

Phil Nystrom  
Team 1st Assignment  
2/26/2018

## **Team First Assignment, Light in the Dark**

Phil Nystrom, Luke Collier, Zach Marshall, Eric Robinson, Yousef Shashtari



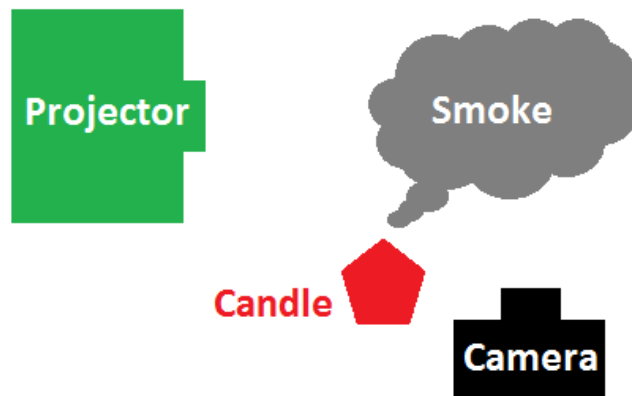
To start our first project, team epsilon wanted to make a setup that not only gave stunning visuals, but a good understanding of the flow physics. We decided to capture a smoke plume, as they generally give interesting swirl patterns and complex fluid flow. Further, we wanted to add more character to the image, and decided some color incorporation would go a long way. In the end, the objective of our first project would be a complex, swirling smoke plume hosting a wide range of colors.

As a team we discussed many ways to produce smoke, everything from the smoke machines provided by the ITLL, to vape pens, to dry ice. In the end we decided to use a candle as it is blown out. This gives a nice, sudden plume of smoke with nice patterns. We found that larger smoke producing machines such as vape pens make a solid cloud, instead of individual streams and swirls. Note that candles normally do not produce much visible smoke, because a lit candle produces complete combustion and very little soot makes it into the air. However, when the candle is blown out, not all of the soot is burned completely, and it goes into the air as fine particles.

To add color to our image, we discussed different backgrounds and light sources. The goal is to make a very brightly colored image, moving with the smoke if possible. We decided to use a projector cast directly into the smoke plume, as it is able to illuminate the entire plume very brightly. To create the

color effects, we played a video from YouTube titled "The Splendor of Color Kaleidoscope Video v1. 1080p", which gave stunning color and a great range of images. Overall it gave the video fantastic visuals and a sense of life. Note that the room was completely dark other than the projector light, to give the highest contrast from the smoke. Note that this is a similar technique to that used in 'Important parameters for smoke plume rise simulation with Daysmoke'. [1]

The setup overall was composed of the candle, the projector, the camera, and if you count it, the smoke plume. The smoke was blown directly in front of the projector, with the camera offset by 90°. The smoke plume was about .3m tall and .5m wide, making it a fairly substantial object to photograph. The setup can be seen in the figure below.



To analyze the smoke, it is beneficial to know the speed when first blow out. This equation is simple, we can count the frames it takes to go a certain distance, and calculate speed using known quantities such as distance traveled and frame rate. [2] This equation is below.

$$Speed = Distance * \frac{Frame\ Rate}{Frames} = .75m * \frac{60FPS}{38F} = 1.18 m/s$$

The videos were shot with a Canon 6D DSLR camera. Because they were shot in video format, it is difficult to extract metadata since the camera is constantly changing the parameters. What can be said, however, are the physical specs of the camera. The camera had a fixed 50mm canon prime lens, with a max aperture of f1.8. The objects were about 1.5 meters away from the camera, and the total captured area was about .6 meters across. The video was taken at 1280x720p, basic HD. Seen below is the original, unedited video, at roughly the same frame as the image above.



The final cut processing was done in YouTube video editor, and consisted of cutting out the first 8 seconds and last 4 seconds, as they did not contain any valuable images. Next, the contrast was increased by one value in the editor. Lastly, a title and team names were added to the first few seconds. With all that done the video was both uploaded to YouTube, and downloaded as an MP4 file to preserve image format.

This image reveals much about the complex fluid flow of a candle being blown out. First, you notice the smoke blows in the direction of the applied breath, and up as it is hot and lighter than cold air. Further, the complex patterns show how quickly the turbulence can scatter the air throughout the space. One thing I would like to change is the contrast and color balance. If I were more knowledgeable about video editing, I would have made the colors much more vibrant. To further develop the ideas I would try to apply more light to the smoke, and give more vibrant colors. In addition, I would try different smoke making devices, such as incense and fog machines. Overall, I am very pleased with how the videos turned out and would gladly do this experiment again.

## References

- 1 - Y. Liu, G. Achtemeier, S. Goodrick, W. Jackson, Important parameters for smoke plume rise simulation with Daysmoke
- 2 - H. Baum, K. McGrattan, R. Rehm, Simulation of smoke plumes for large pool fires