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Flow Visualization
Group Assignment 1
10/25/07

This report details the photograph made for the first group project in the Flow Visualization course at the University of Colorado at Boulder. The group was working with soap films, and had interest in using a high-speed video camera to capture the swirling effect of the soap film reflections, as well as a detailed and in-depth documentation of the instant when the film bursts. However, even with the high-speed video, the film would burst so quickly, and become so thin and transparent beforehand, that the images were not effective. Subsequent image attempts were made with just a standard frame rate HD video camera, as well as a still camera, which captured the image attached to this report.

The intent of this image was to explore the relationship between film thickness, index of refraction, surface tension effects, and the resulting color. There is a relatively large amount of physics at play with soap bubbles. However, in contrast with other flow visualization techniques that are focused more directly on illustrating physics, good soap film photographs do not lose any aesthetic qualities at the expense of technical accuracy. They are both beautiful to look at and illustrative of the physics which guide them.

This image required a relatively simple setup of just a washbasin with a dish soap solution, a six-inch diameter plastic tube, and a lighting source. The light source consisted of three tungsten studio modeling lights positioned behind a diffuser screen. The soap film was held approximately two feet from the screen, and the camera was positioned approximately two feet from the soap film. A large angle is required between the camera, film, and light source. In this case, the angle was approximately 120-150 degrees.

The phenomenon of soap films results from surface tension effects and light refraction effects. Soap acts as a surfactant to reduce the surface energy of the water with which it is mixed, and serves to stabilize the bubble, strengthening the weakest parts of the film, and reducing evaporative effects such that the bubble may persist longer. The interesting color effects of the film is not precisely due to the presence of the soap, the soap simply allows the film to exist. The amazing colors that are observed in soap films are due to how light is reflected off of a film of varying thickness. When full spectrum light strikes the film, a portion of it is reflected back directly, and a portion is transmitted through the outer surface of the film, and again may be reflected or transmitted through the “backside” of the film in the same way. However, as the light is reflected around inside the film, the differences in the indices of refraction of the liquid and air causes a certain amount of interference and phase shift. This shift is proportional to the film thickness and the light wavelength, so some colors (wavelengths) become more intense than others. In effect, the color reflected indicates the thickness of the film in that area. Films are generally very thin, often 20-1500 nanometers.

In this picture, the field of view is approximately 3”x4”. The camera is approximately 2 feet from the film, with lighting another 2 feet from the film with a 120 degree angle from camera to film to lights. The camera was a Nikon D200, with a Nikon ED 24-120mm VR lens. Focal length was 75 mm, shutter speed was 1/80th of a second,

aperture was f/36, ISO was 800. No photoshop manipulation was required aside from cropping the image.

What I like about this image, and soap films in general, is how surreal they seem, despite the fact that they are extremely physics driven. Another thing I like about a still image of something so transient is that it allows the opportunity for close inspection and deliberation of something with which in life we are only allowed such brief interactions. Also, depending on when in the life of the bubble the image is captured, one can see the beginnings of the bubbles ultimate demise is the streamers of fluid moving from top to bottom, thinning the film to the point where the top becomes too thin and unstable to persist. When an image is captured early in the life of the bubble, there is much more swirling effect and it looks especially psychedelic. I always wondered what the driving inspiration behind psychedelic art was, but now I'm guessing soap films must have had something to do with it. They seem to complement the psychedelic scene wonderfully in the sense that my impression of that scene is that they are seeking to experience the same everyday world in a totally different way, and soap film images certainly do allow a glimpse of something very unique and interesting that goes unnoticed every day.

In developing this concept further, I'd like to get a similarly vivid image as this of an actual bubble, and not simply a film over the end of a tube. I imagine that this will be difficult since the angle of refraction is the driving force behind the interesting colors. I'm not sure I will be able to achieve strong colors across the whole surface of the bubble, but I'd like to give it a try.

References:

http://en.wikipedia.org/wiki/Soap_bubble