

## Group Delta Project II

The purpose of this project was to observe the effects of different flows in a tank of water. Our original intention was to help each other to observe a Worthington Jet. We used food coloring dropped into the water to see this phenomena. After putting the drops of food coloring in the water, we also observed many different beautiful fluid flows under the surface, created by the different density of the food coloring. We also decided to observe the effects of dropping dry ice into the tank with food coloring inside. My final image was produced by dropping a single drop of red food coloring into the tank from three feet above the surface.

The flow apparatus used for this photograph can be seen in Appendix 1. The tank had dimensions of 8 gallons and was filled with 4 gallons of water. A white piece of plastic was placed behind the tank to diffuse the light. A drop of red food coloring was dropped from three feet above the surface of the water. As soon as the food coloring hit the surface of the water, "an enormous pressure impulse similar to a water hammer is created within the droplet and the [water]. The droplet spreads outward forming a crown as it is slowed by viscous forces and surface tension. The crown eventually collapses and a Worthington jet is formed as the fluid rushes back into the crater left by the impacting drop." (Lampe) This process was very difficult to visualize, because it is very fast and motion blur was a problem. My final photograph shows the fluid directly after the Worthington jet went down.

The visualization technique used in this photograph was using water and food coloring. The food coloring was McCormick brand. After the Worthington jet was created, you can see that the force caused ripples on the surface. The ripples can be

seen because of light bending the lighted background. The drop of red food coloring can be seen in the center, obviously being the source of the impact. The lighting setup for this flow can be seen in Appendix 1. It consists of one 240 watt light bulb shining onto a piece of white plastic. This diffused the light, allowing a constant lit background on the flow. This light is what was bent in order for the flow to be visualized. The red food coloring looks very dark because all the lighting is from behind, so the food coloring blocks all light to the camera.

The field of view in the final photograph is 4in x 2in. The distance from the flow to the lens was 24in. The lens focal length is recorded as 70mm. The camera I used was a Canon EOS Digital Rebel XTi. The pixel size in the photograph is 1452 x 582, with an image resolution of 72 dpi. The exposure time was 1/30 sec, with an ISO speed of 1600. There quite a bit of Photoshop work done with this photograph. The image was first cropped. The layers were then adjusted and the brightness and saturation were adjusted. Finally some touchup was done using the clone stamp tool. I was trying to get rid of all color in the photo except for the red drop. I wanted to show only light variations in the ripples, but still wanted to keep the red of the drop. I believe I achieved this as best as I could, considering my minor Photoshop skills.

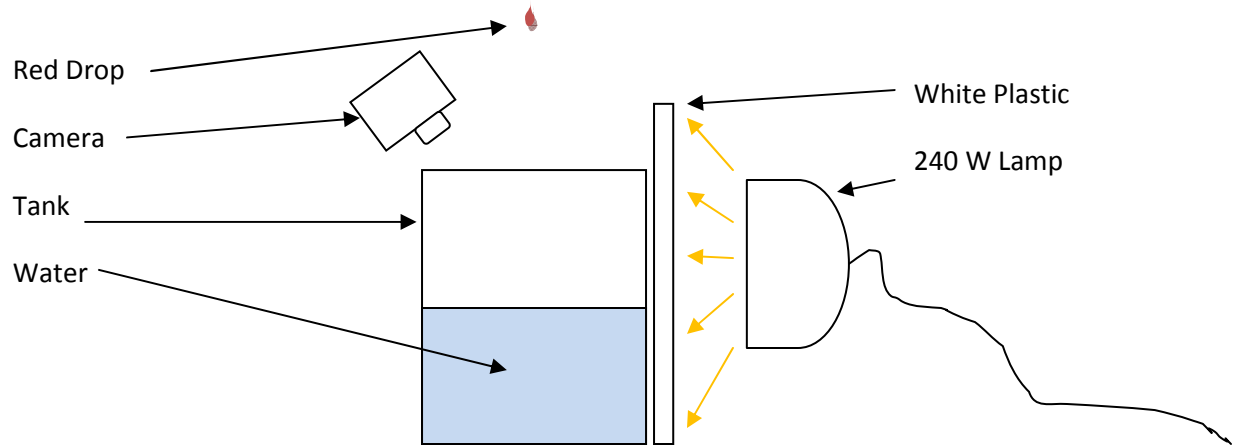
The image reveals a fluid directly after a Worthington jet was formed. We were trying to actually capture an image of a Worthington jet, but they all had motion blur. One way to actually capture a Worthington jet would be to use a high speed camera. I like how the image is mostly grayscale except for the red drop. I fulfilled my intent for this project, but there were some aspects that I would like to improve on. To develop this idea further, we could have tried a high speed camera, different types of fluids, or

even tried to capture the crowning effect. Overall, I am very happy with the result of this image.

Source:

Lampe, J. "Impact Dynamics of Drops on Thin Films of Viscoelastic Wormlike Micelle Solutions." Journal of Non-Newtonian Fluid Mechanics (2005): 11-23

Appendix 1



**Image Assessment Form  
Flow Visualization  
Fall 2007**

Justin Cohee

Assignment: Date: 11/08/07

Scale: +, ! = excellent Ö = meets expectations; good. ~ = Ok, could be better. X = needs work. NA = not applicable

<b>Art</b>	Your assessment	Instructor assessment
Intent was realized	+	
Effective	+	
Impact	+	
Interesting	+	
Beautiful	+	
Dramatic	+	
Feel/texture	+	
No distracting elements	+	
Framing/cropping enhances image	+	
<b>Flow</b>	Your assessment	Instructor assessment
Clearly illustrates phenomena	+	
Flow is understandable	+	
Physics revealed	+	
Details visible	+	
Flow is reproducible	+	
Flow is controlled	+	
Creative flow or technique	+	
Publishable quality	+	
<b>Photographic technique</b>	Your assessment	Instructor assessment
Exposure: highlights detailed	+	
Exposure: shadows detailed	+	
Full contrast range	+	
Focus	+	
Depth of field	+	
Time resolved	+	
Spatially resolved	+	
Clean, no spots	+	
OK, simple print	+	
Mat	N/A	
Mounting	N/A	
<b>Report</b>	Your assessment	Instructor assessment
Describes intent	Artistic	+
	Scientific	+
Describes fluid phenomena		+

Estimates appropriate scales	Reynolds number etc.	+	
Calculation of time resolution etc.	How far did flow move during exposure?	+	
References:	Web level	+	
	Refereed journal level	+	
Clearly written		+	
Information is organized		+	
Good spelling and grammar		+	
Professional language (publishable)		+	
Provides information needed for reproducing flow	Fluid data, flow rates	+	
	geometry	+	
	timing	+	
Provides information needed for reproducing vis technique	Method	+	
	dilution	+	
	injection speed	+	
	settings	+	
lighting type	(strobe/tungsten, watts, number)	+	
	light position, distance	+	
Provides information for reproducing image	Camera type and model	+	
	Camera-subject distance	+	
	Field of view	+	
	Focal length	+	
	aperture	+	
	shutter speed	+	
	film type and speed or ISO setting	+	
	# pixels (width X ht)	+	
	Photoshop techniques	+	
	Print details	+	
	"before" Photoshop image	+	