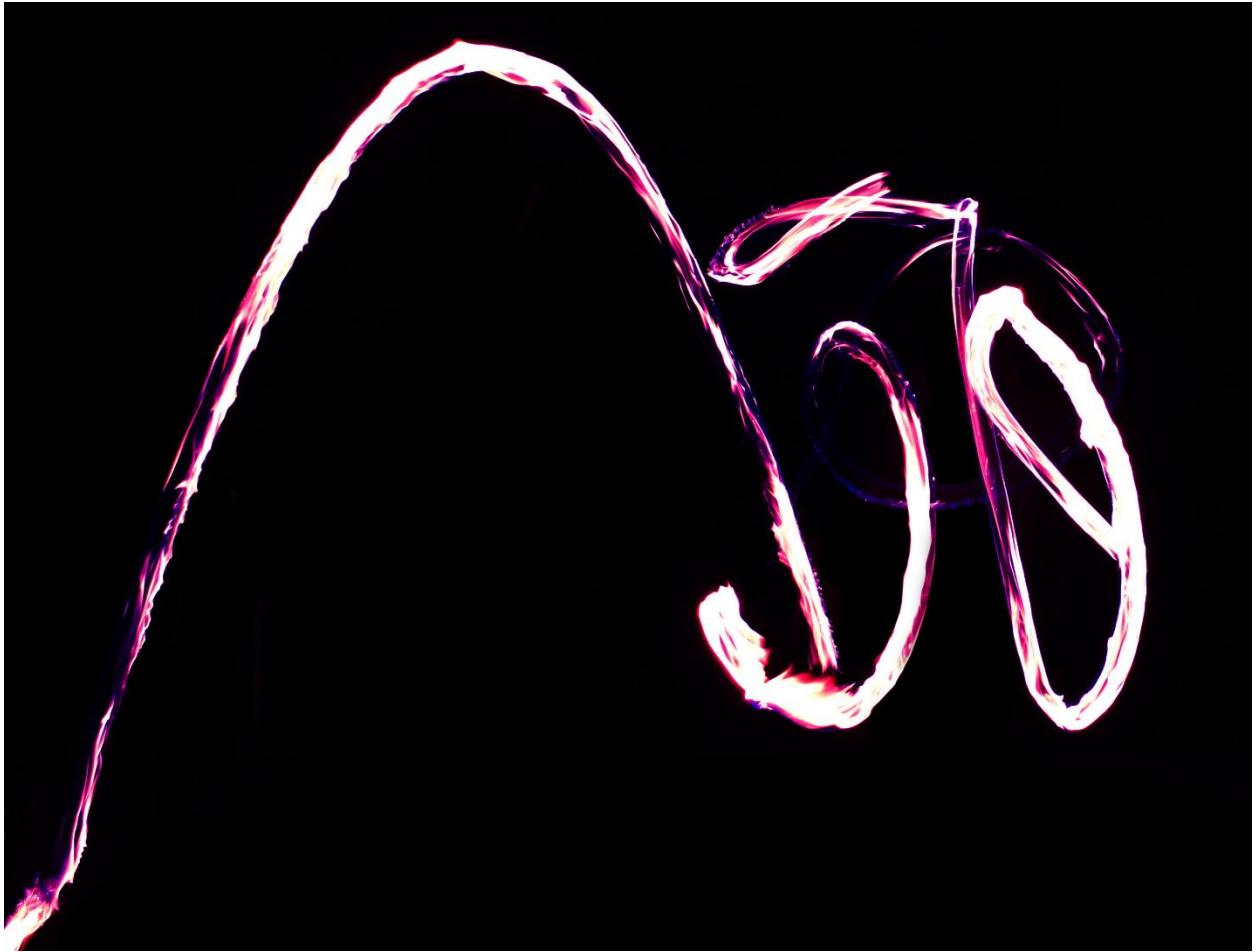


Flow Vis

Get Wet Report

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Introduction

As walking sacks of water, many people are naturally drawn to fluid flows. For good reason too, fluid flows can be absolutely stunning. I personally have always been enamored with manipulating flows such as fire. For this reason, I began juggling fire a couple years back. During my juggling career I have come to a realization, the audiences I juggle for do not see the true beauty behind the art, they only see the danger of the stunt. For this project I intended to shed a new light on juggling fire by displaying the beauty of the flames.

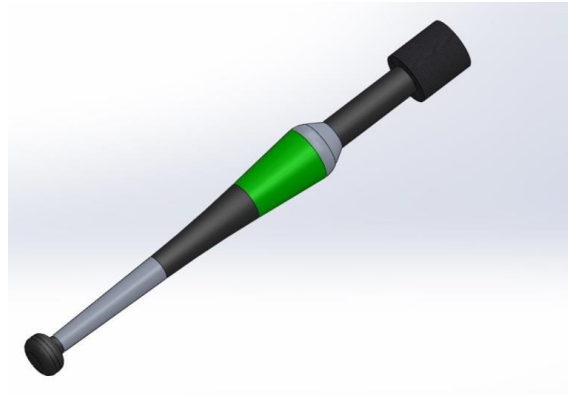


Figure 1 CAD MODEL of Torch

Set Up

The experiment was fairly easy to set up, I had help from Hunter Miller and Marcus Gurule for safety reasons. Hunter Miller also took the photos for me. The materials used were three classic juggling torches (Figure 1), tiki torch lamp oil (burns at a cooler temperature than most other juggling fuels), and a few matches. It wasn't easy to get the final image on the cover page. I began by juggling a cascade, but the long shutter made it look like I was on fire. (Figure 1). So, instead of three torches I began to juggle only one torch. (Figure 2) Unfortunately, juggling one torch didn't exactly portray the magnitude of the flames beauty.



Figure 2

Figure 3

In a last effort to save the experiment I began juggling three torches using different patterns. My intention was to mix up the cascade to really capture the true flow of the fire. My final photo was the last image taken, it was actually an image of a juggling mistake, me dropping the torch.

Deciphering the Image

The final image can be tricky to decipher. To show the flow pattern I edited my image to show the outline of my body in figure 4. One torch starts at my right foot and travels in a trajectory motion across the screen (diagram is in yellow). Torch number two starts at the top of the screen in green and follows its own direction crisscrossing with the third torch which is outlined in a purple. The flow that's being analyzed is the burning of fire and its interactions with the air surrounding it. We are also seeing the fire as it reacts to angular acceleration. By analyzing sections of the flow we can make several conclusions that help us understand the physics of fire juggling. In Figure 4 (section A highlighted in white) we see a small trail of fire compared to the much brighter flame at the top of the torches trajectory. Since the shutter was only on for one and a half seconds, we're able to conclude that the brighter the fire in the image, the slower the torch is moving. This would make sense that section A would be less bright because the torch is accelerating from gravity. Section B is more defined than A which shows it is moving at a slower velocity. The forces that make the fluids move are gravity, and the reactions of my motion as I apply forces on the torches while juggling.

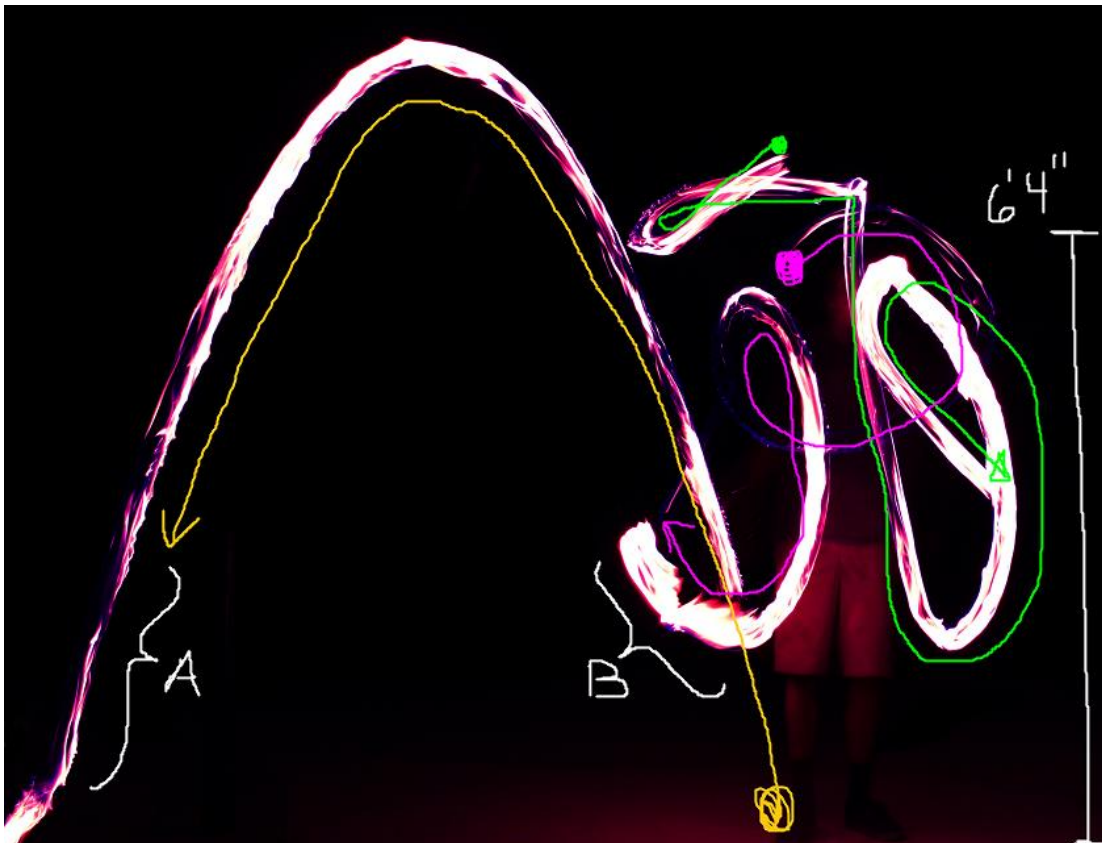


Figure 4

Figure 4 also gives a perspective of the scale of the image taken. I stand at 6'4, so the image shown is around 9x15ft. The torches measure to be about 20 inches in length, with a wick that is 2 inches long.

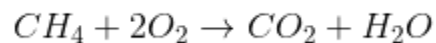
Flow Physics

Fire results in a chemical reaction consisting of carbon dioxide, water vapor, oxygen and nitrogen. From this reaction, heat and light are created. (Equation 1) The formula for combustion is provided in Equation 2.

Equation 1

$$E = \frac{h * c}{\lambda}$$

Equation 2



In order to create the best image, we went to a park where no other light could be seen by the camera. We also used a backdrop of trees to make sure no headlights from cars could be seen during the photoshoot. The visualization techniques used were all natural, the photo is based on the light given off by the fire. This makes this image unique, Instead of using lighting techniques to capture flow, the flow is the light. The camera was about 12 feet from me while I was juggling and was set to an ISO of 1600, an F8 aperture, and a 1.6 second shutter. The camera used was a Canon Rebel T5 with an EFS 18-55 mm lens. A tripod was used for stabilization.

The picture had dimensions of 3368x2560 pixels, this can be seen in figure 5. I chose to stand about 12 feet from the camera because I wanted to make sure the camera could pick up all of the throws during juggling, this includes throws that could go up to ten feet above the ground. I also chose to focus it so I had room to move around with the fire, and in this case enough room for an errant throw to be captured across the screen. The lens used was a 18-55 mm lens because I wanted to make sure I had enough room to capture lateral movement of me and had enough surroundings for errant throws, and the focal length was 35 mm as can be seen in figure 6.

Image	
Image ID	
Dimensions	3368 x 2560
Width	3368 pixels
Height	2560 pixels
Horizontal resolution	72 dpi
Vertical resolution	72 dpi
Bit depth	24
Compression	
Resolution unit	2
Color representation	sRGB
Compressed bits/pixel	

Figure 5

Camera	
Camera maker	Canon
Camera model	Canon EOS REBEL T5
F-stop	f/8
Exposure time	1.6 sec.
ISO speed	ISO-1600
Exposure bias	0 step
Focal length	20 mm
Max aperture	3.625
Metering mode	Pattern
Subject distance	
Flash mode	No flash, compulsory
Flash energy	
35mm focal length	

Figure 6

The most work that was put in on this project was the Photoshop, after cropping the image to its preferred size I decided that taking myself out of the picture would enhance the photo. Personally, I like the resulting image however if one did not have any context behind the fact that I was juggling fire, no one would have an idea of what they are looking at. After taking myself out of the picture, I added in an editing curve (figure 7) to bring out the blue and purple regards of the fire, while still showing the orange traces of the fire. In order to take myself completely out of the image I used the paint tool and zoomed in close to paint each pixel near the fire.

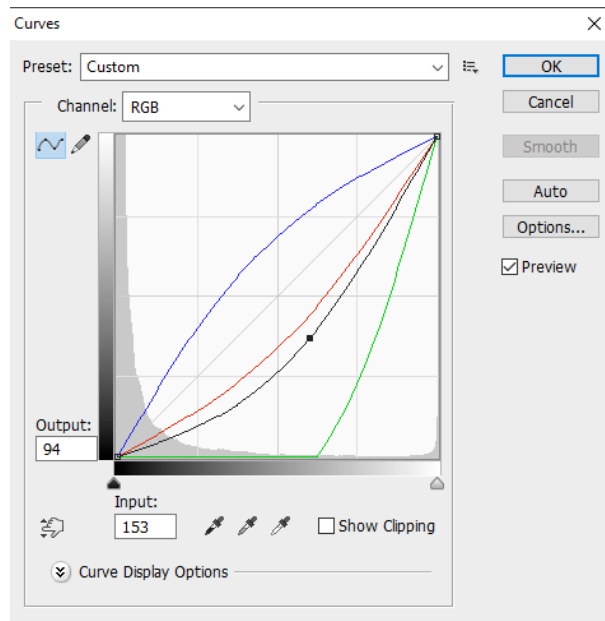


Figure 7

Figures 8 and 9 display the before and after images.



Figure 8 (Before)

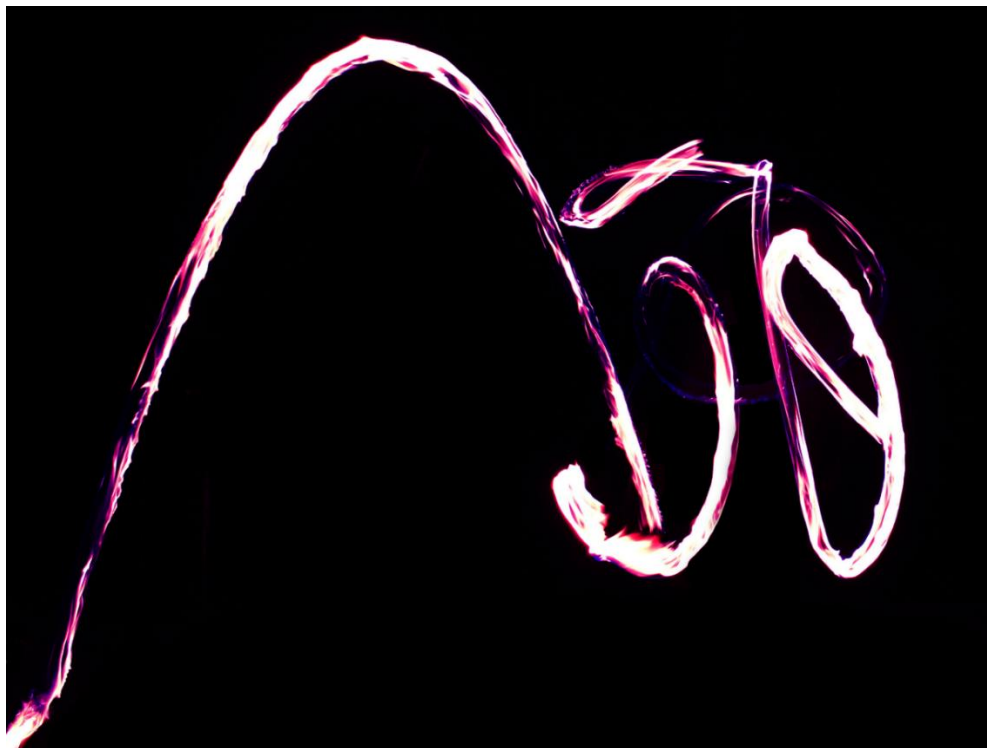


Figure 9 (After)

Conclusion

I believe that the image displays a new dimension of juggling fire. It shows the true beauty of the flames dancing with one another, and hopefully entices people to find splendor in everything around them. I personally like the way the image is centered, with the focus of the image on the right side and the left side containing much more white space that is filled with one lone streak. I also really like the way the fire trail looks, especially in sections of high speeds you can really see the entangling and dancing of the fluids. One thing I don't like about my image is that without some context of what it is, it is very difficult to determine what the heck is going on. I liked the focus of the fire, but in order to solve this problem I may have to bring my body back into the image to give it context. I definitely fulfilled my intent and look to improve on setting up the photo sessions better. With a little research I could have quickly narrowed down that taking a six second shutter would only result in an image like Figure 2. In order to develop my preparation I will continue to take pictures and investigate the reactions of shutter speed and light. I have one question, could you think of any way to give the image more context without bringing my body back into the picture?