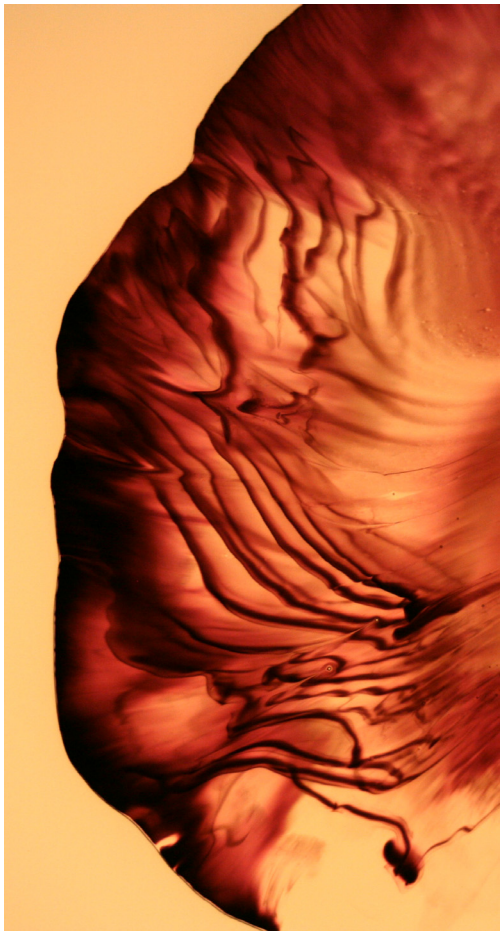
Team Project #1 Delta

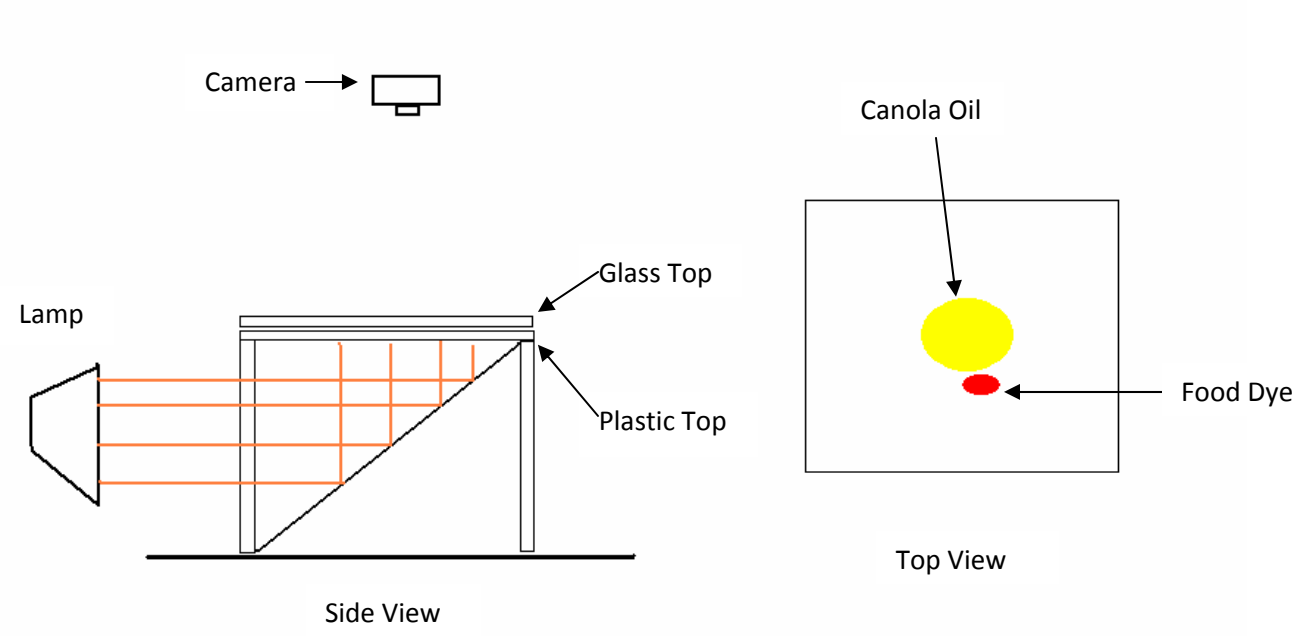


Phil Bollam

October 25, 2007

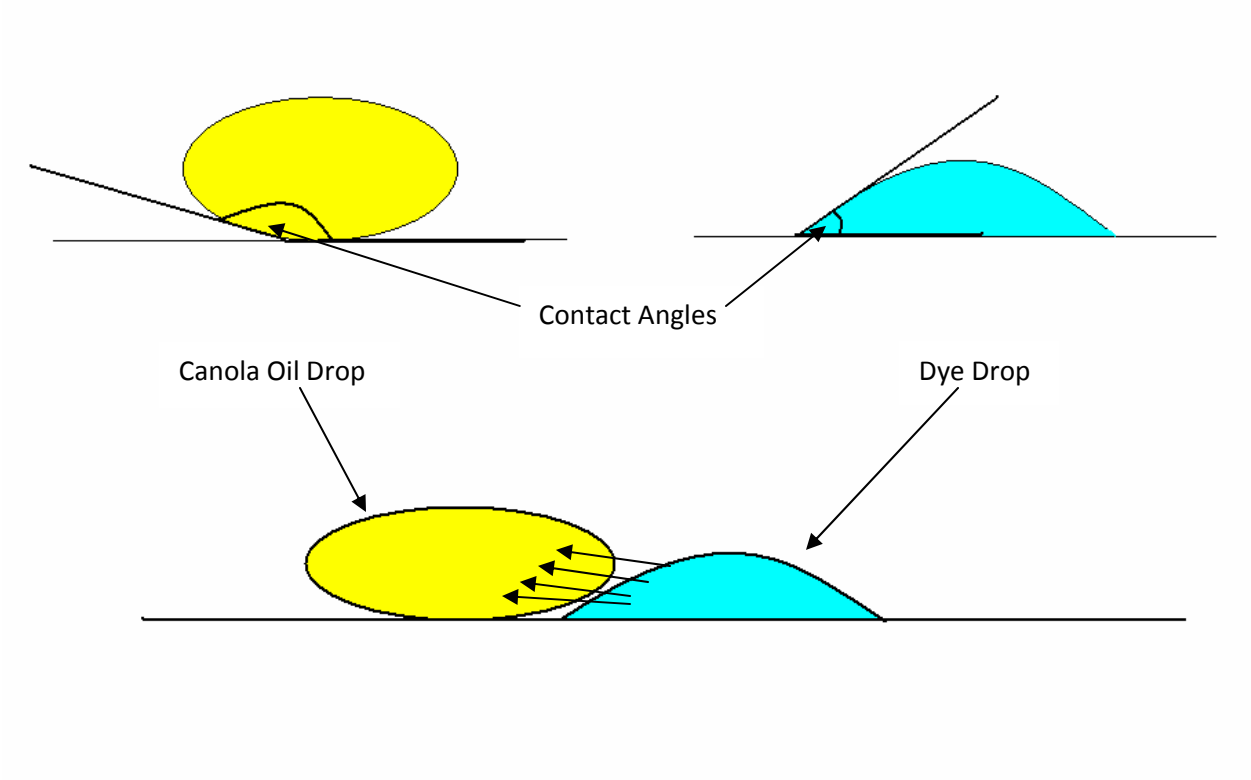
The purpose of this project was to create an aesthetically pleasing image that involved a complicated fluid flow. Team Delta decided to use canola oil and dyes to meet these requirements. The Hele Shaw Cell experiment was conducted several times along with just adding food dye to puddles of canola oil. I chose to use the image from adding dye to a puddle of canola oil because in my eyes, it was much more beautiful. There were several mechanics of fluids principles at work when conducting this project. They include the wetting of fluids, the viscosity of fluids, and the surface and interfacial tensions of fluids. These properties are interrelated and caused the dye to propagate into the oil in layers producing a very stimulating flow.

The apparatus used in this experiment was very simple to set up. A white plastic table covered in glass acted as the surface for the experiment. The lighting source was put underneath the table and deflected at 45 degrees to the bottom of the table. Canola oil was poured on the glass and dye was added to the edges of the oil on the glass. The camera was positioned directly above the oil. The figure below displays this schematic.



The principles associated with this flow are surface and interfacial tensions, the contact angles, the wetting of fluids, and the viscosity of fluids. In this experiment, the dye is considered a penetrant material because of its ability to wet the surface of the glass. At the liquid-solid surface interface, the molecules of the dye have a stronger attraction to the molecules of the glass surface than to each other. This means the adhesive forces are stronger than the cohesive forces and therefore has low surface tension. This causes a very small contact angle between the dye and the glass. On the other hand, the molecules of the canola oil are more strongly attracted to each other than to the molecules of the glass surface and

therefore do not wet the surface of the glass. Since canola oil does not wet the surface, we can conclude that the contact angle of oil is greater than 90 degrees. When the dye encounters the canola oil, there is an attraction between the two liquids. The adhesive forces between the dye and the oil will compete against the cohesive forces of the dye. Since the dye has weak cohesive forces and a strong attraction to other surfaces, the dye will spread into the oil. The dye's contact angle is less than the oil's contact angle and will therefore penetrate the oil from the bottom to the top forming layers. The figure below demonstrates this phenomenon.



The initial size of the canola oil puddle was a 4 inch diameter circle. The canola oil spread over the table growing up to 6 inches in diameter which took approximately 3 minutes. The image was taken after the canola oil had stopped spreading. The dye was not diluted with any solution so we could easily visualize the flow into the canola oil. The lighting used was a 120 v, 150 W light bulb which was reflected by 45 degrees to the bottom of the table. The image was taken in a dark room without using the flash on the camera.

This image was captured with a Canon EOS Digital Rebel XTi camera. The shutter speed was 1/200 seconds and the aperture value was f/4. The ISO was 400 and the focal length of the lens was 40 mm. No flash was used for this image. The pixel dimensions were 3888 x 2592. The field of view was approximately 6 inches by 6 inches and the camera was approximately 3 feet above the image. Photoshop was used to crop and lighten the image.

This image reveals the fluid flow of dye into a puddle of canola oil. It shows that the dye is absorbed into the canola oil through different levels due to the contact angles of each fluid. I really like that the image captures the different levels of fluid flow but I dislike that it is very dark around the edges of the fluids. Maybe a different color dye could be used to get a better contrast around the edges. I believe I fulfilled the intent of creating a complicated and interesting fluid flow.