

Team Third Report

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Flow Visualization MCEN 4151

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I. Introduction

This photograph embodies a delightful fluid flow produced by dropping dyed water droplets into a pool of water using a special water dropping/photo taking device. The intent of the image was to display a Worthington jet and its collision with another droplet. Vivid color dyes were added to the liquid to beautify the image and highlight the interesting aspects of the phenomena. We hoped to get a great photograph of the Worthington jet and droplet collision and it worked out perfectly. I would like to thank my teammates, Michael Lloyd, Ryan Daniel, and Schuyler Vandersluis for their hard work and generous help in setting up the water droplet device and in creating this image. The photo/droplet contraption for controlling the size and release rate of drops to create Worthington Jets was made by Kyle Hollis and Kyle Walters called DropSplash (Hollis & Walters, 2016), so they also receive our great appreciation.

II. Flow Apparatus

In regard to the flow apparatus, we used a photo/droplet contraption made by Kyle Hollis and Kyle Walters called DropSplash. We then used an acrylic board for a white background that we secured to the contraption and a clear glass cooking container to hold the water that the droplets collided with. As you can see in the photograph, there were two tanks of water, one dyed purple and the other red, that we used for the droplets. In order to work the apparatus, we used an app built specially for it that allowed us to control the number and size of the droplets from each container. Not only this, but it also allowed us to determine when we wanted the camera to take the picture. After many trials and errors, we were able to determine the perfect timing at which the droplets hit the water and collided in the photograph. The two spouts releasing the water from the container were at a slight angle with the red side being slightly higher. This cause the droplet to be slightly behind the purple droplet which caused it to collide with the purple's Worthington jet in a magnificent photograph. The reason for the very slight ghost image is most likely due to our lighting. We used the normal overhead light in the room as well as two flashes, one on the side and one behind the acrylic background itself. A slight discrepancy between the timing of the flashes may have caused the ghost image but we are not exactly sure.



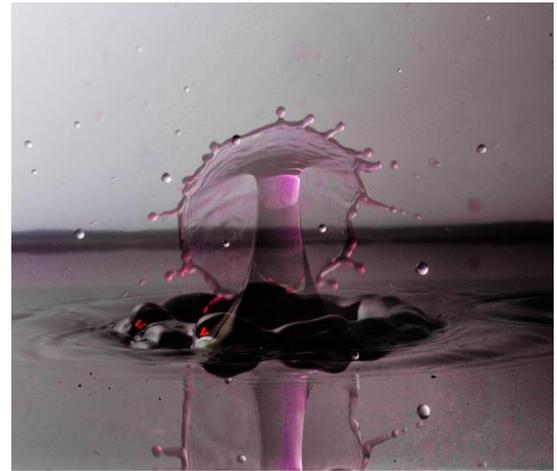
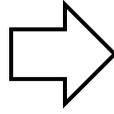
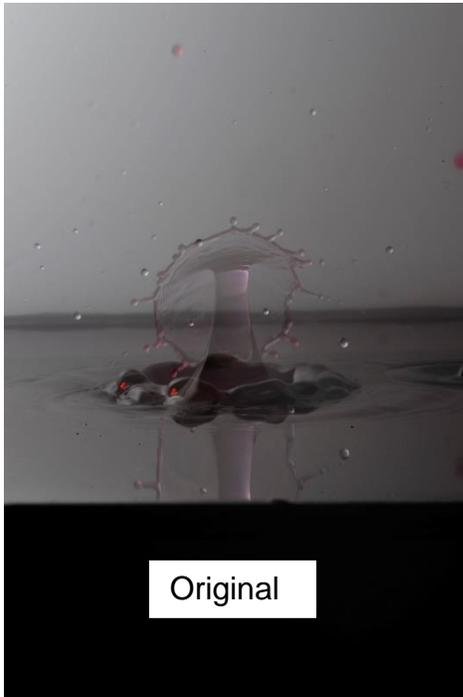
DropSplash contraption setup

III. Visualization Technique

In order to create the flow phenomenon in the picture, we used red and purple dyed water. The dye was not necessary for the phenomena but it did add some color to the water to create more contrast and liveliness in the photo. The Worthington jet is purple as the purple droplet collided with the water first and the outside ring of the umbrella of the collision point with the red droplet is slightly more red. This photograph as a whole shows a few different fluid flow phenomena. The first is the crown where the first purple droplet collided with the stagnant water in the container. The crown is caused by the droplet creating a crater in the stagnant water and the displaced water forming a crown shape around the impact zone. This phenomenon gives way to the next, the Worthington jet. The Worthington jet is caused when the water falls back in to the crater created by the first droplet; which then, due to momentum and pressure difference between the air and fluid, causes the water to spout up in what is called a Worthington Jet (Gekle & Gordillo, 2009). The last phenomena, the umbrella like explosion at the top of the Worthington Jet, is caused by the second droplet colliding with the Worthington Jet created by the first. The droplet didn't hit the Worthington Jet straight on so the umbrella is facing the viewer. The droplets and fingers coming off of the umbrella are due to a lack of strength in the surface tension to keep the water in a clean sheet. The sheet breaks off into fingers and then into droplets, a phenomenon that is explained by the Plateau-Rayleigh instability which states just this.

IV. Photographic Technique

We used a Nikon D700 with a 18-55mm lens to photograph this flow pattern. We shot the image about .2m away from the fluid and used a focal length of 105mm in order to truly focus on the fluid and remove any unneeded background. The fluid was moving quite quickly so we used an exposure time of 1/2 sec and an F-stop of f/32 with an ISO of 200. We needed to take quick shots so the camera was set to shoot continuously in order to get a picture with the desired wave formation. The edited version of the photo is 2572x2225 pixels while the original was 2832x4256 pixels. The photo was edited using Adobe Photoshop Express through which I was able to mess around with the contrast and clarity to make the image more colorful and crisp. Below is a side by side of the original and edited versions.



V. Conclusion

This beautiful phenomenon was a literal splash to experiment with and try to capture. I really loved the way the purple dye is seen in the Worthington jet. The second droplet colliding with the Worthington jet creates an absolutely magnificent visual and the crown from the first droplet is in perfect focus. In hindsight, I would like to remove some of the out of focus water spots on the right side of the photo and touch up the random dark spots in the water on the left side that wasn't there in any other of the photos. Overall, I really enjoyed using the water droplet apparatus and would definitely like to take photos of different types of droplets using the contraption again.

VI. References

Gekle, S., & Gordillo, J. (2009, Jul 29). Generation and Breakup of Worthington Jets After Cavity Collapse.

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