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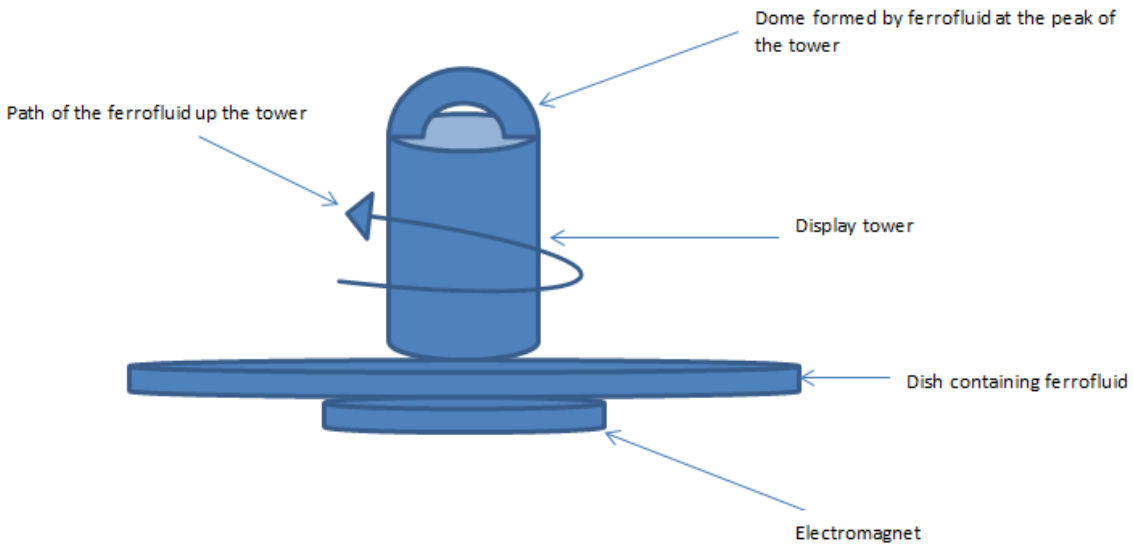
03-27-12

Team Image #1 Report

This report documents the effort of Group 3 of the Spring 2012 Flow Visualization Course in the first team image. All members of the team were present and actively participated in the effort to capture this image, and credit for this photo not only belongs to me but also to Peter Davis, Kerylyn Lay, David Oakley, and Brayden Hass. The purpose of this shot was to capture the ferrofluid display that will be placed in the ITLL at the end of this school year. The project is being designed by a senior design group in the mechanical engineering department (a team which Peter Davis is a member of). The purpose of my shot in particular was to capture the ferrofluid climbing one of the sculptures in the display, a spiral sculpture with a small orb at the peak which the fluid gathers upon and creates a small, spiked tip. The process by which the fluid is able to climb this sculpture will be described in later portions of this report.

The basic setup for the photo is shown below:



The setup shows the dish that held the fluid being captured in the image, as well as the tower that the fluid ascended with the help of the electromagnet. A ferrofluid is a fluid which contains nanoparticles of iron within the fluid itself, allowing the fluid to be polarized and exhibit unique behavior. Magnets will interact with each other due to their respective magnetic fields, however due to the fact that a magnet is a solid, we only see these effects in very simple forms (linear motion, attractive and repulsive forces, etc.). However, a ferrofluid is free to move as any other fluid, and thus we can

observe the forces of an applied magnetic field in a very special way. The fluid will move either towards or away from an applied field, and will do so in a similar manner as water flowing from gravitational forces. The result is a fluid flow that can be controlled and manipulated unlike any other. In this specific case, a magnetic field was applied from the electromagnet below the display, causing the metal structure to become polarized and the ferrofluid to flow up the spiral sculpture. The fluid can be seen to follow the path of the outside edge of the sculpture, and this is caused by the concentration of a magnetic field caused by the geometry of the object. The "point" that an edge comes to along the outer spiral portion of the structure will cause the magnetic field to amplify, which forms a gradient of higher magnetic forces moving radially outward from the center of the structure. Due to the ferrofluid's ability to move freely to the strongest force, we see that the fluid gathers at these edges until it reaches the tip of the sculpture, where it gathers and forms the characteristic spikes that ferrofluid forms when gathered at a single point. The applied magnetic field, combined with the unique geometry of this structure from the ITLL display combine to form the spiral flow seen in the image.

The photographic setup for this image was fairly basic. A dark purple sheet was held directly behind the sculpture as seen from the camera's line of sight, removing any stray light or glare caused by reflection. The camera was placed on a tripod and shot from a directly horizontal angle looking at the sculpture from the side. The sculpture itself is approximately 6 inches tall, and the portion seen in the image is roughly the top half of the sculpture, providing 3 inches of fluid flow. Lighting was applied from an angle above and to the side of the fluid, offset from the camera line of sight to reduce glare. This was the only source of lighting, flash was not used from the camera and the lighting in the room was shut off. There were no windows in the room. The direct source of lighting above the fluid was the only source. Photographs were taken as the fluid made its way up the sculpture and gathered at the top. The images were then reviewed and the best one was selected, at a point where the fluid had reached the peak and was gathering into a small dome at the top.

The image was taken with a Canon EOS 7D camera with a shutter speed of 1/125 sec, an F-stop of f/3.2, and an ISO of 800. The dimension of the shot was 5184 pixels in the X direction and 3456 pixels in the Y direction. The only work done in Photoshop was cropping to center the image and a black and white effect. The camera was approximately 12 inches from the object when the shot was taken.

Overall, I was very pleased with this shot. If I were to do this again, I might like to have a slightly larger setup, including a larger sculpture and more fluid. This might allow for the flow to be seen better, or it might not. However, the limitations of the project working for the ITLL display set the boundary for size and fluid available. However, I feel that the image clearly displays the unique effects of the fluid flow, as well as brings a very artistic touch. I would again like to thank my team for their wonderful contributions of ideas, equipment and talent.

References:

"Field-Induced Structures in Ferrofluid Emulsions" http://prl.aps.org/pdf/PRL/v74/i14/p2828_1

"Instability of ferrofluid magnetic drops under magnetic field"

http://prl.aps.org/pdf/PRL/v74/i14/p2828_1

Image Assessment Form

Flow Visualization

Spring 2010

Name(s)

Assignment: Date:

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

Art	Your assessment	Comments
Intent was realized	√	
Effective	√	
Impact	√	
Interesting	√	
Beautiful	√	
Dramatic	√	
Feel/texture	√	
No distracting elements	!	
Framing/cropping enhances image	!	

Flow	Your assessment	Comments
Clearly illustrates phenomena	√	
Flow is understandable	√	
Physics revealed	√	
Details visible	√	
Flow is reproducible	!	
Flow is controlled	!	
Creative flow or technique	√	
Publishable quality	√	

Photographic technique	Your assessment	Comments
Exposure: highlights detailed	√	
Exposure: shadows detailed	√	
Full contrast range	√	
Focus	!	
Depth of field	!	
Time resolved	!	
Spatially resolved	!	
Clean, no spots	!	

Report		Your assessment	Comments
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	N/A	
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)	OK	
	light position, distance	OK	
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	!	