First Team Assignment:

Condensed Smoke Flow around object

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Flow Visualization

Date Published: November 2, 2016

INTRODUCTION

Air flow around objects are very fascinating because you get to see the turbulent flow result in special and interesting patterns. As a team we agreed we wanted to perform this experiment with different objects and smoke as our flow. The idea was to use different objects and capture the streamlines, using the same process in which experts can predict drag coefficients. The experiment isn't necessarily to find the drag coefficient, but to choose a shape that will result in a very interesting flow, which happens to be shapes with high drag coefficients.

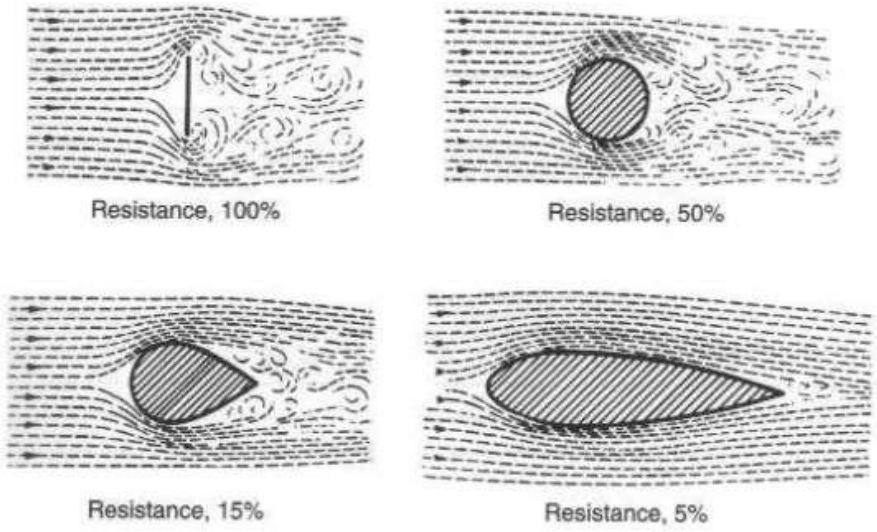

Figure 1: Streamlines of different shapes.

Aerospaceweb mentions "When the flow becomes turbulent and uneven, sometimes called 'dirty flow,' as in the top two examples." This is what we wanted for our images because they are much more fascinating to look at. We wanted that "dirty flow."

TECHNIQUE

For the experiment, a smoke machine was borrowed and used from Professor Hertzberg. This smoke machine had a cooling chamber and this is very important because if you just sent the glycerin mixture without cooling it the fog rose pretty rapidly and was very difficult to capture a good visual of the flow. The flow initially did not rise but that is because of the momentum generated from machine and did not produce the streamlines we desired. Thus, we can had to cool the glycerin mixture. Dry ice was purchased and used in the Styrofoam cooling chamber. This worked fantastically, and after the initial burst from the fog machine, the fog did not rise and stayed near the surface for the more part. A roughly 3 inch tall piece of cardboard was cut out and crafted into a display board shape. The setup was on a large black poster board to

reduce any distractions in the background and to hopefully increase the clarity of the white fog. The object was roughly one meter away from the outlet slit of the smoke machine to reduce the large momentum contributions to the flow. Above the smoke machine was a chair and tripod with the camera attached. The light source was handheld above the camera. The image below shows a rough setup of this experiment. This experiment was conducted with the help on Harrison Lien and James Julian%%.

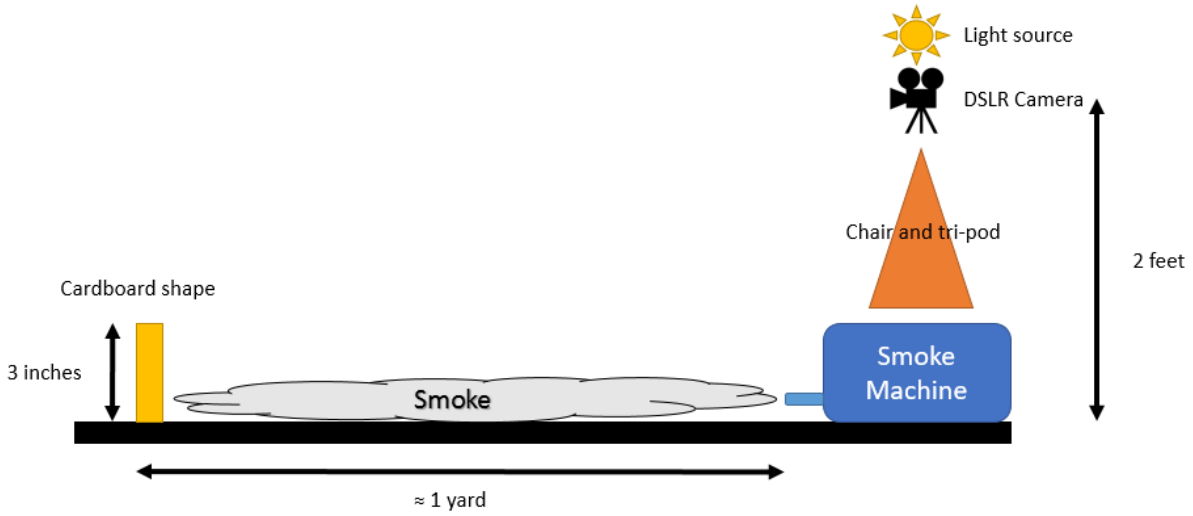

Figure 2: Experiment Setup

IMAGE AND POST PROCESSING

A Nikon D3300 DSLR camera was used from my teammate Harrison. The image was taken at f/7.1, ISO-800 ISO, 38mm focal length and a 1/50 shutter speed with a pixel size of 6000 x 4000. Numerous photos were produced at different time stamps for multiple runs of the experiment. I chose this image in particular because of how clear you can see the vortex on the left side. As time increased you slowly lost that clear vortex and the flow all just became “meshed” and eventually met up with the other side further down the line. This image is only like a second after the smoke hit the object. As I stated above, I really enjoy the vortex however the original image had a lot of “distracting” elements.

Figure 3a: Original Image

Figure 3b: Post Process Image via Photoshop

Post processing was entirely done through Adobe Photoshop, and as you can see a lot was done. First I cropped the image to the size shown on the right, however in that frame part of the water bottle and small left object were still in the image. I decided they were distracting to the overall flow and wanted the viewer's eye to go instantly see the vortex. I used the Spot Healing Brush tool on both objects and I was very pleased with the results. The bottle part looks fantastic, and the left object was deleted but with some very small residue. I also altered the vibrance so the cardboard color would come out more to increase the contrast. I had a hard time changing the settings to get a black background without losing detail. The final size of the image is 2648 x 2464. The image does seem a little "grainy" but that is probably from the shutter speed.

CONCLUSION

Overall, I am very pleased with the results of this experiment and the images my fellow team members generated. Some issues with this experiment was the light, we never realized the effect of the light on the black background until we uploaded images to the computed. Because the smoke was a darker white a strong black background would be ideal, with a different light location, and would make the smoke "pop" even more than what I was able to do in post processing. Improvements to this experiment could be to use real objects and compare the images with the proposed streamlines. The comments were very supportive with lots of people saying how easy the vortex is seen. Some of the constructive criticisms are that the background is not completely blacked out and the cardboard. I acknowledged on how to fix each of these issues earlier.

RESOURCES

My team mates: Harrison and James, and Harrison for taking the picture with his camera.

Scott, Jeff. "Streamlining and Aerodynamics." *Aerospaceweb*. N.p., 15 Sept. 2002. Web. 03 Nov. 2016. <http://www.aerospaceweb.org/question/aerodynamics/q0094b.shtml>