Flow Vis Spring 2011 **Steven Hendricks**
Team Photo #2 **4/3/11**

Whipped Vis

The second team photo for the Flow Visualization class of 2011 took place during our spring break in the final week of March. Because our team schedules didn't line up during the break I chose to work independently on this project with some inspiration from the local super market and my buddy Jaewon for graciously lending me his camera. My goal with these images was to use a simple food item and show its fluid physics in great detail with the macro lens on the camera. I chose to photograph whipped cream because it is a thick liquid that is sprayed from a can which retains the unique shape of the nozzle for a brief amount of time. In the end this project was a fun and tasty event to do at home during spring break for Flow Vis.

The flows of whipped cream presented here were captured once the whipped cream had been sprayed from the bottle onto a plate. Although the flow didn't continue once the whipped cream landed on the plate, it did seem to have a residence time as it was most 'crisp' once it was just ejected. In order to capture these images, the whipped cream was sprayed for approximately five to ten seconds until a substantial pile was made on the dinner plate. The remarkable thing about the whipped cream is that it retains the shape of the nozzle for a small period of time. This is due to the fact that the whipped cream is experiencing a shear thinning effect as it travels through the nozzle. The cream in the can is the same viscosity as the cream on the plate, but its viscosity reduces as the pressure from the gas forces it through the nozzle and it retains this shape because it is returning back to its thick state.[i] Over time, however, the cream began to melt as it heated up and it reduced to a puddle on the plate.

Capturing these photographs required a little bit of luck in order to get the weather and sunlight to cooperate but the natural lighting and a lack of wind allowed a lot of fine details to show up naturally in the foamy substance. An olive green dinner plate was used as the target for the whipped cream and the sequential-shutter-mode on the camera allowed me to get many photos in a short amount of time.

To take these pictures I used a Canon Digital SLR T2i Rebel camera with a 100mm macro lens attached. I held the camera only a few inches away from the subject and the width of the whipped cream seen in the pictures is two to three inches wide. During shooting, the ISO was set to 100, the aperture value was set to f/7.1, the shutter speed was 1/800 seconds and the focal length was 100mm. The pixel dimensions for the photos are 6144 x 4096. The specifications are the same for the image below except that he shutter speed was 1/1000 second and the aperture was f/8. These settings allowed the foam to be photographed immediately after it was released from the can and before it melted in the sunlight.

I really like the fact that the whipped cream changes viscosity as it travels through the nozzle and I think it is interesting that this is what I was trying to capture on camera before I even knew that shear thinning was occurring. It is also interesting to note that the whipped cream experiences shear thinning whereas a substance like corn starch and water will experience shear thickening when forced. These remarkable properties of the fluids yield further research into the fundamental theories as to why these substances behave the way they do and how we can take advantage of these properties in certain circumstances to provide the behavior that we want and improve our daily lives.

[i] Phillips, Dr Tony M. "The Physics of Whipped Cream." *Nasa.gov*. Web. <http://science.nasa.gov/science-news/science-at-nasa/2008/25apr_cvx2/>.