

Get Wet

Flow Visualization

MCEN 4151



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Introduction

The purpose of this first assignment was to introduce us to the art of photography, as well as gain a basic understanding of visualizing fluid flow. I chose to explore the fluid experiment of using milk, food coloring and dish soap. Originally, I imagined the image being this intricate standing fluid with an explosion of different colors and flow, but as the iterative design process continued I began to explore different elements. I found myself mixing numerous colors of food coloring and drawing abstract designs in the milk trying to obtain different results. All this trial and error led me to my final experiment that allowed me to capture the image above.

Experiment

My experiment was relatively simple and only involved a few objects: 2% white milk, blue and yellow food coloring, a 10" diameter white plate, generic dish soap, a toothpick, and a q-tip. I began by filling the plate with approximately $\frac{1}{4}$ " of milk. Then I poured blue food coloring into the center of the plate until the puddle was approximately a $\frac{1}{2}$ " in diameter. Following that, I poured the same amount of yellow food coloring into the center of the blue. Using the toothpick, I then drew a "star" shape by sticking the toothpick in the center of the food coloring and moving straight toward the edge of the plate (refer to figure 1). I repeated this step four more times to create five points. Finally, I put a small amount of dish soap on the end of a q-tip and immersed it in the center of the star.

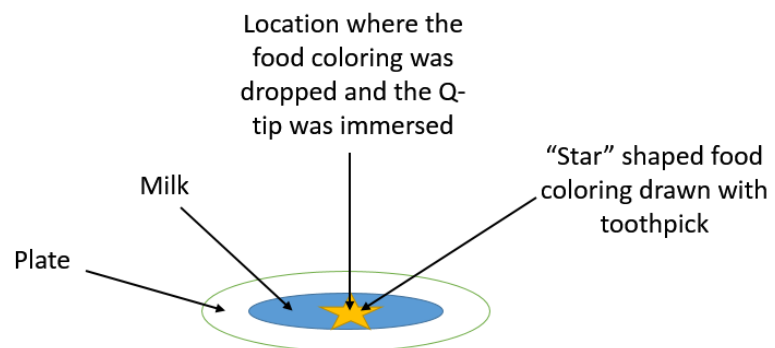


Figure 1: Diagram of experiment

This caused the food coloring to mix and "flower" outward. The result was interesting but I wanted to take it a step further. I then decided to drop more food coloring and try my hand at a stop motion shot. I had an assistant (my roommate) drop a droplet of food coloring from a distance of approximately 12"-16" above the plate. This created a very neat Worthington Jet. A Worthington Jet is created from fluid rushing to fill a crater created on the surface when a drop impacts the fluid ^[1]. After about five drops of food coloring I was able to achieve the image I wanted.

Lighting

The lighting used were two fluorescent light sources in my kitchen located directly above the experiment. I did not use a flash and there was some diffused sunlight coming in from some nearby windows. This light was actually very bad. It took me a decent amount of time to get the camera settings set appropriately in order to let in enough light. This is an element I was I had explored in more detail.

Photographic Technique

The camera I used for this experiment is a digital Canon EOS REBEL T1i with a standard kit lens. I captured this shots from approximately 6"-8" away with an estimated field of view of around 10" x 8". Figure 2 shows the before (left) and after (right) post processing that was completed.



Figure 2: (Left) Before Post Processing, (Right) After Post Processing

I actually did not crop this image, so both the before and after images had the same number of pixels: 2424 x 1498. I decided to test my abilities throughout this experiment by using the manual mode on my camera. The shutter speed was at 1/250, Aperture: 4.375, and ISO 3200.

In post processing, I first played with the curves to really make the blues pop. Then, using the spot healing tool, I removed some of the excess splatter from the dropped food coloring that I thought may be distracting. I also used a brush with low opacity to color out the plate, and finally put unsharp mask filter to ultimately sharpen the image.

Conclusion

This image does an exceptional job at showing the physics behind the Worthington Jet. The crater of milk has collapsed on itself, launching a single droplet of food coloring into the air. My favorite aspect of the image is the focus of the droplet while it's in midair. I must have caught the droplet at the peak of its apex. The image does have a bit of motion blur especially right below the droplet, which can be distracting. Next time, I plan on playing around with my camera settings as well as the surround light so I can further explore the power of shooting in manual mode. I wish I had used a faster shutter speed to reduce some of the blur but I can imagine lighting may become an issue. I would also like to use some sort of apparatus to consistently drop the droplet in the same spot.

References

[1] Jenna Marie Mckown. "An Experimental Study of Worthington Jet Formation After Impact of Solid Spheres" MIT (2011), Available: <http://dspace.mit.edu/handle/1721.1/67750>