For this final project we wanted to use a rheoscopic fluid that responds to shear forces to show fluid dynamics. The rheoscopic fluid our group tried to use was the Blackstock fluid, an inorganic, streaming birefringent fluid. The Blackstock fluid is a special fluid manufactured by Bob Blackstock of Laminar Sciences Corporation. When light passes through a polarizing filter through the fluid and then through another polarizer this fluid lights up with different colors. Shear force is proportional to velocity so we figured that different velocities would produce different colors. We wanted to get a fully developed laminar flow with different velocity profiles to show this effect most clearly. Each velocity was expected to have a specific color associated with it. To achieve this effect we milled three types of channels out of acrylic a straight channel, an L channel and a T channel. To make sure we had a constant velocity we used an instron to push syringes that were connected to the channels. We loaded the syringes from the top and bleed out the air by allowing the fluid to run through the system into a beaker. We then ran the instron and tried to get the desired shots in each channel. We discovered quickly that this did not work. It turned out that the acrylic that we were using scattered the incoming light through the first polarizer so much that the light that passed through the final polarizer was incorrect to illuminate the Blackstock fluid.

We then tried to visualize a vortex using this fluid. It became very clear very quickly that getting the fluid to spin at a constant velocity and be illuminated from below was impossible. We had to settle with reflecting the light source off a silicon wafer through the fluid. This technique worked but the light source was insufficient to get the desired effect. Images from all this effort were worthless and uninteresting. It turned out that taking a picture of this fluid in the ambient light from the Durning lab's fluorescent lights.

The setup for this photo is very easy. We used a magnetic sturring plate and a magnet to spin the fluid at a constant velocity. The plate was set at the second power level because any faster would make the magnet in the fluid unstable. This is because the dish with the Blackstock fluid was suspended about an inch above the plate. It was suspended because we were trying to reflect light up through the dish. I then set my camera on a tripod and took the shot from directly above the dish. The rotational velocity was not very fast but I cannot quantify it. The vortex that was formed seemed to be laminar. The leading edges of this vortex are clearly visible in the photo. The fluid physics here are related to the equation

$\vec{\omega} = \nabla \times \vec{u}$, where omega is the rotational velocity and U is the fluid velocity.

This photo was taken about two feet above the dish. The lighting used was just the ambient lighting from the lights in the Durning lab. There was no visualization technique used. However, I did capture the motion of the fluid using a time elapsed shot.

I used a Nikon D70 with a 52 mm lens to take the shot. The camera was set at an f stop of 5 and exposure value of 0.0. The shutter speed for this shot was $1/30^{th}$ of a second. The focal length for this shot was around infinity and the size of the field of view is only about 5 inches in diameter. The ISO value was set at 200. I did no photo editing in Photoshop but I did adjust the exposure value in my photo transfer program. This image is 3039 by 2016 pixels.

This image does not reveal the desired rheoscopic effect. No matter what we tried we could not get this fluid to cooperate. However, the final image I got is visually interesting and does show fluid dynamic information. I only wish we could have gotten this image to be in a rainbow gradient. If I was to try this again I would design a smaller channel with black walls and a polarizing filter on the bottom of the channel and another one at a 90 degree angle to the first on the top of the channel. This way the light from the source can be concentrated in the channel and hopefully the fluid will do what is supposed t do.

Basic Information:
http://en.wikipedia.org/wiki/Vortex