

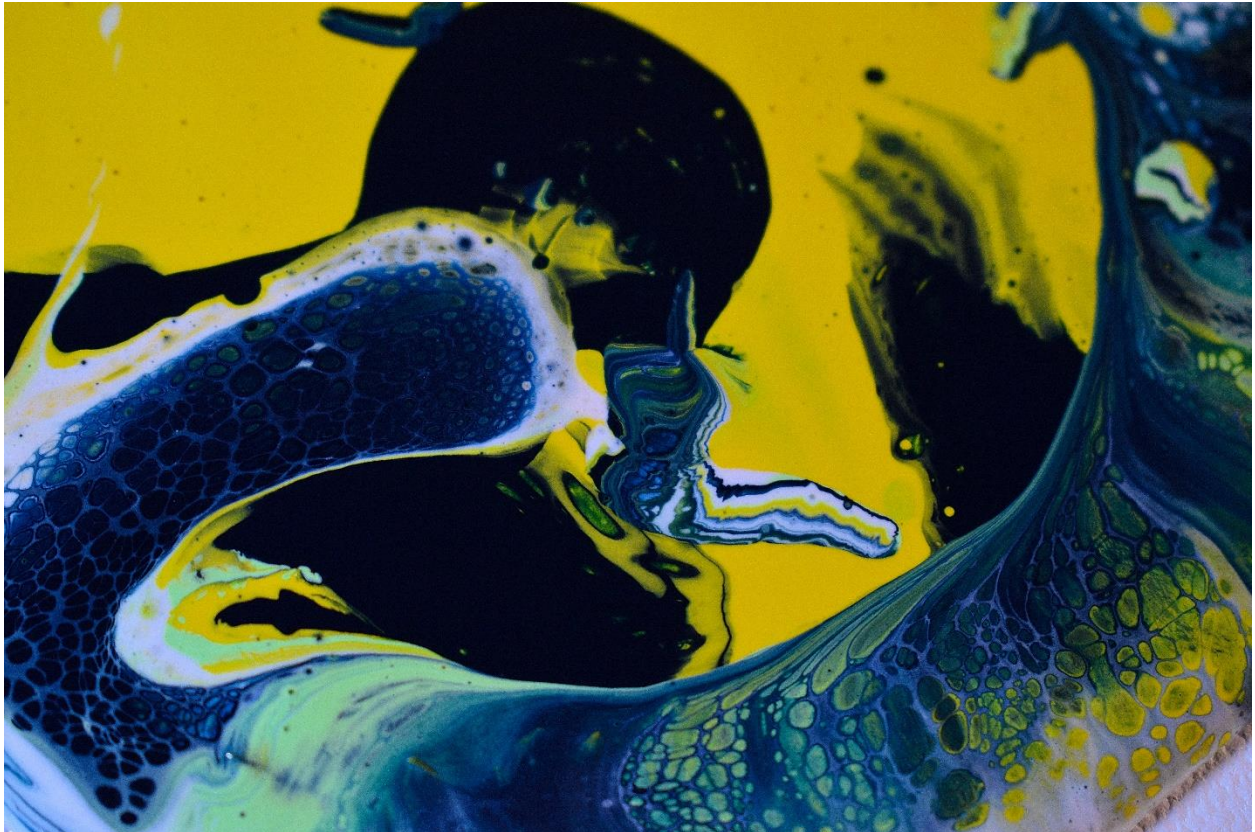
MCEN 4151: Flow Visualization

Section 001

Team First Report

10/14/2019

By: Jared Moya



The Team First Assignment allowed us to collaborate with our team members to create an experiment and visualize any fluid physics phenomena of our choice. After researching various interesting fluid physics experiments, we decided that the art of Acrylic Pouring would provide us with some very artistic, yet highly scientific images. Acrylic Pouring is a painting technique where acrylic paint is mixed with a pouring medium, in our case silicon, and poured on a canvas. The fluid phenomena we were trying to capture was Rayleigh-Taylor Instability which occurs when fluids of different densities interact dynamically—where the lighter fluid applies a buoyant force to the heavier fluid.

In order to capture this effect, two of my teammates (Alejandra Abad & Nebiyu Tadesse) and I gathered all the appropriate materials which are listed in **Table 1**.

Materials	Quantity
Acrylic Paint	4 colors (Yellow, Blue, Green, & White)
Silicon Oil	1 bottle
Water	3 Solo Cups filled
16oz Cups for Mixing/Pouring	3
Pipette	1
Blank Canvas	2 (white)
Photography Lighting Set	2

Table 1. List of materials used to create the Acrylic Pouring Painting

In order to capture this effect, it was essential to concoct a mixture of the acrylic paint, silicon, and water so that everything would flow smoothly during the pouring process. Through trial and error, we found that the optimal mixture consisted of 1 part water, 2 parts acrylic paint and 2 drops of silicon via pipette. It was also very important to keep the acrylics paints that were different colors separate so that you can have different layers of acrylic paint. The following procedure occurred to properly set the experiment up:

Step 1: Change viscosity of acrylic paint by mixing the different colored acrylic paints of your choice in a separate cup for each paint color with 1 part water, 2 parts acrylic paint, and 2 pipette droplets of silicon (this may change depending on how viscous your acrylic paint already is—if it flows easily you may need to use a smaller ratio of water and paint).

Step 2: Set up photography lighting so that you are able to capture a high-quality image.

Step 3: Layer the different colored acrylic paint mixtures into a clean cup—make sure not to mix the different paints as you want them to sit on top of each other to best visualize the acrylic pouring effect.

Step 4: Take the blank canvas and place it on top of the open end of the cup mixture.

Step 5: Pushing both the canvas and cup mixture together so no paint seeps out, flip the canvas and cup 180 ° and lay the canvas on a flat surface.

Step 6: Slowly pull the cup mixture up and you should see the paint begin to flow radially outward.

The experimental setup can be visualized in **Figure 1**.

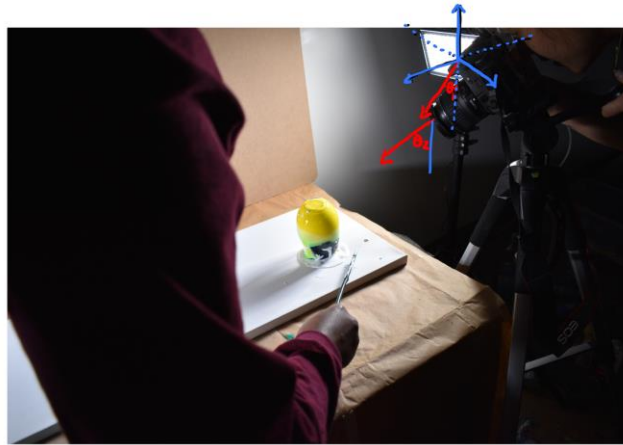


Figure 1. Photograph of the experimental setup. $\Theta_1 = 30^\circ$ (light angle) and $\Theta_2 = 45^\circ$ (camera angle)

By following this procedure, we were able to visualize Rayleigh-Taylor Instability first-hand. Adding the silicon pouring oil to the paint changed the density of the mixture and therefore we were able to see cells form in our pour as the lighter fluid pushed the heavier fluid mixture up. We were also able to see the paint flow outward and visualize vortices in the flow. Looking at the two-dimensional Inviscid Vorticity Equation described by *Eq.(1)* we can estimate how vortices were formed during the flow.

$$\frac{D\omega}{Dt} = \frac{1}{\rho^2} \nabla \rho \times \nabla P \quad \text{where,} \quad \begin{array}{l} \omega = \text{vorticity} \\ t = \text{time} \\ \rho = \text{density} \\ P = \text{Pressure} \\ g = \text{gravity} \end{array} \quad (1)$$

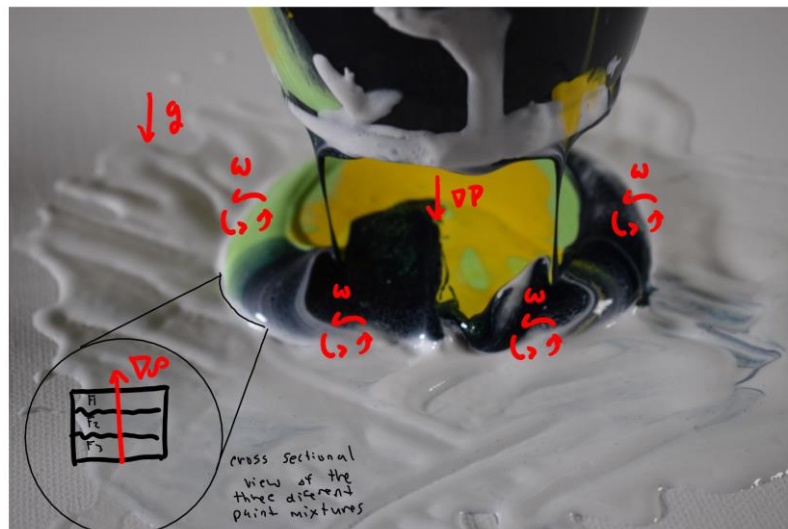


Figure 2. Visualizing the Rayleigh-Taylor Instability in the flow

This photograph was taken a few inches away from the paint at a focal length of 48mm, an exposure time of 1/125s, a maximum aperture of 4.9, and an f-stop f/5.3. A Nikon d3500 DSLR camera was used to capture this 4,000 x 6,000-pixel image. I decided to take my picture up close and zoomed in to the paint because I liked how it clearly showed the cells created by the acrylic and zinc mixture. I also enjoyed the abstractness of the image because it is not very clear what exactly is going on and allows for a more creative interpretation by the audience of the art. During the post-production phase, I used Nikon ViewNX-i photo editing software to add a color boost to the photo, so the image was a bit more vivid—besides this no other aspect of the photo was altered. The difference after post-production can be visualized in **Figure 3**.

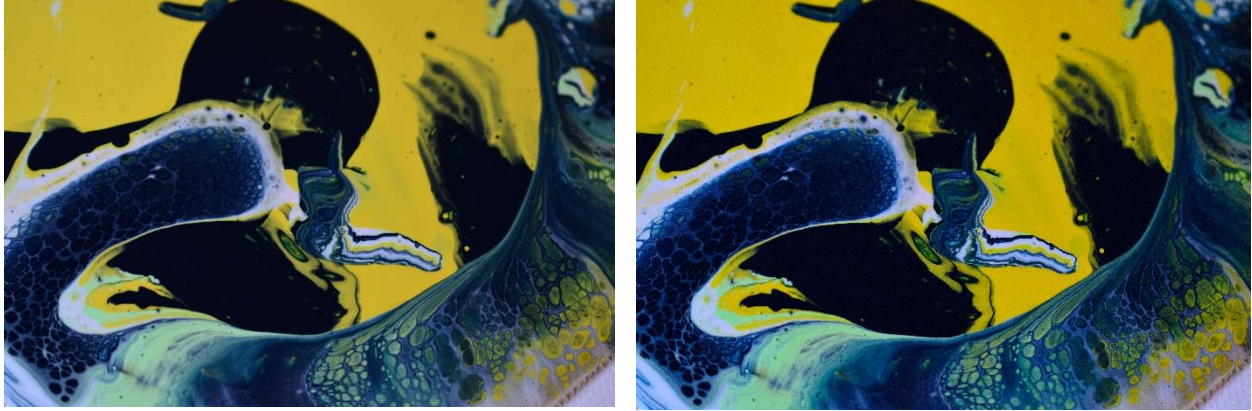


Figure 3. Side by side comparison between non-edited image (left) and edited image (right)

Overall, I am very pleased with the outcome of my photo. I was able to successfully capture both a nice abstract view of the acrylic paint along with the clear fluid physics that was a product of the acrylic pouring technique. I enjoy how the image required little post-production editing as it was already naturally aesthetically pleasing. The intent of my photo was fulfilled but I could have captured the Rayleigh-Taylor Instability even better with a slow-motion video.

References

- admin, By: "The Science Behind Acrylic Flow Painting." *Fluid Art Projects*, 4 July 2019, www.fluidartprojects.com/the-science-behind-acrylic-flow-painting/.
- Kelley, Carrie. "How to Do a Pour Painting: A Tutorial for Beginners." *FeltMagnet*, 26 Feb. 2019, feltmagnet.com/painting/How-to-Do-a-Pour-Painting.
- "Rayleigh–Taylor Instability." *Wikipedia*, Wikimedia Foundation, 15 Sept. 2019, en.wikipedia.org/wiki/Rayleigh%E2%80%93Taylor_instability.