

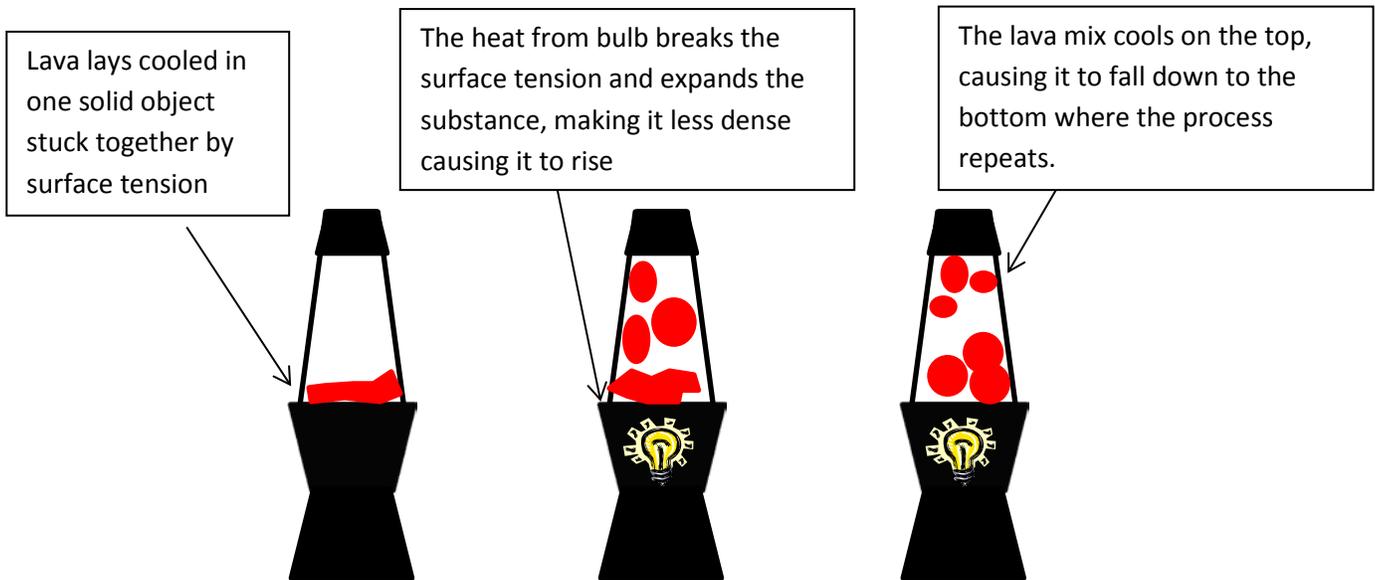
Get Wet Image Report

The purpose of the first project in flow visualization was to become familiar with camera techniques and observe and record an interesting fluid phenomenon. Several years of this course have provided an extremely large gallery of images and videos showing various flows of flames, gases and fluids. Many experiments have been repeated with slight modifications that basically show the same effects. It was my intention to be innovative and capture an image and experiment that previously had not been done. Therefore, I decided to experiment with a lava lamp. I originally allowed the lava lamp to heat up and flow as a single object from top to bottom, as most people are familiar with. I recorded several images of this, changing the shutter speed, aperture, and ISO to become more familiar with features of my camera. Although the images were interesting, I continued to experiment in other ways by changing the lighting and other aspects of the setting. Finally, I recorded an intriguing image by slightly shaking the lava lamp and disturbed the lava inside to observe thousands of agitated rising and falling bubbles. Many features in the photo editing software GIMP were used to alter the chosen picture.

A lava lamp is an excellent balance between conceptual physics and practical engineering. The lava (primarily colored wax, but also has oil and other solids²), has mismatched polarities then water keeping the liquids in the lamp from mixing¹. The wax sticks together by surface tension. The heat from the bulb at the bottom breaks the surface tension, pushing the mass apart into separate beads and making different patterns of wax in the lamp. How the lava flows up and down in the lamp itself has to do with its specific gravity. Specific gravity is simply the ratio of substances density to the density of water as seen in the equation below:

$$SG_{true} = \frac{\rho_{sample}}{\rho_{H_2O}}$$

The waxy matter in the lamp has a specific gravity very close to that of the liquid that surrounds it¹, and therefore similar densities. When the wax warms, the molecules spread and the material becomes less dense which causes it to rise to the top of the glass. At the top, it cools and the specific gravity rises higher than the liquid, causing the wax to fall down to the bottom again. This is where the engineering comes in due to the volume needing to be designed so the wax cools enough at the top to fall down to the bottom instead of remaining at the top. This cycle repeats over and over. A drawn schematic of this can be seen in the figure below:



These scientific details describe how a lava lamp typically works. However, the final image taken was snapped after the lava lamp was shaken abruptly. These vibrations caused the surface tension of the wax to break, resulting in thousands of individual pieces. The pieces moved in random directions due to forces placed on the fluid. Slight vortexes formed and waves propagated through the entire glass causing complete chaos. In the final image, you can see the small disturbed particles as well as large pieces that are still rising and falling from changes in density as the lava lamp normally acts.

There were a few visualization techniques used. The surrounding area was blocked from indirect light such as sunlight. In fact, the only lighting used was the direct lighting from the bulb at the bottom of the lamp. The room the photo was taken in was completely dark and no flash was used to avoid seeing a reflection on the glass. A dark fabric was wrapped around the outside of the glass in order to focus the viewer only on the lava and not on magnified images behind the lamp.

The following photographic techniques were used to capture the image:

Size of field of view	3 inches across
Distance from object to lens	Approximately 1 inch
Lens specs	6.0 – 22.5 mm
Type of camera	Digital Canon S90 Powershot
Original/Final Image width	3648x2736 pixels
Aperture/ISO	F 2.0 / 160
Shutter Speed	1/60 s
Photoshop processing	<ul style="list-style-type: none"> • Increased contrast making “S” curve • Bucket fill tool to add black and white colors to foreground and background

The close-up image used a wide aperture because a shallow depth of field was desired. Therefore, the shutter speed was adjusted to 1/60 to ensure the correct exposure for the image. The image was not intentionally overexposed or underexposed. When editing the image in GIMP, the curves feature was used to increase the contrast and give more color and life to the image. Many other features were tested, and ultimately the fill tool was used to add a few black areas and white area. This was a bold decision, but I believe adds a lot to the image. It gives the image a lot of contrast and allows the viewer to focus on the small bubbles of lava in front of the white background. The before editing image and after editing image are shown below:

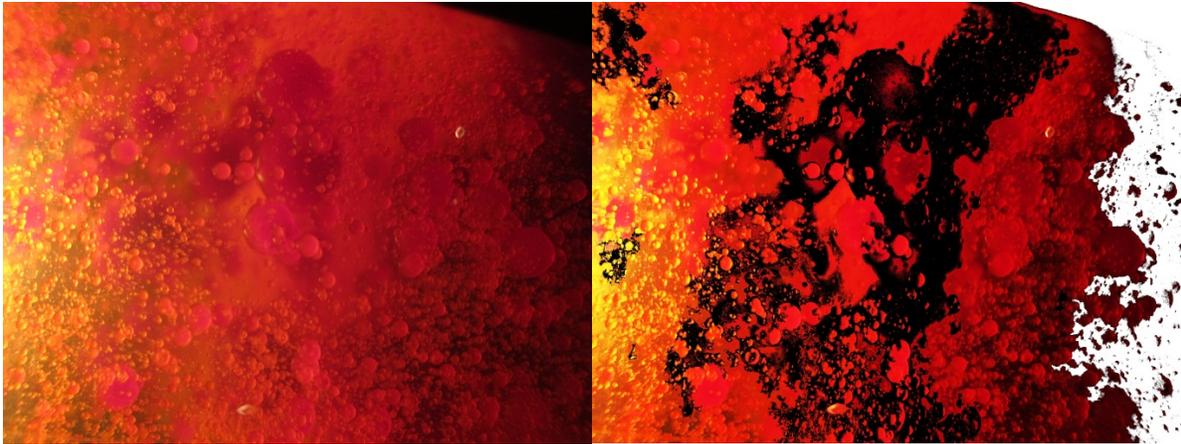


Figure 1 - Image Before Editing

Figure 2 - Image After Editing

The invention of a lava lamp shows several examples of science. Fluid dynamics, heat transfer, chemistry, and thermodynamics are just a few topics present in the functionality of a lava lamp. The chemical composition of the waxy substance allows the physical matter to change by convection and then rise and fall in the liquid from a change in density. To add even more to the existing occurrences, the vibrations by shaking the lamp caused forces on the fluid and aggravated the lava. The final image taken shows several scientific features and is an excellent example of flow. The use of photo editing software drastically changed the image. After seeing what the software has to offer, I am curious to how else I could have edited this image and what the limitations of the program really are. I look forward to learning more about photo editing software and using it in upcoming images, but also understand it is useless without practicing great photo shooting techniques.

References

1. "Lava Lamp." *Wikipedia*. Wikimedia Foundation, 02 Feb. 2013. Web. 06 Feb. 2013.
2. Merry, Bellis. "The History of Lava Lamps." *About.com Inventors*. N.p., n.d. Web. 06 Feb. 2013