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Project 4

The goal of this project was to photograph a fluid flow phenomenon while making a visually appealing picture. To do this water was simply dropped into more water. This simple setup can create interesting pictures with surprisingly complex physics. A phenomenon known as a crown splash can be seen in the photograph. This flow physics can be described and predicted using the Rayleigh-Plateau instability.

To create the flow colored water was simply dropped into the same bowl of colored water. To create the drops a small amount of liquid was removed using a spoon, which was raised then slowly tilted. The spoon was raised to a height of 3 to 4 feet above the surface of the water before the drops were released. As the drops hit the water there was a progression of different flows. First the water started as an individual drop before it hit the water. As the drop hits the water a secondary upward motion is created. A smooth cylindrical jet starts to form. As time progresses this cylinder moves upward and outward, increasing in diameter, until the rim reaches a critical point. [1] Once the rim reaches this point there are many different geometries that can form. The rim generally breaks up into smaller jets extruding further up and out from the cylinder. In the picture the cylinder is starting to break down after releasing these smaller jets. The drops from the jets can be seen above the mass of water. The formation of the crown splash can be explained and predicted using the Rayleigh-Plateau instability according to Deegan, Brunet and Eggers. In a 2008 article they explain that splash is driven by a surface-tension instability.

As described above colored water was removed then dropped into a bowl of the same liquid. The bowl used was a large cooking bowl with a diameter of approximately a foot and a half. The inside of this bowl was white, which was ideal for a contrast to the colored water. The water in the bowl was colored orange using a Gatorade powder mix. There was a gallon of water and 3 scoops, using the supplied scoop, of the Gatorade powder. The water became a translucent orange. The light used was a desk lamp that had a white CFL bulb. It was positioned on the left side of the bowl facing the middle.

The size of the photograph is approximately six by four inches. The splash was one foot away from the lens. The lens used was a Canon Zoom Lens EF-S 18-55mm 1:3.5-5.6. The photograph was taken with a focal length of 55 mm. The camera used was a Canon Digital Rebel XT. The original size of the photograph was 3456 x 2304 pixels, the cropped version is 3141 x 1589 pixels. The exposure setting were an aperture of f/6.3, a shutter speed of 1/400 sec and an ISO of 400. In Photoshop adjustments were made to improve the image. First the image was cropped so that the flow was centered in the picture. Second a reflection of the light was removed using the clone stamp tool. Third the picture was changed to black and white. This change improved the picture without removing any information. The colors were a little dull because of the relatively fast shutter speed.

This picture is a nice example of the final stage of the crown splash phenomenon. The individual drops which have departed from the rest of the flow can clearly be seen. It has good focus on the flow, with minimal blur. There is still a little blur from the motion; however it would hard to remove without a better light source to increase the shutter speed. The flash created too much reflection to be used. If I was to try and take this picture again I would change two things, the light source for focus and the fluid used. When doing further research I found that the different fluids can create this phenomenon better than others. Two good examples are milk and glycerol. When creating drops with these liquids, the flow pattern can be more easily created.

References

- [1] Deegan, Robert, Philippe Brunet, and Jens Eggers. "Rayleigh-Plateau instability causes the crown splash." 03 12 2008 Web.27 04 2009.
<http://arxiv.org/PS_cache/arxiv/pdf/0806/0806.3050v2.pdf>.