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Team 8
Flow Visualization
First Team Report

Introduction

For our first team photo, we wanted to channel the halloween holiday spirit. This is why we chose to use a carved pumpkin. To deviate from the traditional pumpkin aesthetic, the team wanted to utilize fire. To do this we had an idea of using boric acid inside the pumpkin to give it different colored flames. We ended up deviating from this route due to safety concerns. We didn't believe that we could safely contain a fire within the confines of our experiment zone.

To offset the fire, we decided on using smoke and fake blood. We thought that the blood would be a nice touch because the pumpkin itself has very jagged teeth. These sharp teeth have the blood it's scary authenticity. To add to the scary appeal, we added smoke to the inside of the pumpkin. With the combination of the blood and the smoke, we felt that we had the perfect combination of flow visualization techniques as well as the spooky artistic appeal.

Procedure

The following procedural items below are noted from our teammate Theo Petrides:

"The procedure was rather simple. The list below shows the items required to give us our final photos for each team member.

- Camera Equipment: DSLR/tripod
- Pumpkin and various cutting utensils for carving
- Fake blood and dry ice used for flow visualization
- Gloves to handle dry ice and Q-tips to apply fake blood
- Flashing LED lights and scented candle to light up inside pumpkin
- Various house lighting fixtures for proper uplighting up pumpkin
- Newspapers to avoid mess"

The first steps of the experiment were fairly simple. To begin, we had to carve out the pumpkin. First, we set down newspaper on a table. Now it was time to remove the top and take out all the seeds and inner guts of the pumpkin. After this step was done, it was time to decided on the design for the face of the pumpkin. We had access to many different stencils. We chose the one you see above because it had the most pointy teeth. After tracing out the facial design, we cut the out the face of the pumpkin.

Now that the carving was done, we then placed the candle inside the pumpkin. To ensure safety, we added water to the bottom of the pumpkin so that if the candle fell, it would be put out. The

candle was quite small at maybe and inch in diameter and half an inch tall, but it provided wonderful illumination of the pumpkin. The water also allowed the sublimation process of the dry ice to work more effectively. For the sublimation process, we tried different color LEDs to add a multicolored effect. Ultimately this did not work as well as hoped so we abandoned this method.

Originally we had problems with the candle. It produced a more smoke than expected. To not let this smoke darken the dry ice, we decided to keep the lid off of the pumpkin. This allowed the smoke to rise and get released through the top of the pumpkin rather than come through the face. This overall produced a better photoshoot of the pumpkin.

Finally, the dry ice was placed inside of the pumpkin close to the mouth. The dry ice sublimated more quickly than expected, so we had to take the pictures immediately. The gases produced gave the pumpkin a unique oozing effect that the group was very pleased with. It was now the time to apply the fake blood. This was done by using Q-tips. Fake blood was applied to most of the teeth. As the blood ran down the teeth, accumulating at the tips, photographs were taken.

Analysis

Camera Specifications and Settings:
ISO: 3200
Shutter Speed: 1/30 sec
Flash: None
F Stop: f/5.6
Date Photographed: October 15, 2006

Original Image:

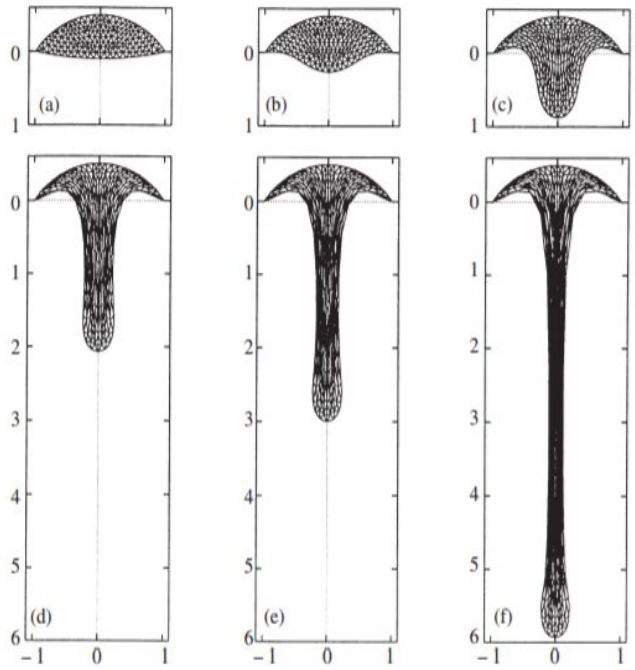
Final Image:

Camera Technique and Post Processing:
All of the photographs of our pumpkin were taken with one camera. Photographs were taken at approximately 18 inches from the pumpkin. The editing was done was Adobe Photoshop. The original photo was cropped to focus on the teeth. This was done to spotlight the large blood droplet in the middle. The brightness was increased as well as the contrast. I also added an orange hue to the photograph to get the reds and oranges to show a little more prominently.

Viscosity:
The blood itself was made up of cornstarch and red food coloring. The high viscosity of the mixture allowed the blood to accumulate slowly on the teeth, allowing time to photograph the equation. The drop that was formed on the base of the tooth can be equated by the equation below:

$$A(x,t) = 2\int f(x,z,t)dz$$

The diagram below (found by Theo Petrides from the Stokes "Extension Fall of a Very Viscous Fluid Drop") demonstrates how the droplet was formed.



The image above shows that as the longer the time progresses, the thinner the diameter of the drop becomes. The length of the droplet also increases. The equation above assumes that the length goes to infinity and does not break. We can ignore this assumption because the droplet did break after about an inch in length.

Conclusion

Overall, I am very satisfied with the image. I feel the image perfectly combines the spooky artistic aesthetic as well as the science of flow visualization. If the blood had a lower kinematic viscosity, the experiment would not have worked as successfully. I believe the cornstarch in the mixture is what gave the red food coloring the increased viscosity. Additionally, the dry ice put out a gorgeous white gas that contrasts wonderfully with the red blood droplet.

There are a few things I would do improve the image in the future. I wish I would have focused more on the teeth in the original image. The cropping which focused on the teeth cause to much loss in resolution. I also would have reduced the noise in the ISO which I believed cause the odd colored pixelation. Finally I wish I made the image black and white. I feel like that would have given the photograph an even spookier vibe.