Visualizing Air Vortices in a Room

MCEN 5151

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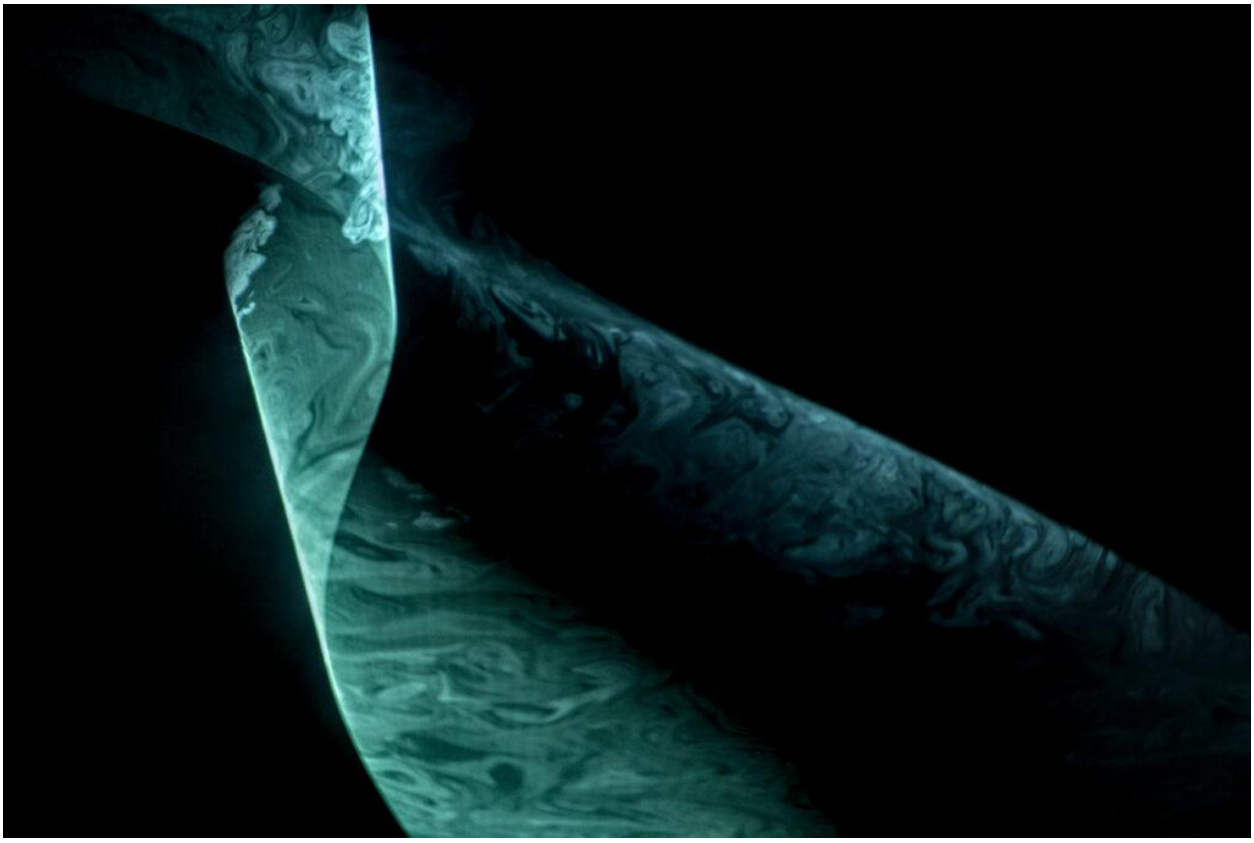
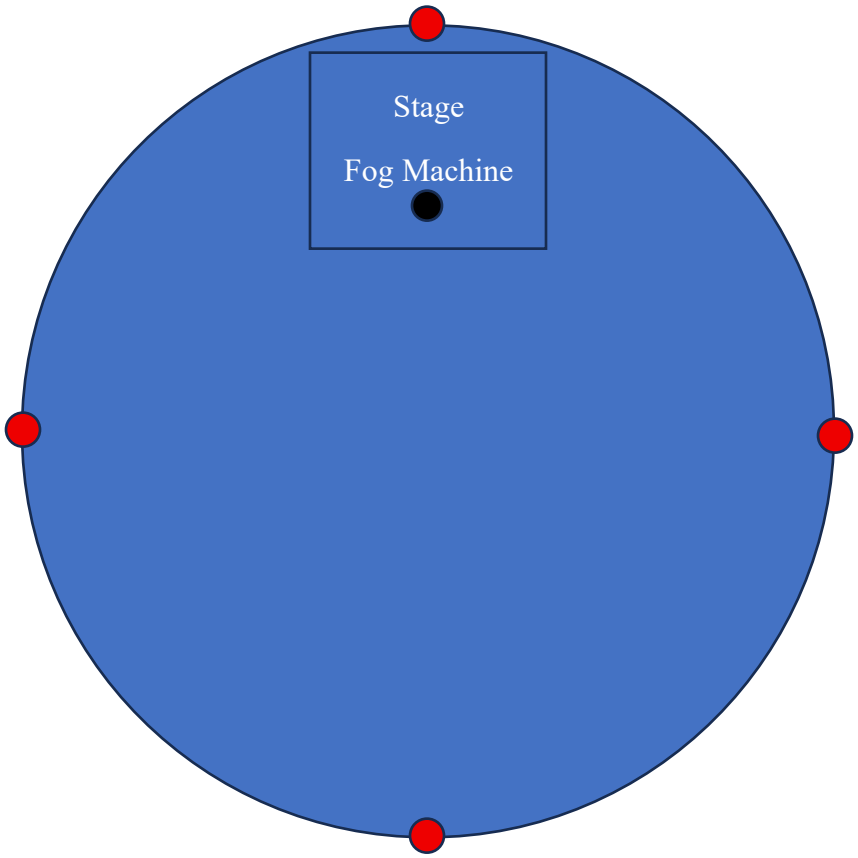


For the Team Third project in Flow Visualization, I worked with Avery Calloway to observe the vortices formed in a large room (planetarium). The vortices were driven by the movement of people and electrical equipment cooling fan. The actual visualization was accomplished by the laser projectors in the Fiske planetarium which were shined on fog generated by a large fog machine. Jeremy Osowski at the planetarium helped us by running the lasers as we took picture. I took hundreds of photos. In an attempt to get less motion blur, I shortened my shutter speed, but this when combined with the scanning of the laser projectors ended up causing bad rolling shutter effect where there was only a thin sliver of exposure in the frame. The final picture had some of this effect for the pleasant artistic look without sacrificing fidelity of the actual flow visualization.

The flow apparatus was a fog machine, and the fog was lit with various laser projectors. The room was about 20 meters in diameter. The red circles represent the laser projectors, which were at about 2 meters in height and shined parallel to the floor

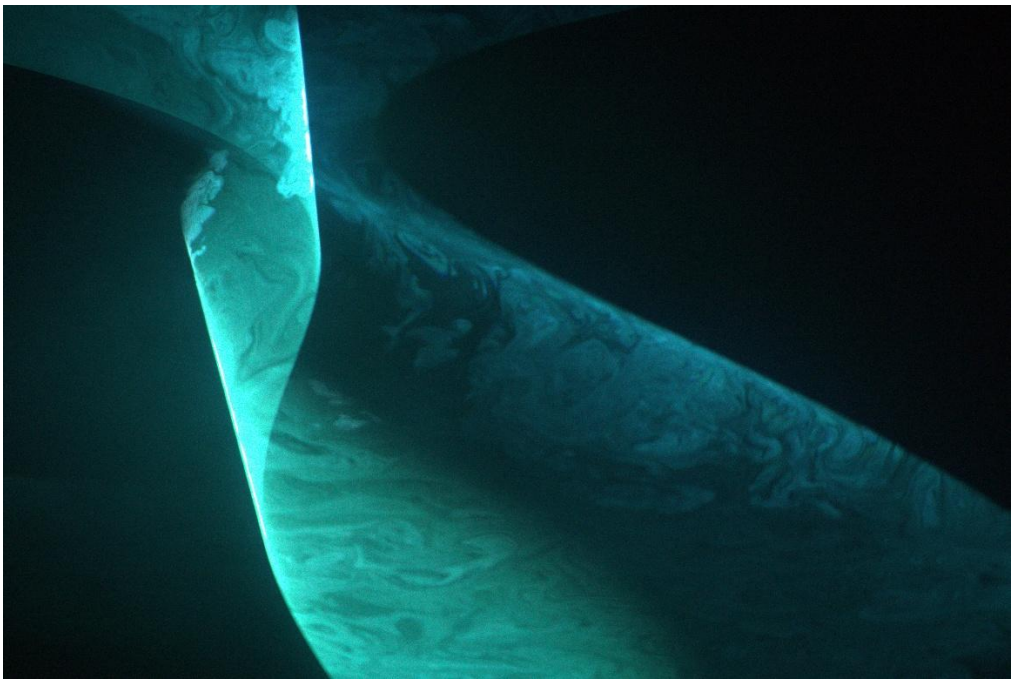


The Reynolds number for the flow can be calculated using the viscosity of air and an estimate of the air speed. The air speed would be close to the speed of a person walking in the planetarium as this is something that is driving the flow. A slow walk is about 5km/hr or 1.38 m/s.

$$Re = \frac{UL}{\upsilon} = \frac{1.38\frac{m}{sec} * 5\ m}{1.5 * 10^{-5}\frac{m^2}{sec}} = 460000$$

This means that the inertial forces in the air in the planetarium drive the flow much more than viscous forces. Mixing that is driven by respiration, ventilation, and movement is important in analyzing airborne pollution in offices (Cermak 2006).

For the photographic technique, a Sony α 5100 with a Helios 44-M lens was used. The aperture was set to its maximum diameter of F/2. The only lighting source was the laser projectors which were scanning at a rate that was close to the shutter speed of 1/1000 sec. The image was shot at ISO 1000. The initial resolution was 6024x4024. The original photo had more glow, so postprocessing was done with black level correction to reduce the glow.



R. Cermak & A.K Melikov (2006) Air Quality and Thermal Comfort in an Office with Underfloor, Mixing and Displacement Ventilation, International Journal of Ventilation, 5:3, 323-352, DOI: 10.1080/14733315.2006.11683749