



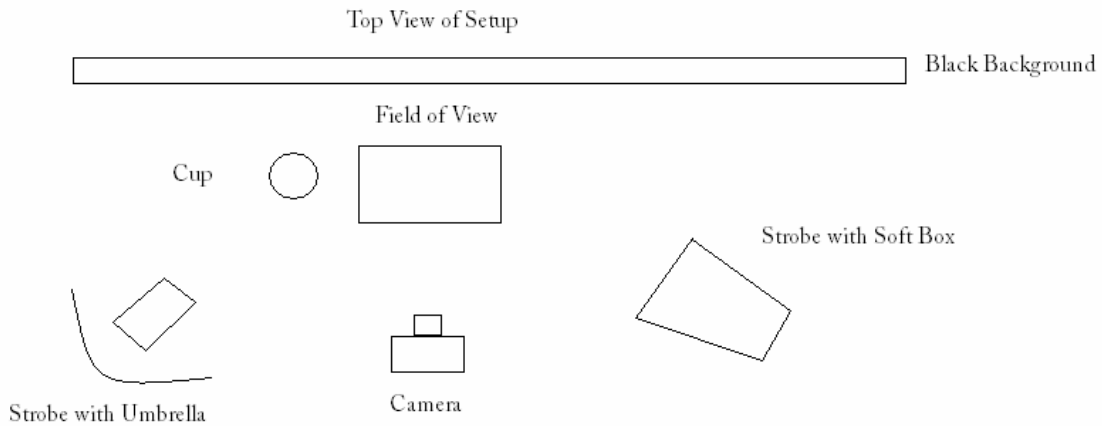
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Project #3

The purpose of this image was to capture the flow of cold water vapor created with the use of dry ice and hot water. The flow captured is both laminar and turbulent. The phenomena captured in this image are vortices and vortex rings. These phenomena occur in everyday life; from hurricanes to wingtip vortices produced by wings as they generate lift. Yet these vortices are overlooked for their beauty as they are just seen in a scientific eye. This image reveals the aesthetic beauty of vortices and at the same time gives us clues to how they are formed.

The flow apparatus used for this image was simply a Taco Bell cup filled with hot water and dry ice. The cup was tipped sideways at about 60 degrees so the water vapor could flow out. The setup can be better pictured through the figure below.



The Reynolds number can be calculated as:

$$Re_x = \frac{U_\infty x \rho}{\mu}$$

where U_∞ is the free-stream velocity
 x is the distance from the leading edge
 μ is the dynamic viscosity of the fluid
 ρ is the density of the fluid

By assuming that the gas has a density of 1000 kg/m^3 and a dynamic viscosity of $.001 \text{ N-s/m}^2$, and a free stream velocity of $.2 \text{ m/s}$ and a distance of $.01$ to $.2 \text{ m}$ from the leading edge, the Reynolds number ranges from approximately 200 to 4000. This indicates that at the edge of the cup there is laminar flow and around $.2 \text{ m}$ there is turbulent flow. The temporal or time resolution can be calculated by multiplying the velocity of the flow by the shutter speed. The value gives a distance traveled during the exposure which is $.002 \text{ m}$.

There were two lights used in this setup. The first was a strobe with a softbox and the other was a strobe with an umbrella. Both of these lights were 1600 Watts. The flash on the camera was used as well.

The details of the camera are listed in the table below:

Camera:	Nikon D80
Shutter Speed:	1/100
Aperture Value:	f/5.3
ISO Speed Rating:	100
Focal Length:	60 mm
Flash:	Camera and Strobe
Pixel Dimensions:	2348 x 2080
Adobe Modification:	Lightened

Adobe Photoshop was used to lightened the picture in order to see more contrasts in all the vortices present in the flow.

This image reveals some interesting phenomena involving vortices in laminar and turbulent flow. It shows that the longer the fluid flows, the more turbulent it gets through vortices. I enjoy this image because one can learn a great deal about flows by looking at this simple image. I dislike the shadows in the background, which could have been removed using photoshop. I feel I have fulfilled the intent of this project by creating a flow which is both aesthetically pleasing and scientifically defining.