, 10% to 15% for field archery and 10% to 15% for hunting (Ashby, 2005).

\[ FOC = \frac{\text{arrow balance point}}{\text{total arrow length}} \times 50 \times 100 \]

**Arrow Performance Measurement**
- Arrow performance can be evaluated by measuring the arrow drag as instable arrow flight will increase the arrow drag (Barton et al., 2012).
- High speed video recording is one of the most common tools and need to be captured directly side-on of the travelling object and the frame rate of the video need to be known.

**Drag Force**
- According to Miyazaki et al. (2013) in their experiment, two high speed camera was placed 45m apart and velocity decay rate is used to determine the drag coefficient.

METHODOLOGY

**Experiment Set up**
- A distance of 2.5m, 45.5m, 2m for Camera 1, Camera 2.
- Distance of 7m for concepts selection.

**Concept Selection**
- 3D point, 5.46mm carbon shaft
- 7mm fiberglass shaft
- Cone shaped head
- Bullet shaped head
- Using high speed camera.

**Table 1**

<table>
<thead>
<tr>
<th>Point</th>
<th>Averaged Drag Force (N)</th>
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<tbody>
<tr>
<td>3D shaped</td>
<td>0.1176</td>
</tr>
<tr>
<td>Bullet shaped</td>
<td>0.1139</td>
</tr>
<tr>
<td>Cone shaped</td>
<td>0.1088</td>
</tr>
</tbody>
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