Aerodynamically Silencing a Model's Mount (Design)

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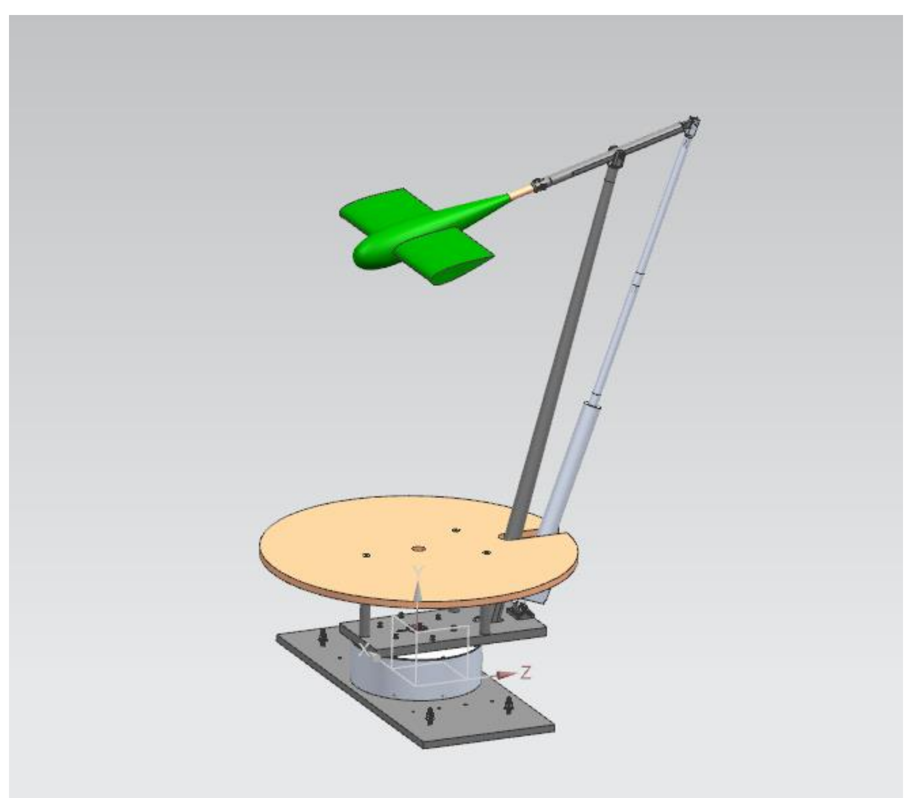
Introduction

The setup shown below is used to hold models and allows for some rotation in order to test the model at different angles. The actuator (the rightmost cylinder) can extend or contract, which raises or lowers the angle of attack. The base can also swivel to change the side-to-side angle. However, it causes disruptions in the air flow which are picked up by sensors.



CAD design of the setup in the Dryden Wind Tunnel.

Objective

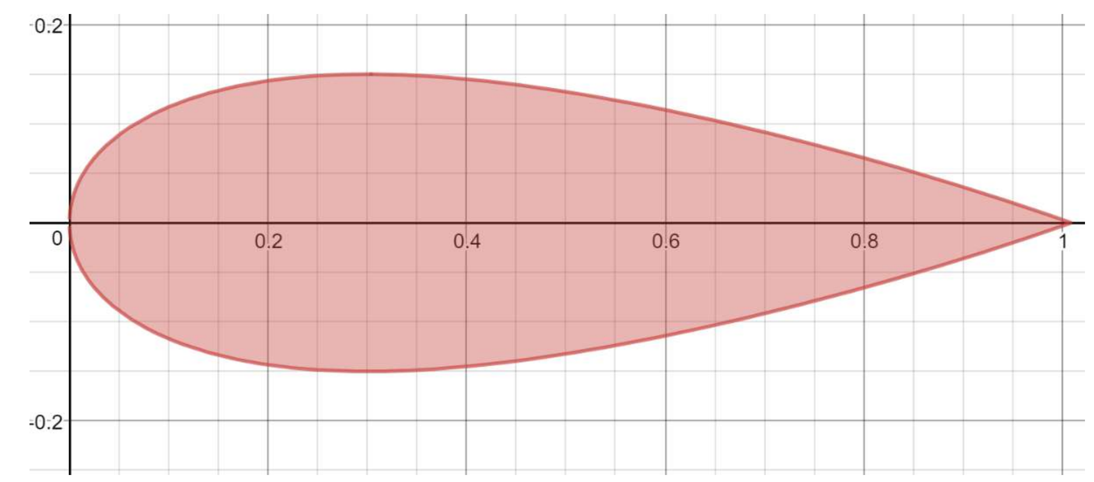
The goal of my lab is to design an aerodynamically silent "shroud" for the structure that will hold up models in the wind tunnel. The structure by itself is not aerodynamic and will cause perturbations in the air flow behind it, which are picked up by sensors and can skew the data of the model. After the shroud is utilized, the perturbations will hopefully be minimized and the sensors will pick up more accurate data of the model. The apparatus was scaled to around a third of its original size to fit in the Biegler Wind tunnel.

Skills Learned: MATLAB NX

Design Process

Choosing a Shape

Almost immediately, there was a consensus to use a symmetric airfoil shape. The airfoil has been proven to be one of the most aerodynamic shapes. My lab also agreed to surround the entire mount with the airfoil shape, as it would be simple and effective. In the end, a 3:10 ratio of thickness to chord length was used to minimize the chord length while maintaining aerodynamic characteristics.

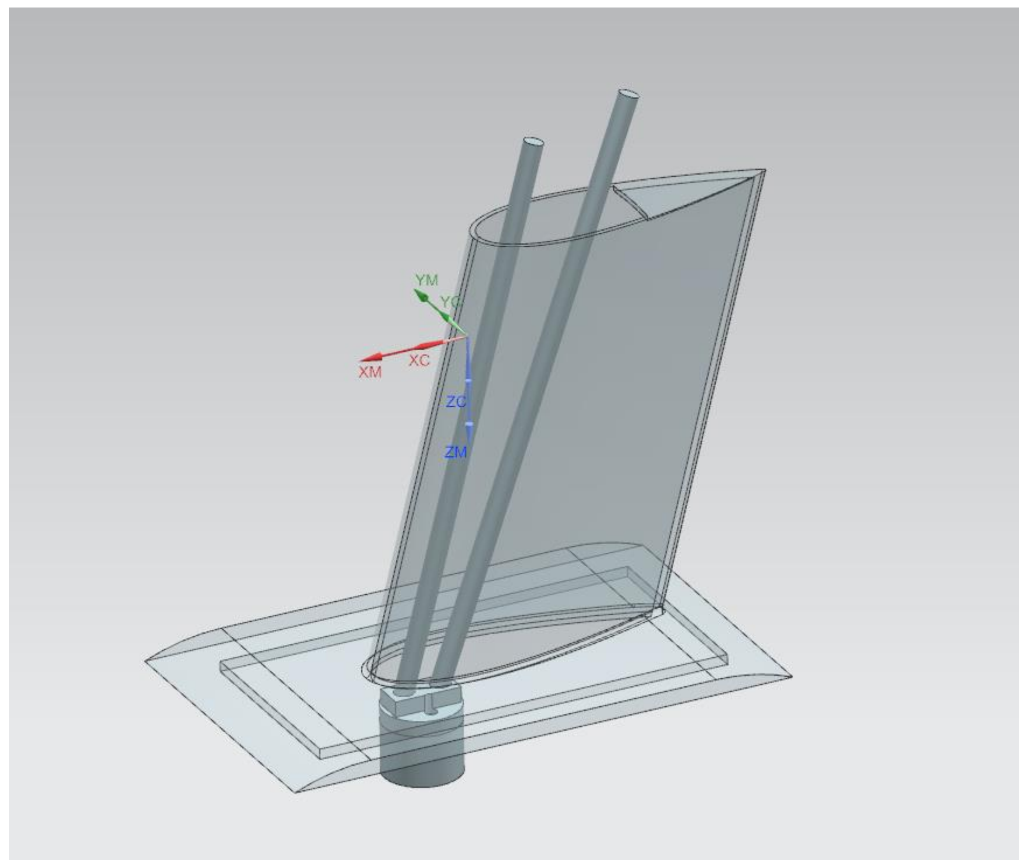


NACA 0030 airfoil, 0.3 units thick and 1 unit chord length

Designing the Shroud

The hardest part to accommodate in the shroud is the tip of the actuator, which swivels the farthest distance. Using trigonometry, we calculated the minimum thickness ("height") of the airfoil. Then, we tried to minimize the chord length ("width") of the airfoil while still maintaining an aerodynamic shape for manufacturing and sizing purposes.

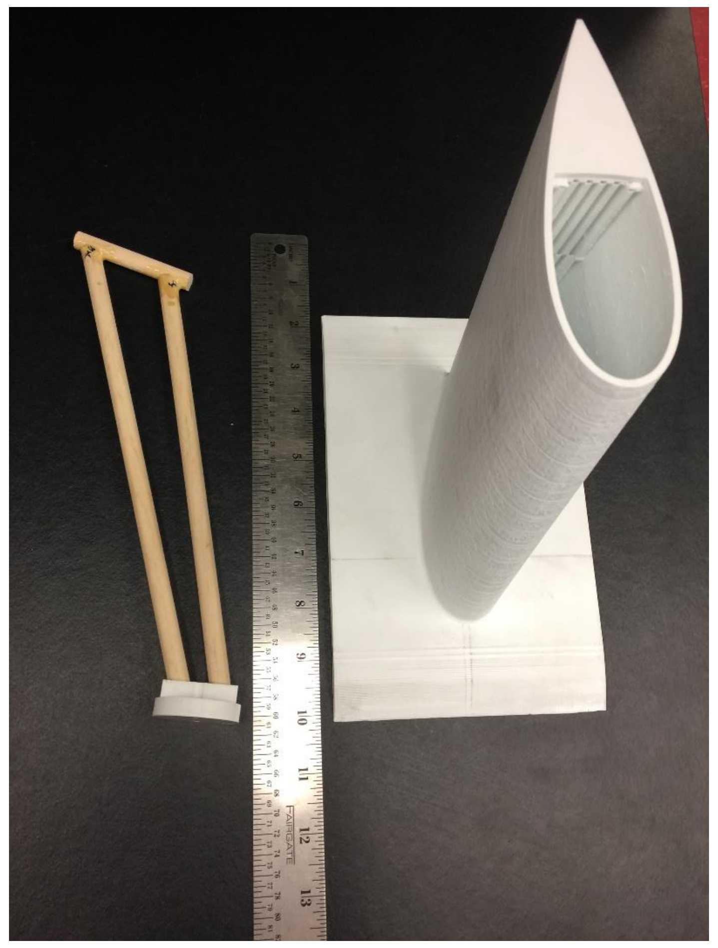
We extruded the airfoil shape parallel to the trunnion (the leftmost cylinder) to help reduce the chord length. A cap was also added to the shroud in order to minimize the air flowing into it, which could cause unwanted effects.



CAD design of the shroud and the setup

Designing the Base

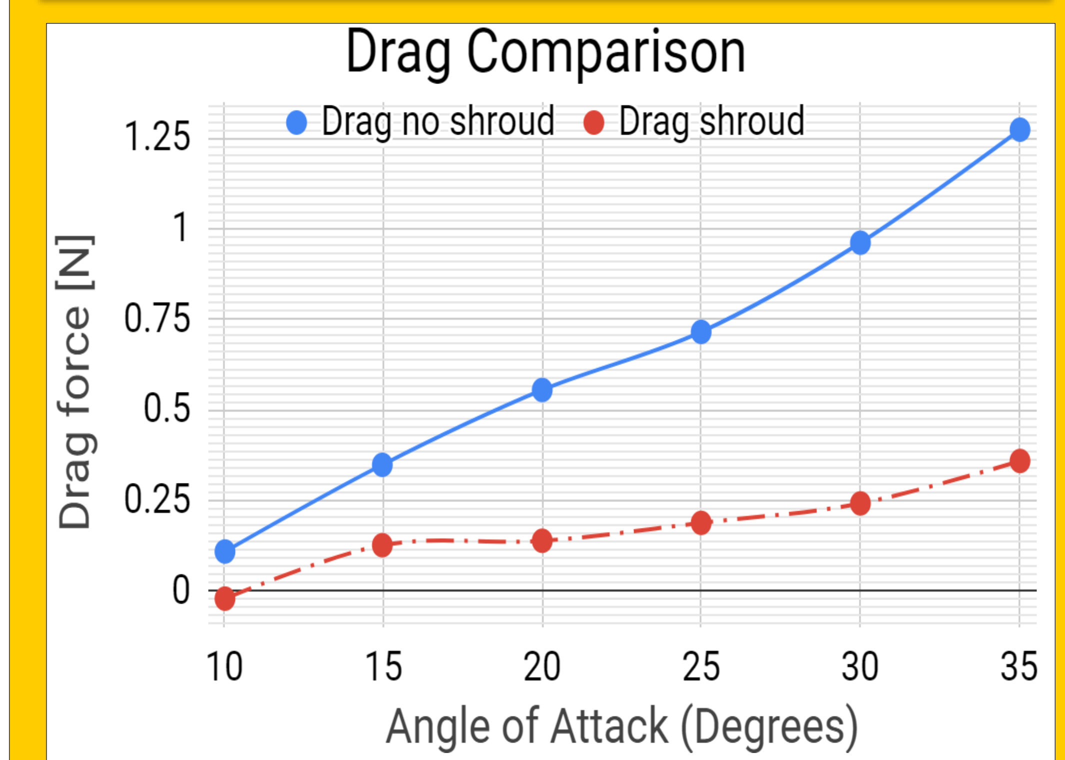
The base was curved to minimize disturbances caused by air flowing over it. The edge where the shroud meets the base is smoothed out in order to improve aerodynamics and minimize disturbances to the air flow. There is an indent near the bottom to facilitate mounting and to reduce material usage. The base will be secured to the wind tunnel by tape.



3D printed shroud and model of the setup, chord length: c = 5.25 in., height: b = 7.19 in.

Picture of my SHINE lab + Luke and Jessica

Did It Work?



Evidently, the drag of the shrouded apparatus was significantly lower than the bare apparatus. The drag force was reduced by 70% when tested at speeds of 35 m/s.

Acknowledgements

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