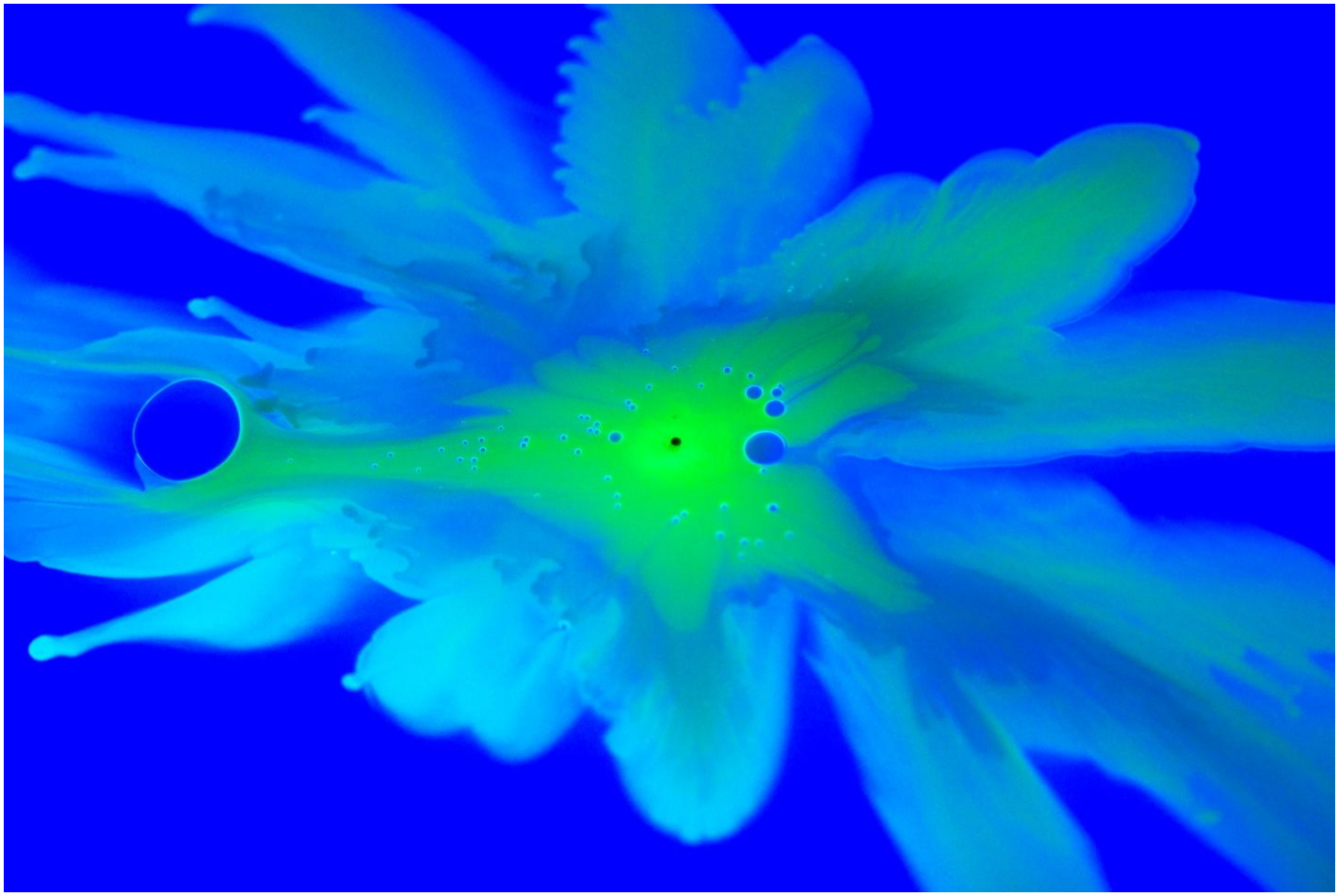
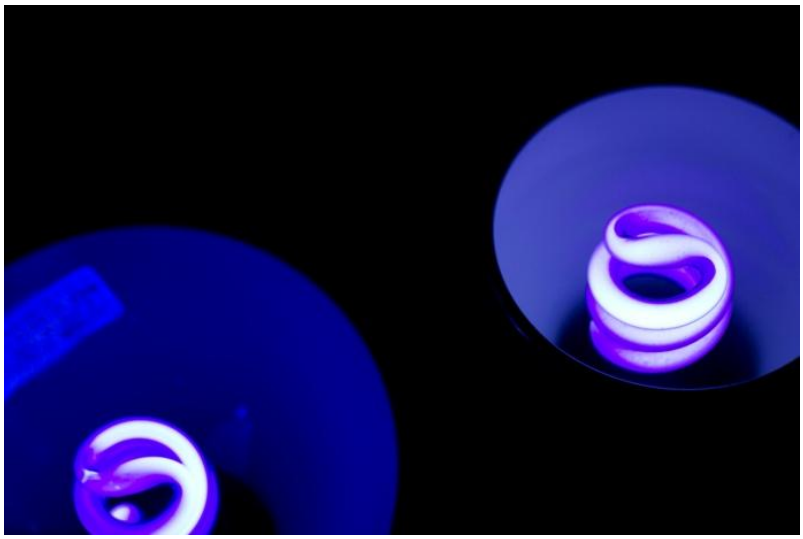
**Flow Visualization** **Steven Hendricks**
**Spring 2011** **4/28/2011**
**Team Assignment #3**

For the final team assignment of Professor Hertzberg's Spring 2011 Flow Visualization Course, I wanted to incorporate fluid physics with bright fluorescent colors in a dramatic visual effect. In order to display the colors that I was imagining, I wanted to use various liquids that glow when placed under a black light. Basic research led me towards items such as vitamin b-12, tonic water, highlighters, laundry detergent, and various other household items. Our team decided to take advantage of the Hele-Shaw Cell which was provided by the course instructors to create the marvelous pedals of liquid presented below.



In order to create this set of photos, we used the Hele-Shaw Cell, which consists of a small frame with four legs and resembles a small end-table. This is not merely a table, but a creative device used to exploit various fluid properties and display them with great clarity. The horizontal table-top consists of two flat sheets that are placed parallel to each other with a viscous liquid sandwiched in between. The upper sheet is fully transparent and is composed of an acrylic material, yet the bottom sheet is made from a white, semi-transparent plastic plate with a $1/8^{th}$ inch hole drilled in the center for injecting another fluid. We were instructed that the 'finger' effects would be present with a significant

viscosity difference between the two liquids so we took this into consideration when picking our materials. After some testing with the ultraviolet light on various liquids, our team decided to use laundry detergent as the initial layer in the cell due its viscous nature and bright blue hue when illuminated. For the second liquid we needed something that had contrast against the blue but was also thin and runny so we ended up using the yellow ink from highlighters and injected it into the cell through the port. The pedals in the image are composed of a diluted highlighter mixture and were created by forcibly injecting it between the plates. Since the highlighter was bounded by the laundry detergent, it needed pressure to push it through other liquid, this is why we used a syringe. What we are seeing in the picture is the result of this pressure as we force the liquids together but their surface tension tries to keep them separate therefore the pedals and fingers are created.[1] The vivid fluorescent colors glow due to the fact that the UV light has a shorter wavelength and higher energy than the mostly longer wavelengths that we are used to seeing in normal daylight. The laundry detergent and highlighter begin to emit many photons when exposed to the black light and it was a combination using the proper liquids with the black light and the use of the Hele-Shaw cell to create these awesome images.[2]

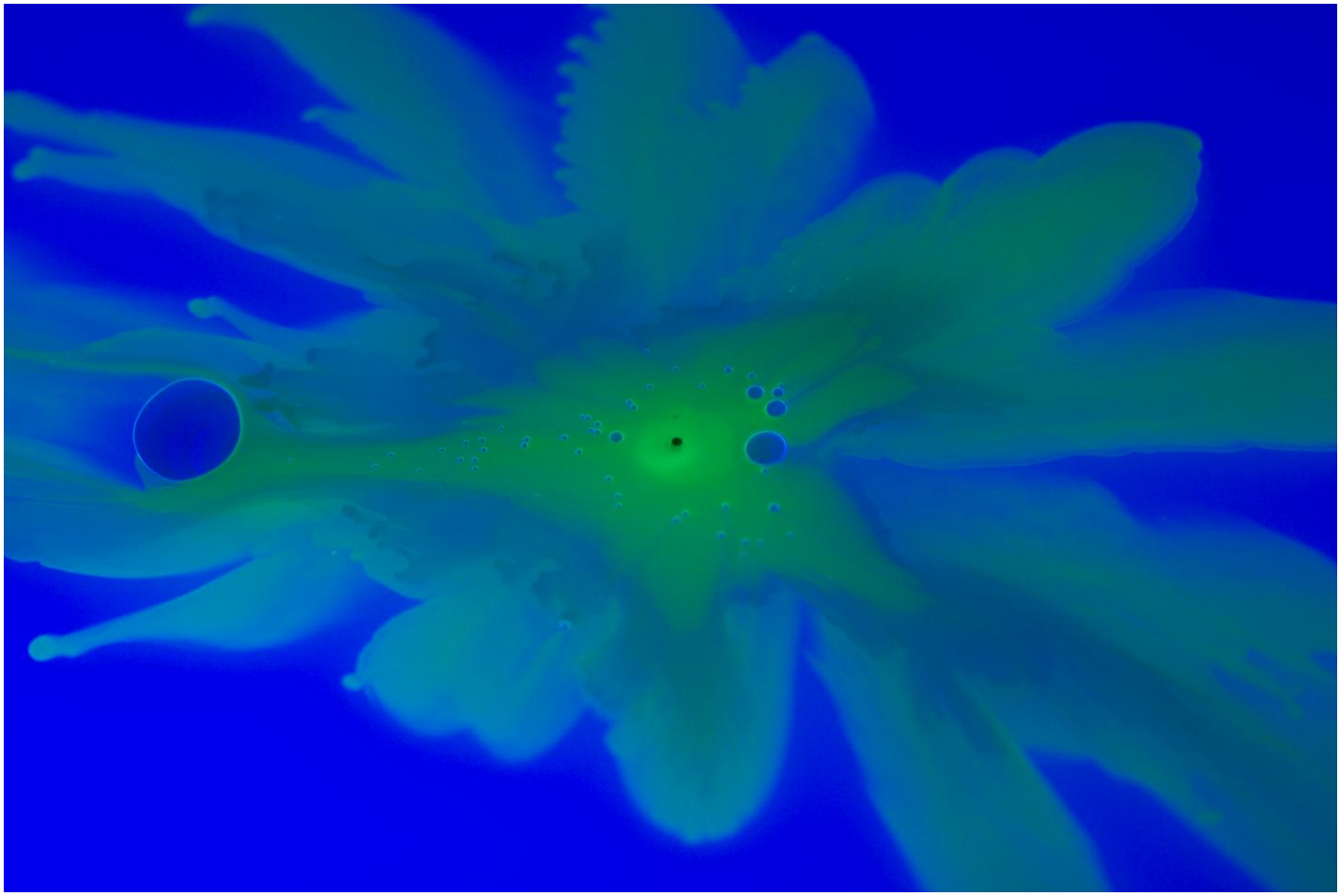


To set up the photo-shoot, we used the media shack in the ITLL and covered the windows so that the room was dark. There were three black-lights that were placed below the table to illuminate the liquids and myself, the cameraman, stood above the table looking down at the display. We started the session by fully cleaning the Healy Shaw cell and finding a syringe that was compatible with the port on the flat plate. Once this was done we spread a layer of laundry detergent across the bottom white sheet and then placed the clear top sheet directly on top of the liquid. The bubbles that are visible in the photo were present when mating the two sheets together but did not move with the insertion of the highlighter, therefore we can see the result of the highlighter making its way around the bubbles. With the lighting coming from below, this created a large blue blob which glowed with an artificial vibrancy. Several highlighters were taken apart to expose the ink which we diluted in a cup of water and filled into the syringe. Once it was connected to the port on the device, we injected the liquid in small slow increments which created some of the finger and pedal effects seen in the picture. There was a balance of fluid control with photo capturing as we would take turns injecting highlighter, then pausing to take many photos. I ended up taking over 95 photographs with the camera before it was time to clean up and fortunately several of them came out great.

During shooting, I was able to graciously borrow Mr Kim's camera in order to capture the images seen here. This is a Canon Digital EOS Rebel T2i with an EF 100mm macro lens attached. We took these pictures on the afternoon of April 19th and according to the camera meta-data, the shutter speed was 1/125 second, the aperture value was f/3.2,

the ISO was 320, the focal length was 100mm, and the F-stop was f/3.2. The dimensions of the image are 5,184 pixels wide by 3,456 pixels high and the image was not cropped during processing. The lighting of the photos was rather dark and although the camera settings were optimized for the dark environment, many of the pictures were dim and somewhat blurry. After fiddling with the settings during shooting, and using manual focus, I was able to better control the camera while being able to recognize the quality of the photos in order to judge that they would be acceptable. Minor adjustments were made in Adobe Photoshop once we were through taking the photos, and I used a combination of the brightness/contrast feature with minor tweaking in the curves department to liven the pictures up and make them appear as close to how they were presented to me in the room with my own eyes.

Overall I am very pleased with the quality and results from the experiment and use of the Hele-Shaw cell. The use of the ultraviolet light enabled me to get the colors and contrast that I imagined from the start, and the camera was able to capture many of the fine details that were created by the fluid movement and interactions. I would definitely work with the Hele-Shaw cell again, and would recommend trying to experiment with many types of liquids in order to get the desired effects.



References


1. "Hele-Shaw Flow." *Wikipedia, the Free Encyclopedia*. Web. 05 May 2011. <http://en.wikipedia.org/wiki/Hele-Shaw_flow>.
2. "Fluorescence." *Wikipedia, the Free Encyclopedia*. Web. 05 May 2011. <http://en.wikipedia.org/wiki/Fluorescence>.