

Get Wet

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Flow Visualization

MCEN 4151-001



The purpose of this first project was to capture an image of fluid flow that is not only aesthetically pleasing but also shows the science behind fluid flow. First off I started by taking pictures of food dye dispersion in water but then I found a much cooler looking experiment online that would produce a much better image. This experiment was with milk and food dye with a drop of soap on a Q-tip.

The schematic seen in figure 1 shows the set up of the fluid flow. This experiment was preformed using a ceramic plate that was about 10 inches in diameter and about a half an inch deep. Milk was then poured into the plate to a depth of a little less than a half-inch. Blue, green, yellow, and red dye was then dropped into the milk. Dish soap on the tip of a Q-tip was then used to initiate fluid motion.

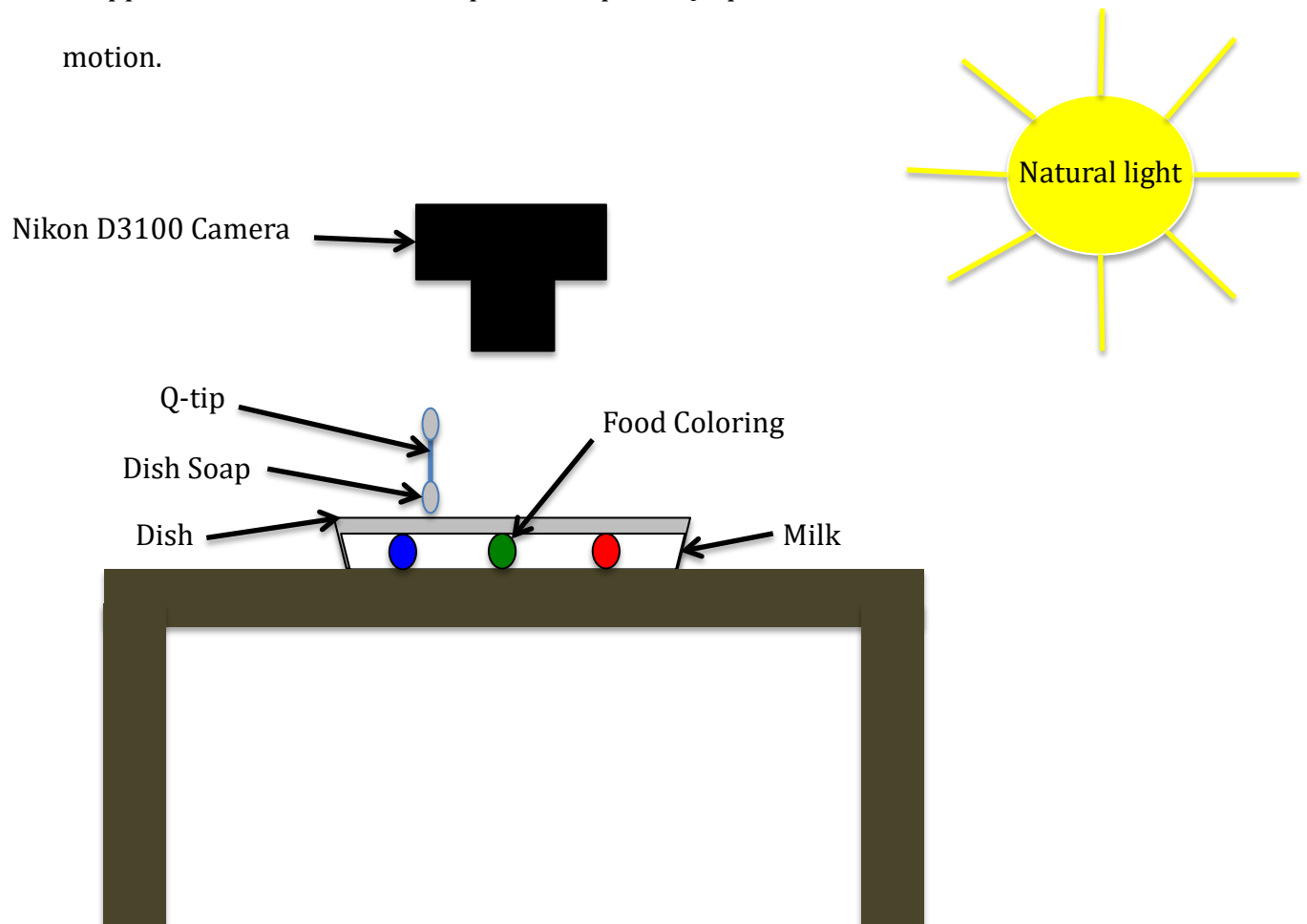


Figure 1 Set up

As soon as you add the food coloring you can see that nothing really happens, the food coloring just sits on the surface of the milk. After adding the soap the food coloring jets away from wherever you placed the dish soap in the milk and continues to move for a few seconds. The more soap you add the more movement you will see. For my experiment I would place the dish soap right on the drops of dye in the milk, which pushed and churned the food coloring combining the colors and making a beautiful image.

The science behind this phenomenon is all about the physics of the different surface tensions of the liquids. Differences in surface tension can create Marangoni effect. The Marangoni effect is the mass transfer along an interface between two fluids due to surface tension gradient [1]. In the middle of the fluid, every molecule is surrounded on all sides by like molecules, which push and pull it equally in all directions. But at the surface, the fluid molecules are only acted on by similar molecules in some directions. This imbalance in molecular forces is what creates surface tension [2]. As soon as you add the soap to the milk with dye the surface tensions vary, which causes the fluid to move from areas of low surface tension toward areas of higher surface tension.

The materials used in this experiment were as follows: King Supers whole milk, Dawn Dish soap, McCormick Food Coloring, and a ceramic plate. When taking this photo I decided to use natural lighting, so I placed the dish outside on a table around 2:00 PM with the sun lined up to the right of my set up shown in figure 1. No flash was used when taking this picture.

The following camera setting were used when taking this photo:

- Exposure Time: 1/125 sec.
- Aperture: f/5.3
- Focal Length: 55 mm
- ISOS: 800
- Distance from lens to object: 1.5 feet
- Original image dimensions: 4608x3072 pixels
- Cropped image dimensions: 3608x2618 pixels

After the picture was taken I used Gimp to do my post processing. I first cropped out the image on a certain part of the milk that looked the most appealing. This also got rid of the rim of the plate. I then played around with the lines of the image, which made the colors of the food coloring darker and the milk whiter. Then I inverted the colors of the image making the background black and the colors look neon. The original and final picture can be seen in figure 2 and 3.



Figure 2 Original Image



Figure 3 Final Image

The image reveals the randomness and beauty that different surface tensions can impose on multiple fluids. The physics can be seen with this photo but a video of

this reaction would have demonstrated the different surface tensions even better. I really like how my image turned out in post processing because I feel like with inverting the pictures color it made my image more unique and original. The colors turned out very vibrant and contrast well with the black background. I could have gotten more of the image in focus in some areas. One thing I could do to improve in the future is that I would wait till the liquid is fully at rest so I wouldn't get motion blur like I did before.

References:

https://en.wikipedia.org/wiki/Marangoni_effect [1]

<http://fuckyeahfluidynamics.tumblr.com/post/100669797046/differences-in-surface-tension-can-create> [2]