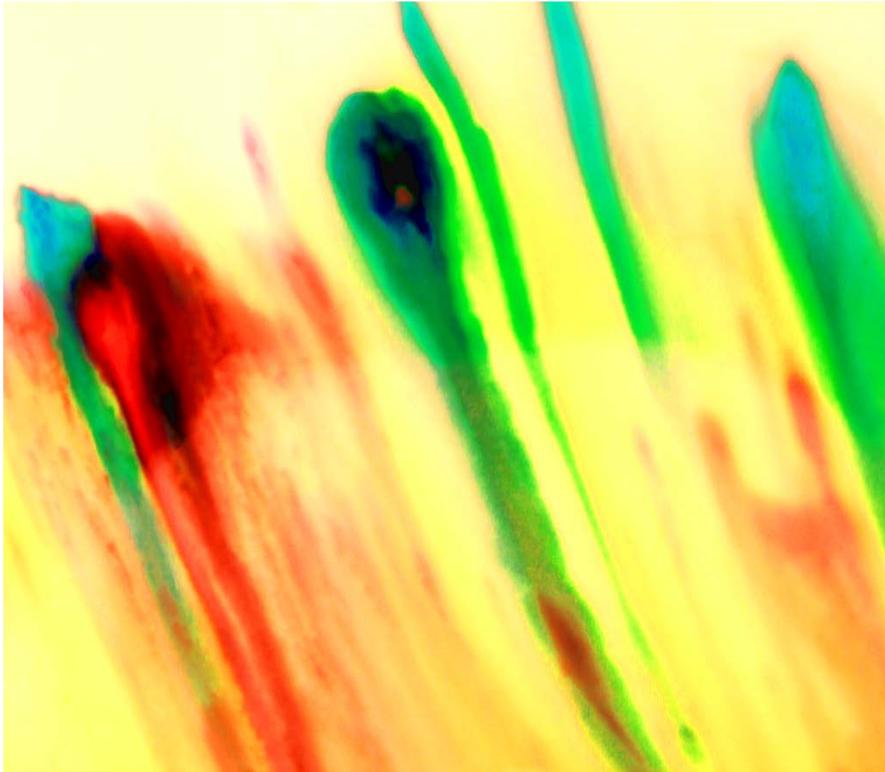


Get Wet 2016

Flow Visualization



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9/8/16

To begin with the project, I bought food coloring dye, milk, dish soap, and drinking straws. I initially tried to drop the food coloring dye through a straw into a glass of water. The effect was interesting but I could not get an image that I liked due to the glare off the glass. I used a lamp to project light onto the plate with the flash turned off on my camera. Next, I tried the common dish soap, dye, and milk technique in a small bowl but quickly realized the milk needed to be spread out into a thinner layer. I repeated the same experiment on a small plate and started to witness the dye flow away from the cotton swab. When I went to wash the plate off in the sink I saw an interesting scenario take place. The dye was thicker under the layer of milk and began to streak as I turned the plate in the vertical position. The milk did not have much effect on how the dye moved after the milk had washed off the plate, but provided an element of surprise in that the dye pattern was unpredictable. I snapped multiple pictures and chose my favorite one to use.

The main force acting on the dye and milk fluids is gravity. As the plate is held in the vertical position gravity acts on both the dye and the milk in different ways. Since the milk is less dense than the dye, it flows off the plate first, leaving behind the denser dye to streak off slower. The density of milk is 1035 kg/m^3 , while the density of food coloring dye is 1330 kg/m^3 . The absolute viscosity of each fluid also contributes to how the fluid will flow. Milk has an absolute viscosity of $0.020 \text{ Pa}\cdot\text{s}$, and dye has an absolute viscosity of $10 \text{ Pa}\cdot\text{s}$. The higher the viscosity, the more friction the fluid has with the surface. The more friction the fluid has with the surface, the slower the fluid will move. During the experiment, the milk flows off the plate quickly with a higher velocity than the

dye. This tells us the dye is encountering more frictional forces with the surface of the plate than the milk.

I was able to create the image shown using household dish soap, food coloring dye, and milk. First, I poured a small layer of milk onto a small plate. Then, I picked blue, yellow, and red food coloring dye and poured a few drops of each into the milk. Next, I took a cotton swab and dipped it into the dish soap to mix the colors around. I set the cotton swab to the side and picked up the plate. I went to the sink and started to pour the mixture slowly off the plate. As the mixture flowed down the plate the dye became more prominent. I captured multiple pictures of the flow and picked my favorite.

The image shown was taken using a Canon Rebel T5 with an 18-55mm lens, which was set to manual exposure mode and no auto focusing. Set the following exposure settings: aperture to F8.0, shutter speed to 1/80, and ISO to 400. For this image, the focal length was set to 24mm and the horizontal field of view angle was 73.7 degrees. When I took the image I was 10 to 12 inches from the plate, so I could capture the flow everywhere on the plate. Then I uploaded the image to my computer and used a computer software, GIMP, to enhance certain features of the image. First, I cropped the image, using only a small area of the original picture. Next, I rotated the image -90 degrees so the streaks of fluid were flowing in the vertical direction. I adjusted the color levels to bring out more of the reds, greens, and yellows. I kept the shadows and highlights the same. Finally, I increased the brightness and contrast settings by a factor of ten.

No one image is going to come out exactly the same, which makes this experiment so fascinating. Every trial is going to result in different streak patterns and different mixes of colors. Some other techniques I would like to try while do this experiment would be to rotate the plate as the streaks begin to form. That way you can alter the direction of flow of the fluid to come up with interesting patterns. I would also like to try different types of lighting to see how it changes the contrast of colors in the image.