

Team Photo 1:  
Liquid Nitrogen Mirror



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MCEN 4151: Flow Visualization  
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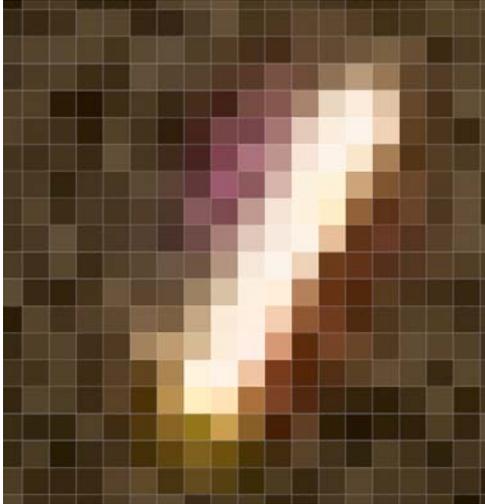
This image was produced for a course titled Flow Visualization at the University of Colorado. The purpose of this course is to explore the art and physics of fluid flow. The image was produced with the help of team mate Travis Bildahl.

To achieve this image I first filled a 3 L dewar of liquid nitrogen from a lab on the 4<sup>th</sup> floor of the Benson Earth Science building. This dewar was brought to a house and the experiment took place on a kitchen table. To produce the flow, the butt end of a pool cue was dipped about 8 cm into the liquid nitrogen and held there until boiling stopped. Once boiling stopped the end of the pool cue was around 70 K. This is about the temperature of Nitrogen in a boiling phase at atmospheric conditions. The pool cue was then removed from the dewar and held vertically by Travis. The chilled pool cue removed heat from the surrounding air bringing the air below its dew point. Then small water vapor droplets formed and fell due to the force of gravity. Right when the flow began off the pool cue the droplets were fairly streamlined. As they fell and interacted with the atmosphere, a more turbulent flow was produced. The original image is shown below.



*Figure 1: The original image*

I will now estimate the velocity of the flow. From the image below, a piece of dust moved about 11 pixels in  $1/800$  sec. So it is moving at 8800 pixels/sec. To estimate the distance of a pixels I will use the butt of the pool cue. The width of the butt is about 1130 pixels. So assuming a .03 m width, that means 1 pixel is about  $2.7E-5$  m. So the fluid is moving on the order of 0.2 m/s.



*Figure 2: Dust used in velocity calculation*

The visualization technique is cooling down air to form small water droplets. The room was a little dusty and this could be the reason relatively large droplets formed. Two lights about 40 cm away were shining in the region of flow. This lighting paired with a black shirt in the background allowed for a very clear image of the flow.

The following photographic specifications and techniques were used:

Size of field of view: 10 cm

Distance from object to lens: 25 cm

Lens: EF 100 mm Macro USM

Make and model of camera: Canon EOS 7D

Aperture: f/3.2

Shutter speed: 1/800 sec

ISO setting: 5000

Original image dimensions: 5184 x 3456

Edited image dimensions: 6444 x 3547

The image was post-processed using Gimp 2.8. Some dust in the air was cut out using the cloning tool. The pool cue was cropped out of the image. The contrast was increased. Then the image was rotated 90° and mirrored.

I think the image is pleasing to the eye and captivating to look at. The image seemed a little too boring without the mirroring. Generally, I dislike mirrored images; however I think the simplicity of the image makes it bode well for mirroring. After it was mirrored I saw a lion in the image and I liked the new power of the image. I would have liked to have more of the flow in focus and cropped a little more of the pool cue out.