Improving the Efficiency of the Dryden Wind Tunnel

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Basic Aerodynamics

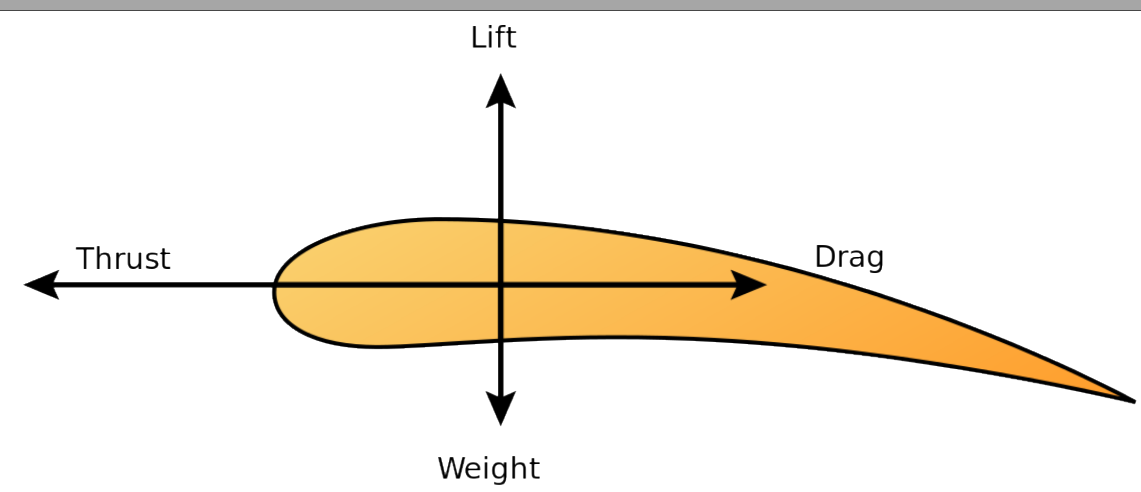

Figure 1: Aerodynamic Forces. These four forces act on all aircraft. <https://en.wikipedia.org/wiki/Aerodynamic_force>

Objective & Impact of Professor's Research

In the Dryden wind tunnel at USC, there is a specific apparatus that holds up models to be tested:

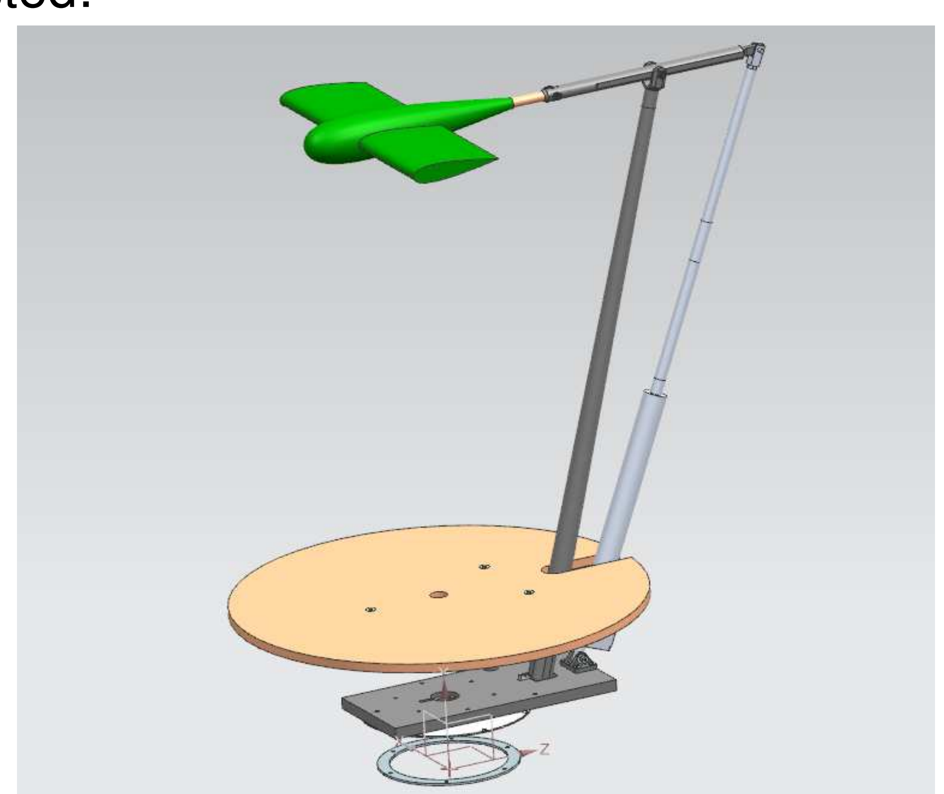

Figure 2: Dryden Wind Tunnel Apparatus. PC: Manaeha Rao

Unfortunately, the apparatus itself isn't very aerodynamic, and it often skews test results. The drag of the apparatus makes the drag measurement for models inaccurate. The objective of the research was to come up with a solution for this predicament: how can we make the apparatus virtually invisible in terms of its effect on models' drag measurements. By accomplishing this goal, all who use the Dryden wind tunnel should have much better test results, resulting in more precise and functioning aircrafts.

Skills Learned

$$\mathrm{Re} = \frac{\rho v l}{\mu} = \frac{v l}{\nu}$$

Where:

v = Velocity of the fluid
l = The characteritics length, the chord width of an airfoil
ρ = The density of the fluid
μ = The dynamic viscosity of the fluid
ν = The kinematic viscosity of the fluid

Figure 3: Reynolds Number. This number is incredibly important in aerodynamic testing: it confirms that tests of small scale models will produce the same results as tests on their full-sized counterparts. That means we don't always have to test on a full-scale airplane wing; a model with proportions inferred from Reynolds number will produce the same results. This is called dynamic similarity (when two vessels are geometrically similar based on Reynolds Number). <http://airfoiltools.com/calculator/reynoldsnumber>

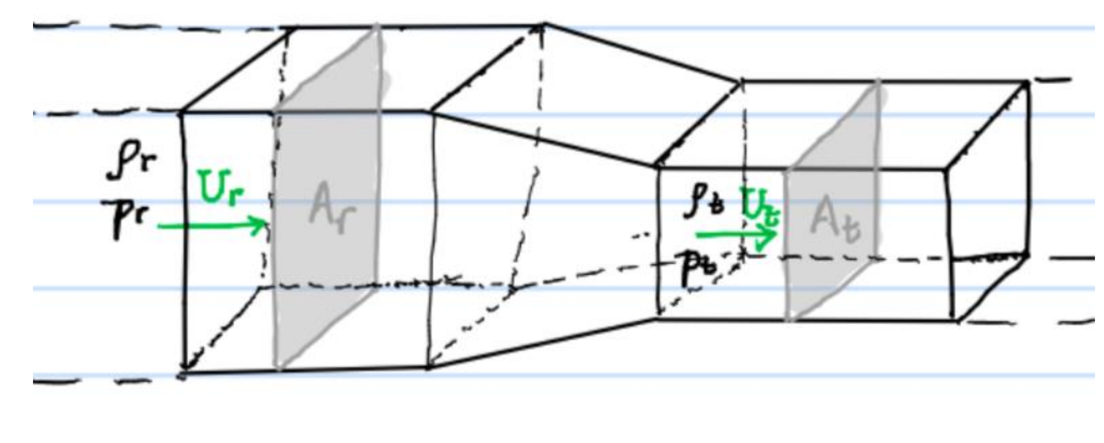

Figure 5: Wind Tunnel. This is a model of a general wind tunnel. The smaller section (called the test section) is the area in which we tested our set-up. PC: Saakar Byahut.

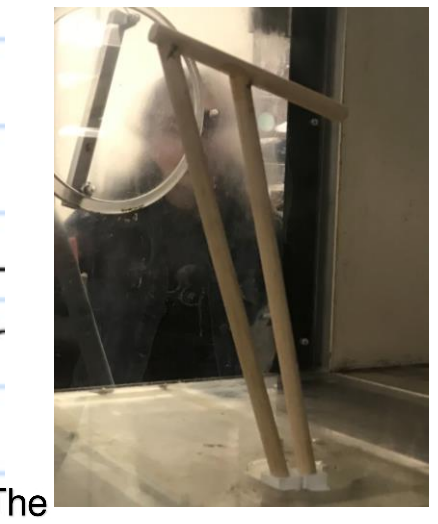

Figure 6: Our model of the structure in the Dryden Wind Tunnel. We tested the apparatus by itself to measure its drag. PC: Saakar Byahut.

Figure 7: Shroud over apparatus. Our proposed solution was an aerodynamic shroud that would encompass the two cylinders to reduce their drag. We tested the drag of the apparatus with the shroud on top. PC: Saakar Byahut.

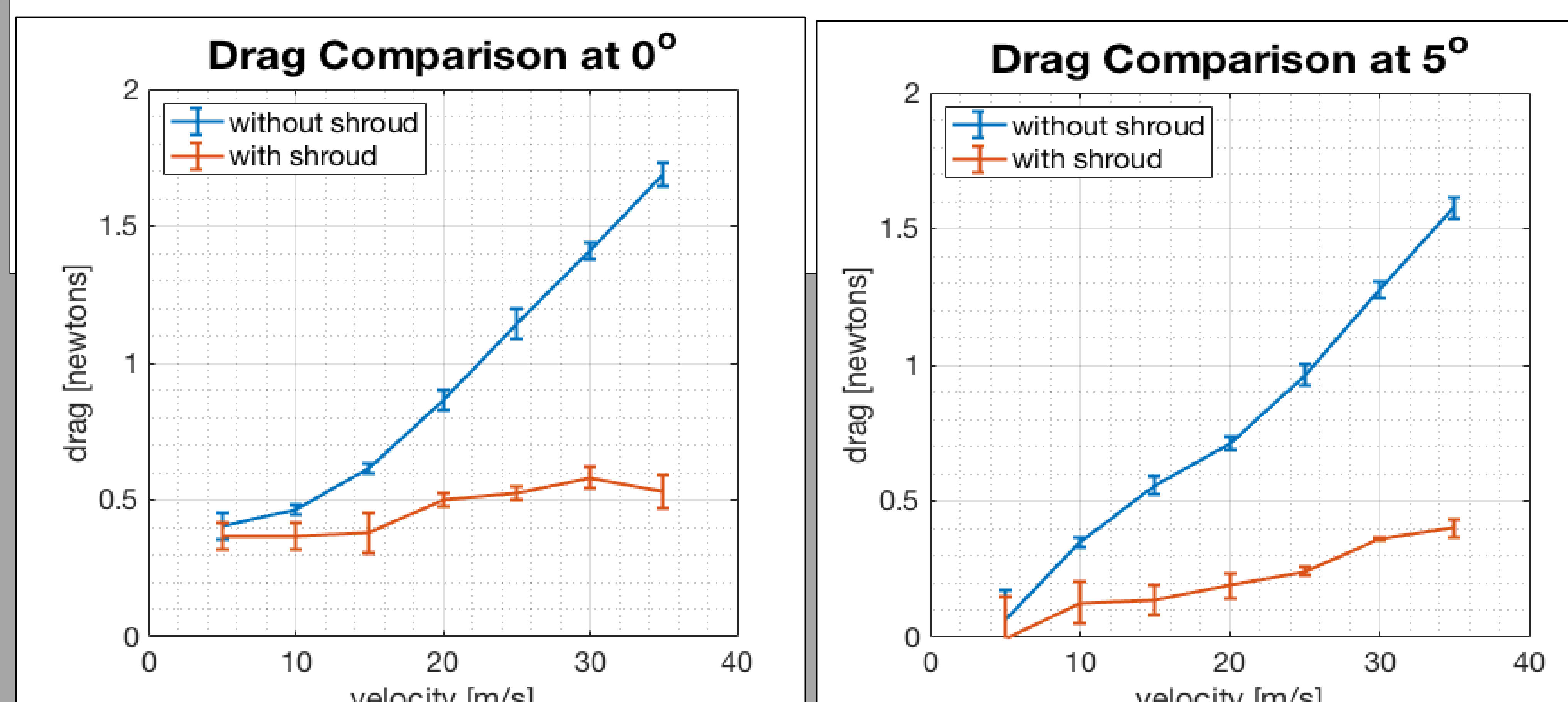

Figure 4: Results of Testing. It can be concluded that our shroud definitively reduced the drag of the apparatus. PC: Manaeha Rao.

Advice for Future SHINE Students

If you feel out of your comfort zone, don't worry. That's where the most learning and growth occurs. Your fellow SHINE students, mentors, and the professors are there to help you, so don't be afraid to ask for their help. Talk to different people everyday. This program brings students from all over, and it's an amazing opportunity to get to know such a diverse and intelligent group of people.

Acknowledgements

I would like to thank Professor Uranga, Saakar Byahut, Arturo Cajal, and Michael Kruger for working with me and helping me through this amazing oppurtunity. I'd like to thank the rest of the SHINE Cohort, Dr. Mills, and Dr. Herrold for being a source of guidance and support. Last, but not least, I'd like to thank my family for their unconditional support and trust.

Aspects that Related to My STEM Coursework

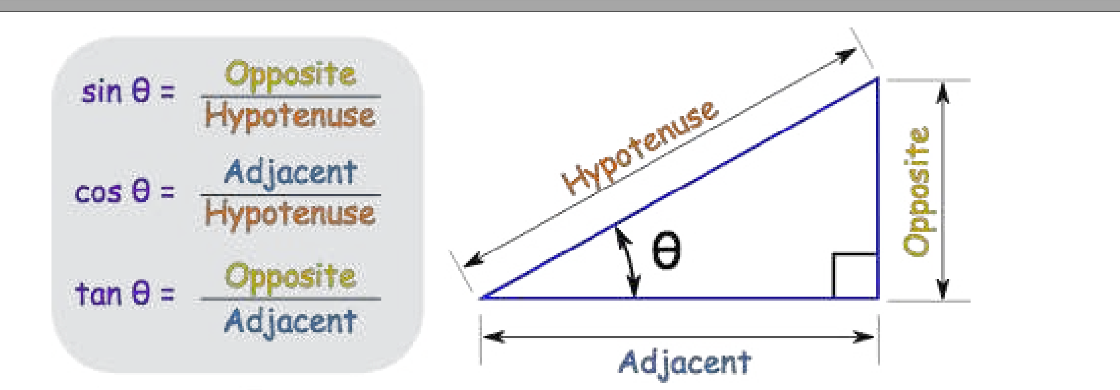

Figure 8: Basic Trigonometry. We used trigonometry to calculate the dimensions of the shroud and apparatus. <https://www.mathsisfun.com/algebra/trigonometry.html>

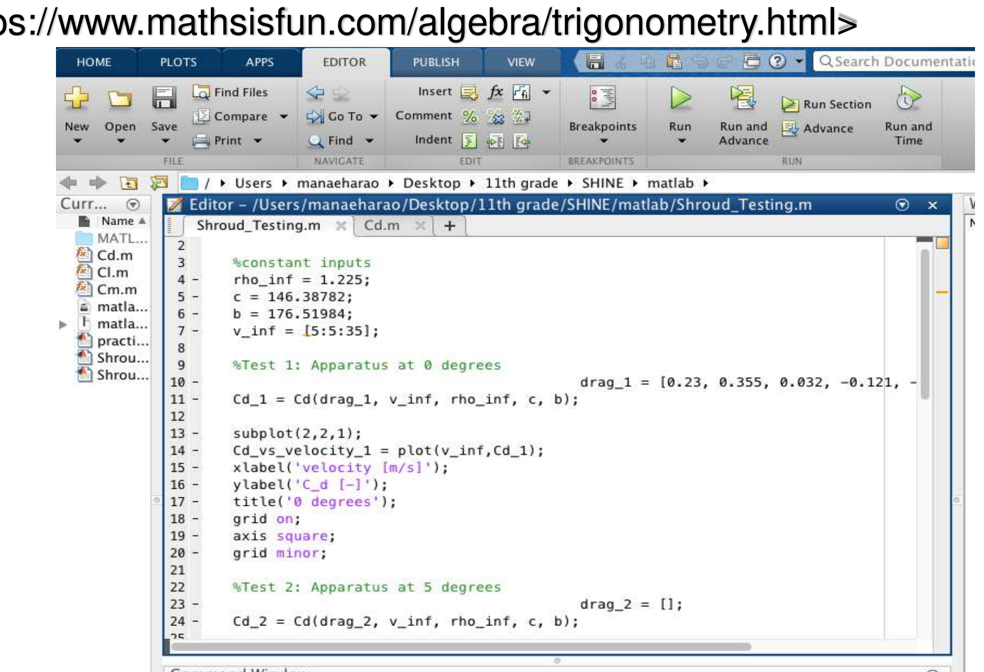

Figure 9: Code used from MATLAB. We used MATLAB to tabulate plots and results of our wind tunnel tests. Even though I was only familiar with Java, I was able to apply basic programming skills to learn MATLAB PC: Manaeha Rao