Wind Blowing Over Sequins

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Introduction

This video was created for the first project, 2025 Get Wet, in the Flow Visualization course at CU Boulder. The intent of this video was to visualize the wind and the patterns it creates in front of the Drescher Undergraduate Engineering ITLL Building on CU Boulder's main campus. The flow of the wind is visualized on an art installation in front of the building. The video presented is comprised of two different videos taken on the same day, with both videos depicting wind blowing over the art piece. About 37 different videos and photos were taken, but remain unused, for this project.

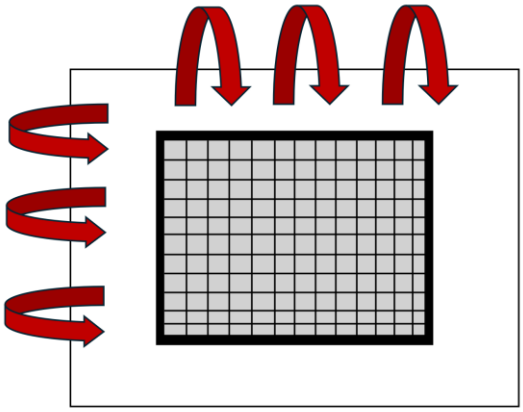

Figure 1. Directions the wind (red lines) can flow over the art piece

Flow Discussion

The art piece was comprised of a board with pinned sequins that flowed freely in the wind. The wind mainly impacted the art piece from two directions, the top and the left side, and tangential flow was visualized. The placement of the art piece relative to the building meant that tangential wind was more than

likely caused by vortical flow rounding corners of the wall (Figure 1). However, flow on the right side of the piece was observed in some instances in extremely turbulent patterns and was most likely a visual of wind deflecting off the structures to the right of the art piece. Wind flow originating from the bottom of the piece was rarely observed.

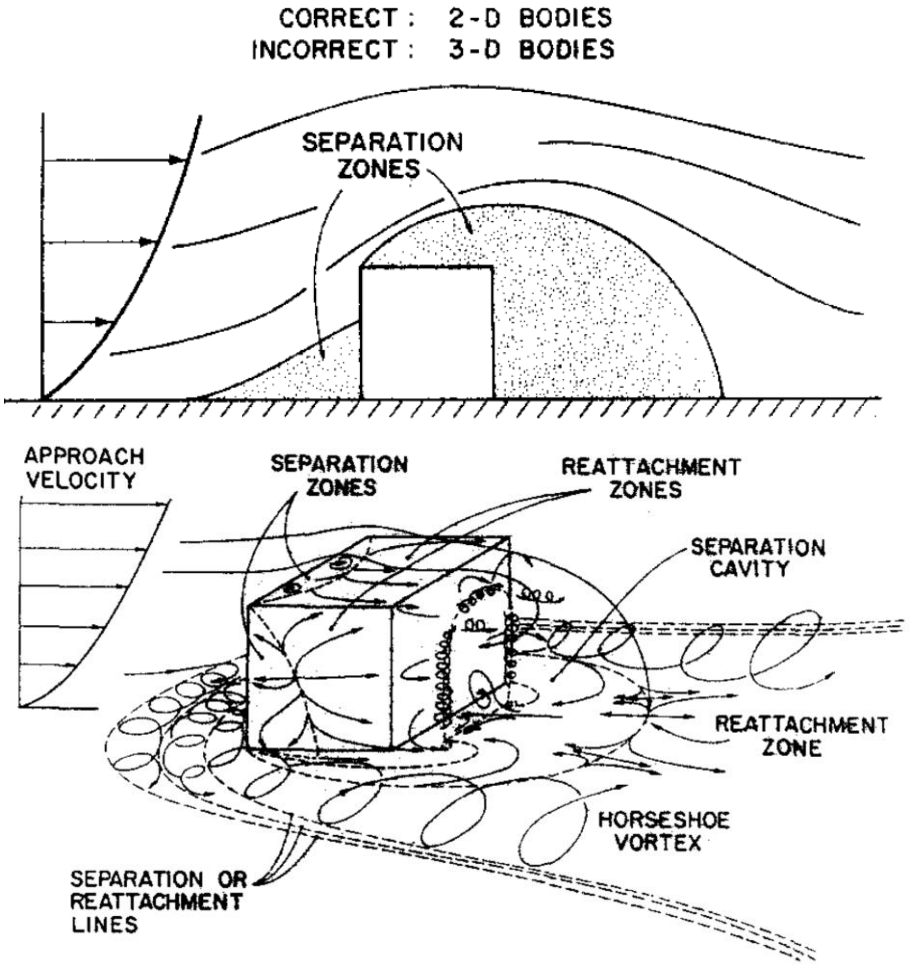

Figure 2. Typical 2D flow over an object (Top) and 3D flow around a building (Bottom)

There are multiple forces that are creating the wind and the subsequent visualization of the wind on the art piece. The most important thing to consider first is the differential pressure caused by the placement of the building in the path of the flow. For wind originating on the side of the building that lies behind the art piece, a pressure difference is created and most subsequently be equalized. This leads to the wind rushing around the building and turbulent vortices are observed due to the separating of the flow around the corners of the wall. This separation is different from the typical conventional 2D flow, and many more complex patterns and structures must be accounted for (Figure 2) (Peterka et. al 1985)The sequins on the board are then affected, and flow in the direction, of the drag force of the flowing of the wind over the surface of the art piece. Various structures are observed in the flow, such as clear ripples in the wind, demonstrating its wave like nature. Using Weather Underground, the max wind speed on September 6th, the day the videos were taken, was 13 mph. The wind varied significantly with time and would increase its intensity then remain quiet for random intervals of time. This unpredictable behavior led to each video clip

being about 30 seconds long, as that was the upper limit of "activity" that could be captured during each wind event. Each wind event was unique in the structures it created on the art installation.

Visualization and Photographic Technique

The flow was visualized through the movement of the sequins in the wind. The wind would blow the sequins at various angles, and the light reflected off the sequins would indicate that it had been changed from its initial position relative to its neighbors. The lighting in the videos is all-natural sunlight, and the videos were taken between 2:00pm – 3:00pm so there was still plenty of natural light. The sun, relative to the position of the camera, was falling behind the building, so the artwork and the area in front of it were shaded.

The camera used was a Nikon D5200 with an 18 – 135mm zoom lens. Various combinations of aperture, focal length, shutter speed, and iso were used between each video to try and make increase the contrast between structures of the flow on the art installation. The videos were captured and played back at 60 fps with a shutter speed of 1/120 seconds, as this was found to best preserve the motion of the sequins. Each video was also captured at a resolution of 1920 x 1080. Unfortunately, the exact aperture, focal length, and iso for each video were not properly recorded, and each video was captured with slightly different settings. Even the length scales involved with the capture of the videos were not recorded, and the camera was slightly moved between captures, making the distance from the object to the lens different between each shot. The videos were edited using MiniTool MovieMaker. Both videos were cropped and then trimmed and positioned side by side to look like one continuous piece. A filter was applied over both videos to give the flow over the sequins a "Cool Blue" look reminiscent of ripples across a pond.

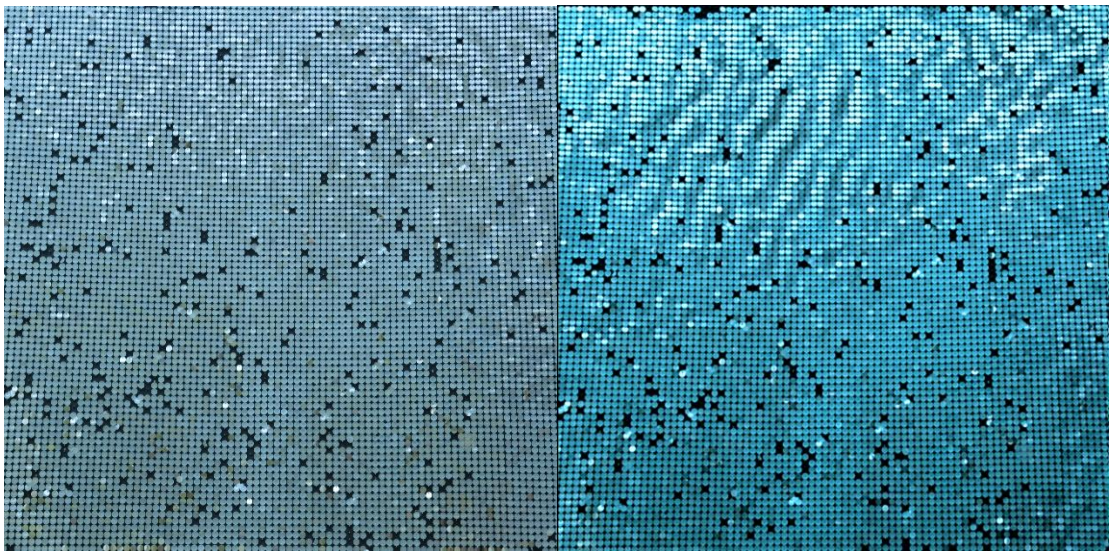

Figure 3. Before post-processing example (Left) and after (Right)

Conclusion

The video reveals the complex structures and behaviors that are formed during even a simple gust of wind. While filming the videos, it wasn't always clear if the wind was blowing until viewing the art piece, showing the constant movement of the air even when not directly observed. The fluid physics are distinct and striking in how they are portrayed. The movement of the sequins on the art piece is akin to wind blowing over a pond, and the peaks and troughs of the ripples are distinct enough to extract velocity information of the wind in a future study. However, I do believe that while this is a great 2D projection of

the flow, it would be interesting to determine if the 3D structure of the wind can be extracted/determined from these videos alone. Alternate techniques, such as holography, could also be explored for visualizing the vortices around the edge of the building in 3D (Meng et. al 1998). If I were to repeat this, I would also like to be able to be more rigorous in my methodology for recording these videos. I would ensure consistency across videos, and attempt to record at an earlier time of day when the sun is shining directly on the artwork.

References

Meng, H., J. Estevadeordal, S. Gogineni, L. Goss, and W.M. Roquemore. 1998. “Holographic Flow Visualization as a Tool for Studying Three-Dimensional Coherent Structures and Instabilities.” Journal of Visualization, J. Vis. (Netherlands), vol. 1 (2): 133–44.

Peterka, J. A., R. N. Meroney, and K. M. Kothari. "Wind flow patterns about buildings." *Journal of Wind Engineering and Industrial Aerodynamics* 21, no. 1 (1985): 21-38.