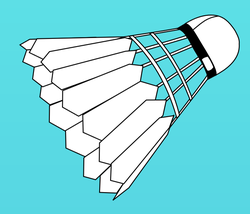
Computational fluid analysis of the effect of changing a synthetic shuttlecock skirt diameter at high velocities



By Cameron Woodruff, St Edwards college,NSW

Research Question: What effects does decreasing skirt diameter on a synthetic shuttlecock transpire on drag properties from a resulted streamlined shape at high velocity trajectories?

Hypothesis: As skirt tail diameter (D) of a synthetic shuttlecock is decreased resulting in a streamlined shape present at high velocities, a decrease in drag is induced, effecting the ability to replicate a feathered shuttlecock drag properties. A controlled model will induce a greater value of drag due to a greater value of (D) comparatively to models which inhibit less value of (D) thus will attain a lower drag value.

Abstract

Synthetic shuttlecocks were simulated across multiple models gradually becoming streamlined in shape by decreasing end skirt diameter (D) across multiple high velocities at which acts of deformation will occur in a game of badminton. This study resulted in models with greater value (D) had induced greater amounts of drag and models with a lower value of (D) had induced lower amounts of drag proportionally due to wake areas formed in producing pressure drag. Although certain calculated values surrounding particular models inhibited various values with no relation with the alternative hypothesis. To deduce this, re-evaluation and access to a greater expansion of resources is viable option to dedicating a valid method in obtaining results to later research.

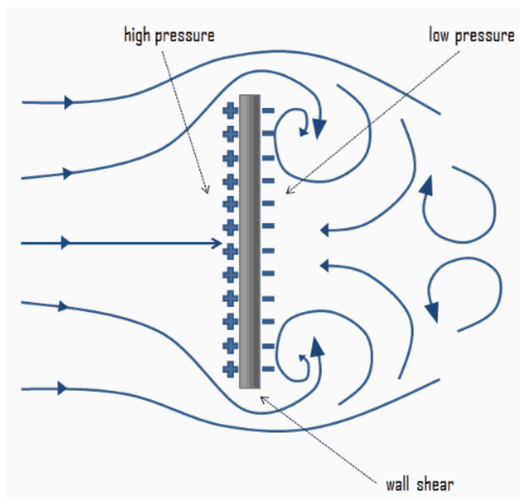
Research Methodology

Computational modelling technology with Fluid Dynamic simulations were used to measure physical properties of individual models. 4 models where designed in stages of progressively becoming streamlined in shape from a controlled bluff model. This simulates a comparison to a shuttle which neglects affects of deformation and shuttle models which have induced effects of deformation upon the tail skirt in producing drag characteristics. Models of shuttlecocks where placed into fluid simulations at consistent velocities, similar to experiences within badminton to apply accuracy in dictating the induced drag properties of models at high velocities in attempt to replicate similar patterns to real world applications

Literature Review

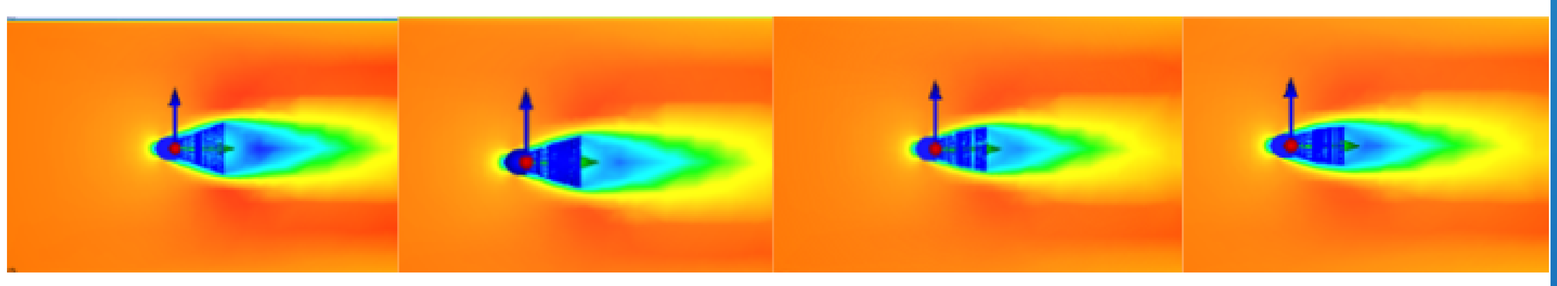
Badminton is a national played sport which entails the use of a shuttlecock. Traditionally, a feathered shuttlecock is manufactured for games using goose or duck feathers which in numerous reports sublime(2023) and Firstpost(2017) identified that the obtaining of the 16 feathers were plucked live and, in some cases, causes of skin and tissue damage to birds. In response, to this badminton world federation introduced synthetic shuttlecocks to tournaments as an ethical alternative, using nylon-based skirt and corks as a replicant shuttle to be used instead of feathers.

Due to the thin nylon making up the synthetic shuttlecock skirt in comparison to feathered structural integrity, at high velocities, acts of deformation inhibit upon the skirt. Deformation composes shuttlecocks to deform into a streamlined shape . A decrease in drag from a more streamlined shape is due to less skirt diameter splitting the fluid at which it travels, spliting fluid relative to motion into differing pressure systems inducing a wake area, proportionally inducing pressure drag to the size of the wake area formed.



This issue lead to players of badminton having to adjust to different physical properties of synthetic shuttlecock from traditional feathered design used in tournaments. This research gives insight into modern issues of deformation within current designs of synthetic shuttlecocks in attempt of being a suitable alternative to feathers by applying similar flight characteristics.

Results from models tested at 130km/hr (36.11m/s)



Discussion

The results gathered from this study proposed that as acts of deformation is induced upon a synthetic shuttlecock by applying a more streamlined skirt shape, less pressure drag is induced due to (D) having the ability to split relative fluid in the direction of travel. At all velocities tested 27.78m/s, 30.56m/s, 33.33m/s and 36.11m/s showed a positive moderate-strong correlation between each models drag coefficient and values of (D) in a proportional relationship. This indicates that as a greater value (D) is put at high velocities of travel a greater resistance force is induced. This extends that current synthetic shuttlecocks hypothetically induce greater range of travel than feathered due to the lack of resistance induced within the nylon shuttlecock skirt.

Image References
2024 Nuclear Power. (2024). Form - Drag - Pressure Drag. Nuclear Power. https://www.nuclear-power.com/nuclear-engineering/fluid-dynamics/what-is-drag-air-and-fluid-resistance/form-drag-pressure-drag/

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