Flow Visualization
MCEN 4151

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Team Project II

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Introduction:

The image shown on the previous page is a one of the images taken by Team 3 during our bubble imaging experimentation. Credit for the original photograph must be shared with Daniel Allen, Anna Gilgur and Jonathan Fritts. Each group member participated in the experimentation process aided in the capture of the final photograph collection. The purpose of this image is to demonstrate to the viewer how the simple nature of the soap bubble is accompanied by unique physics and beautiful imagery. Soap bubbles are primarily appreciated by the youth, so the group thought it could be beneficial, as well as fun, to reach back to the days of our youth and capture these images. The intent of our images was to capture some unique perspectives to convey the physics of the soap bubbles whilst also using some special situations to increase the aesthetic appeal of the images.

Bubble Physics:

The image shown contains several different physical-fluid phenomena. The bubble itself is spherical due to LaPlace's Law. LaPlaces Law states that the larger the vessel radius becomes, the larger the wall tension required to withstand a given internal fluid pressure. Thus, for a given vessel radius and internal pressure, a spherical vessel will have the least wall tension for a specified fluid volume [1]. In order for the surface tension to match the wall tension from the internal pressure, the bubble naturally assumes the spherical shape to preserve itself. On the surface of the bubble, especially toward the top, one can see the glossy surface dynamics of the bubble, as the membrane itself is moving around the contained volume. These surface flows are the product of gravity. The bubble is fluid and has finite mass thus gravity will affect it while it exists. The bubble begins its life with relatively uniform mass and as time progresses the mass on the top hemisphere of the bubble will digress toward the bottom. As the soapy mixture flows downward unique refraction patterns can form within the areas of changing thickness. Thus the sunlight shining down on the image can show where flows are occurring on the bubble's surface. Lastly, and the most beautiful, is the image inversion occurring in the opposite hemispheres of the bubble. The lower *inverted* image is from the bubble's rear surface acting as a large concave mirror. The image is *real* in that it would be visible on a screen if it could be held inside the bubble between its center and back surface [2]. The upper *upright* image is from the bubble's front acting as a convex mirror. The reflected rays appear to come from an image of the sun and landscape placed between the bubble center and its front surface. This image is *virtual* and cannot be captured on a screen [2]. This process is illustrated below in Figure 1 and Figure 2 respectively.

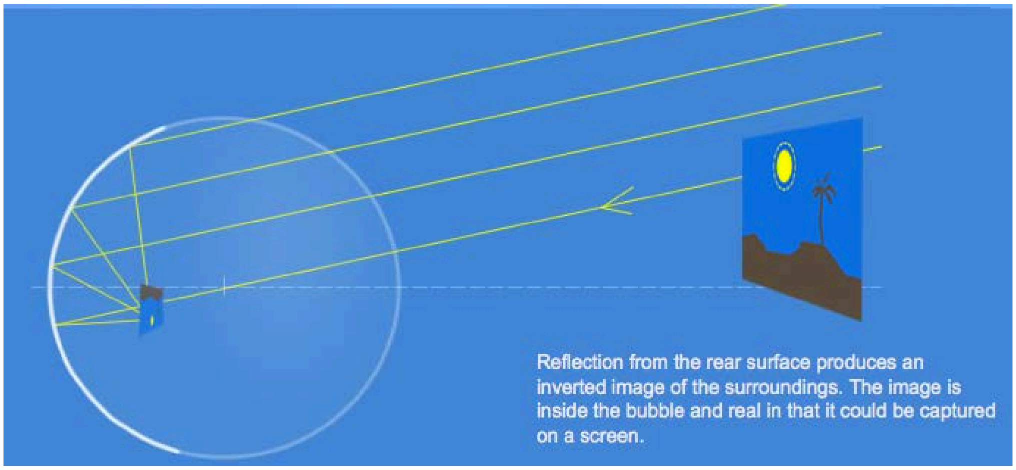

Figure 1- Illustrates the formation of the real, inverted image in the bubble.

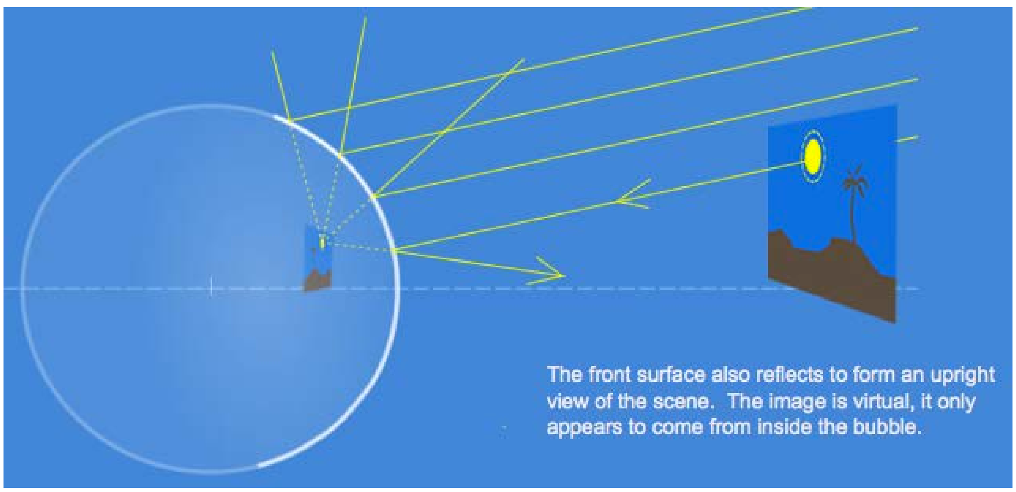

Figure 2- Illustrates the formation of the virtual, upright image in the bubble.

Image:

This image was taken on March 15, 2013 outside the ITLL Laboratory. We constructed a “bubble wand” consisting of two wooden dowels connected by two strings with a weight at the bottom to make the open cavity to form the bubble. It took some time to learn how to use it and create the right type of bubble for the lighting situation. However based on the wind, light, and image goals we learned to optimize the size of type of bubble formation. This image was taken in the area outside the bottom floor of the ITLL laboratory, facing the wall such that the imagery behind the photographer could be captured. Out of over 400 pictures, only about five yielded productive and clear imagery such as this. I elected to use this particular image because I found its projection of the rear scenery to be the most clear as well as the bubble’s surface dynamics appear the most evident. Overall this image had the most potential to educate the viewer as well as captivate them with its overall beauty.

Photographic Technique:

The following is the settings used to capture the image.

- Camera: Cannon Rebel XT Digital
- Lens: Cannon 150mm Macroscopic Lens
- Image size: Original – 3456x2304 pixels and Edited – 1674x1714 pixels
- Exposure Settings: ISO-200, F/-4.5
- Exposure Time – 1/60 second
- Editing- Cropping, color balance and color contrast adjustments were done in Photoshop CS6

Original Image **Edited Image**

The original and edited images are shown above. The edited image was cropped in all four directions to isolate the bubble at its edges. A manipulation of color balance brought out some of the pinks and purples in the reflection. The curves tool was used to sharpen the contrast between the bubble's edges and the background significantly. Lastly the selective colors tool was utilized to separate the black of the trees from the colors inside the bubble.

Commentary:

I enjoy this image very much because it really demonstrates the unique characteristics and behavior of bubbles without spoiling the simplicity. The multiple types of physics occurring in the image offer a variety of opportunities to grab the viewer's attention. The surface dynamics of the bubble are clearly shown and the clear imagery in the reflection of the scenery is the best part, combined it creates a truly pleasing image.

Citations:

1) N.p.. Web. 2 Apr 2013. <http://hyperphysics.phy-astr.gsu.edu/hbase/ptens.html

2) N.p.. Web. 2 Apr 2013. <http://www.atoptics.co.uk/fz618.htm>.