

Brock Ewing

Flow Visualization

Get Wet

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### **Smoke Bubble**

For the get wet project, I wanted to show an interaction of smoke mixing with air. I was most interested in a low velocity, laminar flow. After many attempts I decided that the interaction was most interesting with high smoke density. Constraining the volume in which the interaction took place allowed me to control the smoke density. However, I did not want to constrain the volume by using a rigid container because it would greatly disrupt the flow of the smoke.

The solution I came up with and the apparatus I used was blowing hookah smoke into a soap bubble. By exhaling hookah smoke I was able to control the velocity of the smoke. Hookah smoke worked well because it is cooler than other smokes and so doesn't rise quickly and become turbulent like other smokes such as candle smoke. The soap bubble constrained the air/smoke interaction to a small space, but also allowed to expand and mix as I added more smoke. To do this, I took an empty paper towel roll approximately 28 cm long and 3.75 cm in diameter and made a soap film at one end. I then very slowly exhaled the smoke through the other end (at a calculated 0.07 m/s) until the smoke from my lungs and the air inside the tube began mixing inside an inflated

bubble. Using a kinematic fluid viscosity of  $1.5 \times 10^{-5}$ , the Reynolds number can be estimated to be 173.8.

I liked the white color of the smoke, and so left it undyed and photographed it against a black background. The soap film turned out to be very reflective and produced glares regardless of my lighting technique. I wound up using a flash directly on the bubble and edited the glare out using photoshop.

The size of the field of view is about 8 in. by 8 in. The distance from the object to the lens is about 18 in. This photo was taken with a Cannon 20D digital camera. The Lens focal length is 85 mm. It was taken with an aperture of 4.0, a shutter speed of 1/160 s and an ISO setting of 200. In photoshop, I cropped the image, got rid of the glare from the flash, and created a greater contrast between the smoke and backdrop.

This image shows an interesting interaction between smoke and air. As the smoke enters the bubble from the top, it is forced downward due to my blowing. It then rises back to the top because it is hot. This creates a neat swirling action that this image captures. Another feature of this photograph that I like and did not intend for is the rainbow light refraction at the top of the bubble. A flaw of this image is the fact that the cardboard paper towel roll can be seen and distracts from the smoke bubble. I would like to see a greater contrast between the white smoke and the black background.