Flow Vis IV3: Oobleck on a Shake Table

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Introduction and Background

The purpose of this photo is for the "Flow Vis 3" assignment, which Professor Jean Hertzberg assigned for the course Flow Visualization at the University of Colorado at Boulder. The objective of this assignment is to record a visualization of the physics behind the reaction of Oobleck that is placed on Tupperware, which is mounted onto a shake table as the shake table is shaken at a frequency that ranges from 10-15 Hz. I attempted to record the Oobleck's reaction from being shaken on a shake table in a way that showed the aesthetics of the Oobleck in addition to the flow phenomenon, which we achieved using food coloring.

Team

This assignment was completed with the following team members:

1.) Bryce Dickson
2.) Tobin Price
3.) William Watkins
4.) John Whiteman

Procedure

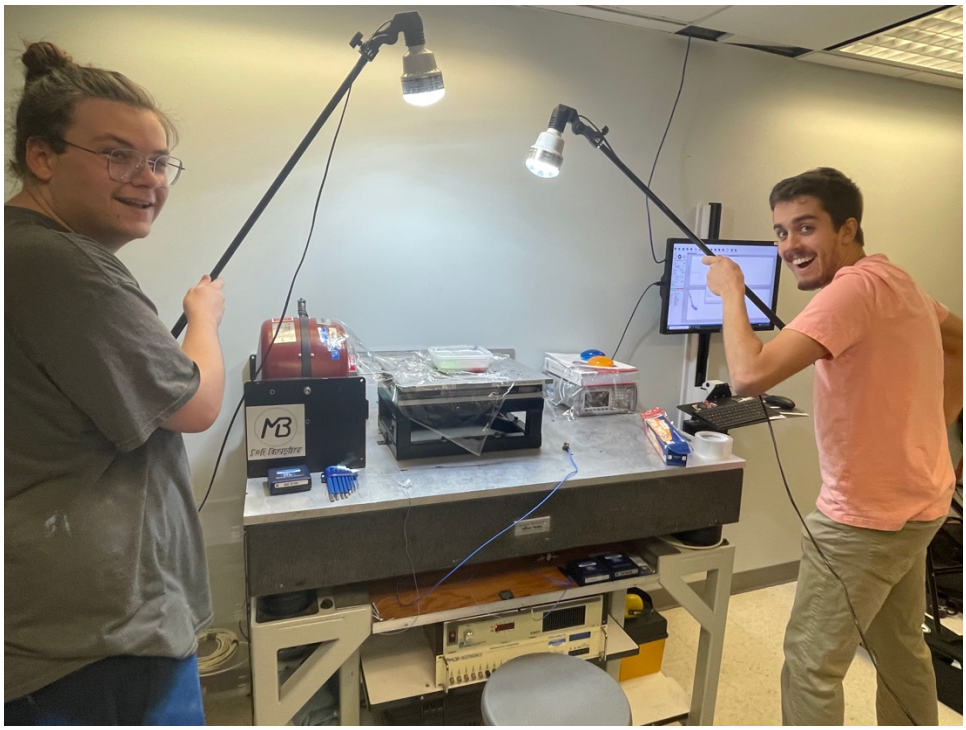

Figure 1: *Photograph of the experimental setup*

The experiment began with our team making Oobleck out of corn starch and water. This was initially 1 cup of water to 1 cup of corn starch. Once we made the Oobleck, we put the Oobleck into a Tupperware container. We then placed the Tupperware container onto the shake table. We made sure to mount the Tupperware container to the shake table using tape so that it did not fall off. Next, we covered the shake table platform with plastic wrap to ensure that Oobleck did not spill onto the shake table during the experiment (refer to Figure 1. for an image of the experimental setup). Next, we attached the motor to the shake table using an Allen Wrench (refer to Table. 1 Below for the complete materials list for this experiment). Once the motor was attached, we entered the parameters of the shake table to get the perfect shake frequency to visualize the phenomenon (refer to Table. 2 Below for Shake Table Settings). We then added food coloring to the Oobleck to capture the fluid flow phenomenon better. Two team members each held an LED light Tripod above the shake table to ensure that we had ample lighting to photograph the spectacle. In contrast, one team member recorded the Oobleck shaking using a Cannon Rebel T7 DSLR Camera. After we tried to capture a video of the phenomenon the first time, we decided that we needed to make the Oobleck less viscous. To do this, our team began adding water incrementally so that we could gauge the suitable viscosity of the Oobleck for our experiment. This was a very iterative process in which we altered some of the shake table system's parameters. Finally, we decided on the shake table frequency values ranging from 10-15 Hz, which was evident to us as the best frequency range for our experiment (refer to Table. 2 Below for Shake Table Settings).

Materials

Table 1: *Required materials for the assignment*

Required Material	***Description***
Shake Table	Shake Table reserved at ITLL at CU Boulder
Allen Wrench Kit	Any standard SI Allen Wrench Kit
Corn Starch	One lb. of Corn Starch
Tap Water	Cups of water may vary depending on desired viscosity of Oobleck
2x LED Lights	Two White LED lights
2x LED Light Tripods	Two Tripods used to hold each individual LED Light
Camera	Cannon Rebel T7 DSLR Camera
Food Coloring	Any standard food coloring set
Tape	Any tape will be sufficient

Shake Table Settings

Table 2: *Shake Table Settings*

Frequency (Hz)	10 Hz – 15 Hz
Displacement	Blank
Acceleration (G)	1.1 G
Velocity (in/s)	1.23 in/s
Sweep Rate (log)	.5 Oct/min (log)
Duration	2 Sweeps

The Physics behind the Phenomenon

Oobleck is a mixture of corn starch that acts strangely to most fluids we, as engineers, are familiar with. Oobleck is a non–Newtonian fluid that is visco-elastic, which means that any attempt to deform it will cause the Oobleck to oppose that attempted deformation (Reference #1). Oobleck is a shear-thickening material which means that its viscosity will change when there is an applied shear force depending on the speed of the shear force (Reference #1). Oobleck gets thicker the quicker and harder you apply a shear force (Reference #1). During our experiment, we added food coloring to our Oobleck so that we could better visualize the properties of the Oobleck while it was being shaken. We were stunned to see that the Oobleck seemed to form vortices (refer to the Title page. for an image of this). We believe this is due to the frequency of the shake table and the geometry of the inside of the Tupperware.

Photography Technique

The Camera used in this experiment was a Cannon EOS Rebel T7 DSLR camera with an 18-55mm lens because it had the best resolution (refer to Table 2. below for camera specifications during the experiment). The Camera was not stabilized with a camera stabilizer; instead, it was held by a team member approximately 10 inches from the Tupperware. The original and edited image had a width of 6000 pixels and a height of 4000 pixels. The lighting used was two white LED lights, each held by a team member approximately two feet above the Tupperware at an unknown angle. The original video was edited using iMovie on my mac. I edited the video first by creating a PowerPoint slide. Then I used the contrast feature and turned it up to allow for a sharper contrast in the colors. Finally, I inserted this PowerPoint slide in front of the presentation and added music to the video. I then posted the video to YouTube.

Table 2: *Camera Specifications for Cannon Rebel T7 used during the experiment*

Specification	*Description*
Aperture	f/0.0
Exposure	1/inf
ISO	0
Focal Length	0 mm

Conclusion

The objective of this assignment was to record an aesthetically pleasing visualization of the flow phenomenon that occurs when Oobleck is placed on a shake table. My team and I were able to illustrate the phenomenon behind the non-Newtonian fluid Oobleck as it is shaken on a shake table with a frequency range of 10 – 15 Hz. This video shows Oobleck's fascinating properties as it is shaken horizontally on a shake table. At the same time, the food coloring allows us to see the flow's true nature in an aesthetically pleasing way. For this experiment in the future, I would want to take the video in a way that allows us to get the Tupperware out of the frame of the video and only highlight the phenomenon behind the properties of Oobleck. In addition, I would want to take the video using containers of different sizes and geometries to see how this change would affect the fluid reaction of Oobleck as it is shaken.

Appendix:

1.) ARSTECHNICA. “The Physics of Oobleck.” Arstechnica.com, 2005, https://arstechnica.com/science/2005/11/1771/