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Flow Visualization Fall 2023

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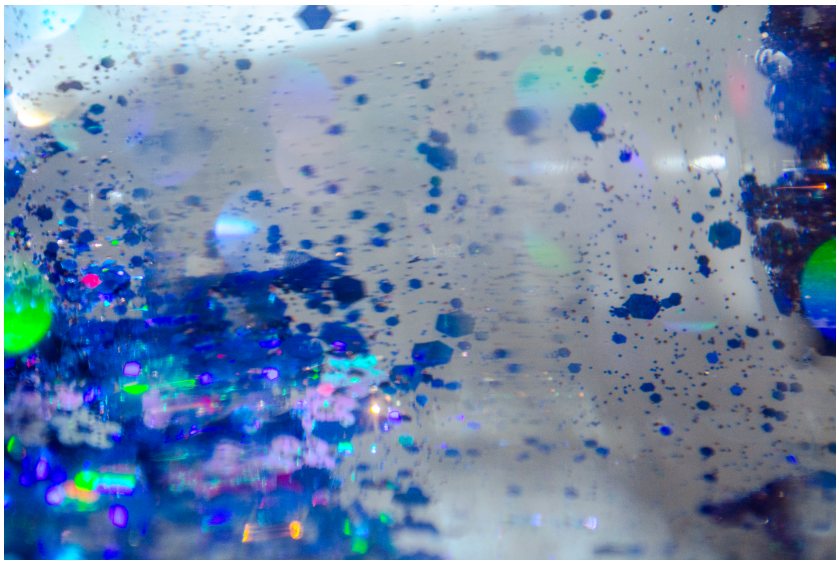
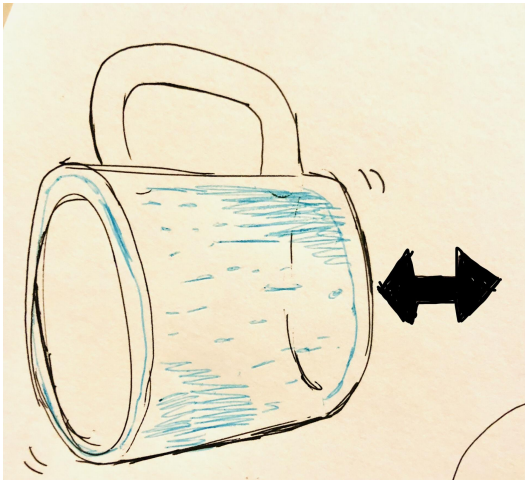
Get Wet: Glitter in Fluid Movement



The intent of the image was to use glitter particles to demonstrate the movement of water, particularly how it flows and distributes. This was done by taking a mug, filling its annulus with water and glitter, then shaking the mug from side to side and quickly snapping a picture. The blurred glitter streaks give a visual representation of the distance and direction the fluid traveled in a short time frame. Through capturing the movement of glitter in fluid, the phenomenon observed would be how fluid responds to external forces, transient flow, mixing, laminar and turbulent flow, as well as fluid velocity.

The flow apparatus used in the image was a double-layered plastic mug. The first layer had a mix of water and glitter sealed around the outside of the mug. The second layer was the hollow inside of the mug. The mug was held parallel to the floor, opening to the side, and shaken horizontally. The length of the annulus was about 6 inches and the specks of glitter were about or less than 1 centimeter wide.



The basic flow of the experiment was impacted by the following forces. The biggest force in this experiment is the external side-to-side force. When the shaking first starts, the fluid's inertia resists the change in motion but then causes the particles to accelerate until they hit the opposite side of the mug and gain speed in the opposite direction. Water is incompressible; its volume is always constant. This means that water can move around and change shape. Centrifugal force is also in play, as seen by the two clumps of glitter on either side of the annulus. The glitter gathers at the two ends of the cup because, as shaken horizontally, the fluid moves away from the center axis. Another force acting on the glitter is gravity. In the image, the particles near the bottom right of the image are not moving because they've settled as the

shaking stops and the picture is taken. The fluid changes with time because of gravity causing the particles to settle.

Several interesting fluid flows can be seen in this image. There is radial flow when the fluid initially is impacted by the centrifugal force pushing it away from the central axis and towards the outer walls (ScienceDirect, 2023). Visually, this shows up as blurred glitter streaks of lines. These lines demonstrate the direction and distance the fluid traveled in the length of time the camera shutter was open. Transient flow is defined as flow when the velocity changes over time, as explained earlier due to the force of gravity (Fluid Mechanics Ltd, 2020). Turbulent flows can be seen initially due to the intensity of the external forces. However as gravity causes the fluid and particles to settle, it transitions to laminar flow as can be seen by the smoother paths of the glitter streaks. This is captured in the image. Velocity is also present in the image through these glitter streaks. It shows where the most movement occurred; longer streaks mean a higher fluid velocity in a direction. Shorter streaks, like the particles near the bottom right of the image, give information on where the fluid is moving comparably less and which direction it's going.

The visualization technique used was capturing the movement of glitter in water when shaken horizontally. The glitter particles served as a visualization to trace where the fluid was moving, making the flow patterns visible. The source of the glitter mug was a craft event held at CU Boulder. The pictures were taken using natural sunlight and a white poster board as a background to illuminate the glitter streaks. The camera used was a Nikon D5200. After shaking the mug horizontally, the camera was held directly in front of the mug to capture the flow. The distance from the object to lens was very close, about an inch, and took many attempts to get the right focus. The focal length was 55mm. When the camera was held closer, glare and reflections

would distract and blur the image but when the camera was held farther back, it either was out of focus or took so long to capture that the fluid would be settled. The ISO speed was ISO-320, which means a lower sensitivity to light because there was a lot of natural light bouncing off the white poster board and in the room. The exposure time was 1/60th of a second, which is slow, in order to capture the glitter moving in that time frame. The dimensions of the image are 6036 by 4020 pixels.

In editing, the white balance was adjusted to be cooler to emphasize the blues and greens of the glitter and saturation increased. The exposure, contrast, and highlights were decreased slightly to show more depth in the image to see the layers of glitter. The RBG curve was also adjusted to an ‘s’ shape to bring out the darker and lighter parts of the image.

The image uses glitter to reveal the movement of fluid when an external force shakes it side to side. Personally, I enjoy the visual interest of the image and how it captures how water flows when shaken. The colors are also bright and visually pleasing. The blur communicates motion well, so I fulfilled my intent of showing the fluid physics. I dislike the way the light refracted through the plastic can distort the appearance of the glitter and find that it could be misleading. The reflections are pretty but could be distracting. It was a little hard to try and capture the motion so fast after shaking the cup; if I were to repeat this experiment, I would try using some kind of blender or frother to create a small whirlpool so I’d have more time to set up my camera and take the shot while there is more turbulent flow. This would create some fun vortexes too. I also would choose dye instead of glitter to demonstrate smooth motion. Overall, this was a very fun experiment and taught me a lot about fluid phenomena that I can see in my daily life.

Works Cited

"Radial Flow." *Radial Flow - an Overview | ScienceDirect Topics*, www.sciencedirect.com/topics/engineering/radial-flow. Accessed 24 Sept. 2023.

"Transient Flow." *Fluid Mechanics Ltd*, 28 Nov. 2020, www.fluidmechanics.co.uk/hydraulic-calculations/transient-flow/#:~:text=Transient%20flow%2C%20is%20flow%20where,the%20system%20is%20steady%20state.