Team Report # 2

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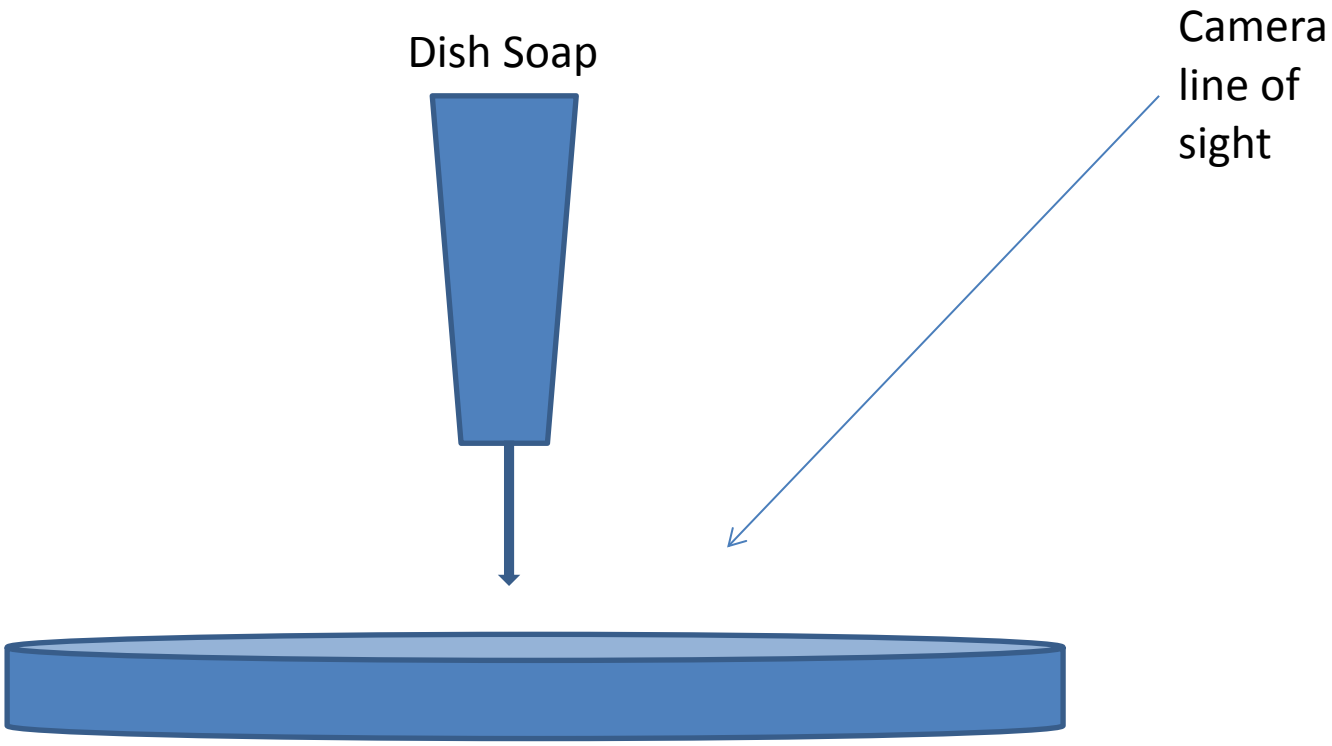
Team Project # 2 Report

The purpose of this project was to capture the interaction formed between milk, food coloring and dish soap when applied in the proper manner. This was a team project, however due to scheduling issues I captured this image on my own. The intent of the image was to capture the flow of the food coloring as it was pulled across the surface of the milk (the science behind this will be discussed in later sections). The final image shows the experiment fully developed, with a nice even spread of colors across the surface of the milk.

The image was created with a very basic setup and experimental design. A ceramic bowl approximately 12 inches in diameter was placed on a level surface, with the camera positioned approximately 18 inches above the surface at a slight (~35 degree) angle from vertical. The bowl was filled with a layer of milk that was roughly 3 inches deep at the middle point. Whole milk was used, as the higher fat concentration in whole milk produces a more dynamic result. Food coloring was placed in the center of the bowl and allowed to settle. The dish soap was dropped from a height of 3 inches above the surface. Only a single drop was placed into the milk/food coloring mixture, and this is more than enough to cause a desirable reaction. The setup for the experiment can be seen in the figure below:



The physics of this experiment are actually quite complex and quite interesting to look at. The food coloring settles on the top of the milk due to a much lower density. Surface tension at this point is uniform across the surface, and thus the milk will settle wherever it is placed and not move until acted on by an outside force. Once the dish soap enters the mixture, things start to change very quickly. The dish soap interacts with the milk and starts to break down the fat molecules within the milk. As mentioned before, whole milk contains a higher concentration of fat molecules, and thus the reaction is more severe. Once these molecules start to break down in the milk, the surface tension at the point of application decreases rapidly, creating force gradients across the surface of the milk. These gradients are caused by the now heightened concentrations of surface tension along the edge of the milk, which begin to pull at the food coloring. This is what causes the flow away from the center, and the reaction that is captured in the image. The food coloring moves away in a laminar flow, so it can be assumed that the Reynolds number of the food coloring flow can be estimated to be less than 2300. Once the food coloring reaches the edge of the milk surface, rebound effects start to take place, causing the food coloring to interfere with its own flow and create unique patterns that vary from experiment to experiment.

The visualization techniques were very simple for this image. The camera was mounted on a tripod to produce steady images, and the only sources of lighting were the natural lighting from the room and the flash from the camera. The specifics of the products used are as follows – Dish soap was Dawn Ultra Dishwashing Liquid, Original Scent. Food coloring was McCormicks Food Color, assorted colors. Milk was Safeway brand, whole milk.

The final image is composed entirely of the bowl and the contents, so the width of the image seen is just a little over the 12 inch diameter, and the height is right about at 12 inches. The distance from the camera to the object was approximately 18 inches above the surface. A Nikon D50 DSLR camera was used to take this photo, with an F-stop of 7.1, an ISO of 400, Shutter Speed of 1/100 sec and Focal Length of 38 mm. The low ISO was a key feature in this shot, allowing for a very clear image. The final size of the image was a 3008 Pixel Dimension in the X direction, and a 2000 Pixel Dimension in the Y direction. Two key effects were used in Photoshop, a touch up effect and a color inversion. The color inversion is the most obvious and gives the image a completely different feel from the original. The touch up was used to remove the flash spot, which can be seen in the lower portion of the original shot.

I think this image captured the unique effect of these three fluids very well. I love the impact that the image has with the use of a color inversion; it really hits the viewer hard and leaves a lasting impression. The flow is also easy to pick out, with the contrasting colors giving a very distinct representation to what is going on at the time that the image was taken. Overall it is my favorite picture I have taken this semester, and I feel that my intent was very well fulfilled. If I had to list anything to improve this image the only things I could offer would be to possibly add more lighting (this may create a sharper image) or possibly record a video of the experiment. The food coloring is quite fun to watch as it moves out of the center of the bowl, and this would be a

nice video to have. However, I am very satisfied with this image and the procedure used to produce the work.

References

http://personal.ashland.edu/marthur/STED/swlmlkwh.htm

http://www.cmste.uregina.ca/Quickstarts/liquidkaleidoscope.html