Homework 3

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CS137

1. In general, I would say that my 2D flow visualization translated well into 3D. I accomplished this by layering multiple planes, each with different flow information represented on them, so as to represent multiple slices of sensor data simultaneously in a 3D space. This allowed me to rely on many of the existing design principles of the 2D visualization, rather than starting completely over from scratch in 3D. With that said, some changes were necessary (see below).

   This approach was enabled in part because the bat was flying forward in a straight line. As a result of this, most of the overall flow was from the front of the wing towards the back of the wing; in short, there was less side to side flow, and so I was able to orient the planes along this axis of motion to benefit the clarity and detail of the visualization.
2. In building a 3D visualization it was important to consider layering effects; in cases where a single plane might be visible, when many planes are stacked due to the line of sight, it can become difficult to perceive if each plane has a high density of information. I addressed this in two ways: I limited the density of content in each plane, and I limited the total number of planes. I also left enough space in-between planes for the user to navigate inside the visualization.

   It was also important to keep a clear sense of scale because as the user gets farther away from some objects, they will shrink in size making them potentially difficult to read. As a result, I tried to ensure that no single icons were too small to be seen at significant distances from the user.

   Another challenge I encountered was actually positioning the planes accurately to be parallel. Since the tools are manual, and do not support axis-constrained motion I had to freehand the position of each plane in free space. Another challenge was in constructing the bat wing itself, which is comprised of a series of planes at steadily increasing angles relative to the first plane so as to create a 3-dimensional, curved wing.

   I think that one feature that might have helped if my visualization were implemented in software would be a “contrast knob” which would allow the user to increase or decrease the visual definition (line width, icon mean size, etc.) of the visual elements. In addition, it might make sense to manipulate the visual definition of graphical elements so as to increase the definition of far away elements and decrease the definition of close elements so as to attempt to hold these constant.

3. I anticipated that the transition to 3D would be harder because it would involve additional issues such as layering effects caused at run time by the user's view location, scaling depending on viewer distance, and contrast issues in the cave. In addition, three dimensions inherently has the potential to show a lot more information, but due to the aforementioned issues, actually realizing this can be quite difficult to do. Thus, to properly take advantage of 3D one must carefully design the visualization to take advantage of as many of the benefits of 3D as possible, while not being seriously hampered by its challenges.
4. The visual characteristics I used were designed first and foremost to be visually sparse, so that each layer of information would not significantly occlude other layers. Therefore, I relied on thin streamlines, and icons which did not occupy a significant visual footprint.

   In addition, I wanted to ensure that the representations were relatively intuitive. Although I did provide a legend, ideally it would not be really needed. Vorticity is represented with circular arrow icons; the size of the icons represents the magnitude and the direction of the arrow represents the direction of the vorticity. This seemed to be a fairly straightforward representation. In addition, the density of streamlines represented pressure, whereas the color (red to blue) and direction of the streamlines represented the magnitude and direction of velocity of the flow. While users might still want to use the legend to double-check their assumptions, I believe this visual representation is fairly straightforward to understand, particularly if the end user is already familiar with fluid flow concepts, as one would presume a scientist in this field would be.