3D Visualization CheatSheet

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3D visualizations

- ☐ if accurate size judgments are required for abstract 3D shapes viewed in a computer-generated 3D scene, provide the best possible set of depth cues
- ☐ consider using structure-from-motion by rotating the scene around the center of interest. This is especially useful when objects are unattached to other parts of the scene
- ☐ to see depth in a 3D scatterplot, consider generating structure-from-motion cues by rotating or oscillating the point cloud around a vertical axes. Also use stereoscopic viewing if possible
- ☐ if it is important to judge the morphology of the outer boundary of a 3D cloud of points, consider employing a statistical approximation method to estimate the local orientation of the cloud surface and use this to shade the individual points
- ☐ for 3D node–link structures, consider using motion parallax, stereoscopic viewing, and halos
- ☐ understand and use the depth cues that are most important for the critical tasks in an application. Implement other cues on which these critical cues depend
- ☐ use consistent representations from one part of a visualization sequence to the next. The same visual mappings of data must be preserved. This includes presenting similar views of 3D objects
- ☐ to represent 3D trajectories, consider using shaded tube or box extrusions, with periodic bands to provide orientation cues. Also, apply motion parallax and stereoscopic viewing, if possible
- ☐ consider providing one or more windows that show a magnified part of the larger data space. These can support a scale difference of up to 30 times. In the overview, provide a visual proxy for the locations and directions of the magnified views
- ☐ in large data spaces containing small islands of critical information, consider enabling the user to add extra windows showing magnified areas of the larger space. This is especially useful for tasks that require frequent queries to compare patterns having more than three visual working memory chunks
- ☐ use a minimum 3:1 luminance contrast ratio between a pattern and its background whenever information is represented using fine detail, such as texture variation, small-scale patterns
- ☐

Surface

- ☐ use Lambertian shading to reveal the shapes of smooth surfaces
- ☐ use specular shading to reveal fine surface details. Make it possible to move the light source or rotate the object so that specular light is reflected from regions of critical interest
- ☐ when applying shading to define the shape of a curved surface, use adequate luminance (as opposed to chromatic) variation
- ☐ consider using texture to represent continuous surface variables. This is likely to be most effective where the data varies smoothly and where surface shape features are substantially larger than texture element spacing
- ☐ consider using cast shadows to tie objects to a surface that defines depth. The surface should provide strong depth cues, such as a grid texture. Only use cast shadows to aid in depth perception where the surface is simple and where the objects casting the shadow are close to it
- ☐ consider using both structure-from-motion (by rotating the surface) and stereoscopic viewing to enhance the user's understanding of 3D shape in a 3D visualization. These cues will be especially useful when one textured transparent surface overlays another

Occlusion

- ☐ when one 3D surface is viewed over another, to prevent occlusion the top surface should have lacey, see-through textures. Ideally, texturing should be low contrast so as not to interfere with shading information. Textures that have linear components are more likely to reveal surface shape than textures with randomly stippled patterns
- ☐ consider using halos to enhance occlusion where this is an important depth cue and where overlapping objects have the same color or minimal luminance difference
- ☐ Consider applying ambient occlusion in the lighting model to support two-dimensional (2D) shape perception for objects that otherwise supply no shading information.

Relationship

- ☐ graphical elements, rather than words, should be used to show structural relationships between entities and groups of entities. Consider using lines, ribbons of color, connecting lines, enclosure, grouping, and attachment. The shape, color, and thickness of lines and enclosures can represent the types of relationships. A small geon attached to a larger geon can show that it is a component part.
- ☐ consider using cast shadows to reveal large-scale spatial relationships. Shadows should be created only where the connection between the shadow and the casting object is clear and where the value of the additional information

outweighs the information that it obscured
- ☐ consider using symmetry to make pattern comparisons easier, but be sure that the patterns to be compared are small in terms of visual angle (<1 degree horizontally and <2 degrees vertically). Symmetrical relations should be arranged on horizontal or vertical axes unless some framing pattern is used

Augmented reality

- ☐ an augmenting image linked to an external object should be at the same focal distance
- ☐ when augmenting imagery does not need to be linked to external objects, the focal distance of the augmenting imagery should be closer, which will reduce visual interference. This will not work for older users who have little or no ability to change the focus of their eyes.

Virtual reality

- ☐ use wrap-around screens to obtain a sensation of "presence" in a virtual space. This is useful in vehicle simulations and some entertainment systems.
- ☐ in 3D environments that support one-to-one mapping between the user's hand and a virtual object, ensure that the relative positions of a hand proxy, such as a probe, and an object being reached for are correct. Also, minimize rotational mismatch (>30 degrees) between the virtual space and the actual space within which the user's hand is moving
- ☐ to create a vivid sense of presence in a 3D data space, provide a large field of view, smooth motion, and a lot of visual detail
- ☐ to support view navigation in 3D spaces, a sufficient number of objects must be visible at any time to judge relative view position, and several objects must persist from one frame to the next to maintain continuity

Stereoscopy

- ☐ ensure adequate luminance contrast in order to define features important for perceiving stereoscopic depth
- ☐ avoid placing graphical objects so that they appear in front of the screen and are clipped by the edges of the screen. The simplest way of doing this is to ensure that no objects are in front of the screen in terms of their stereoscopic depth
- ☐ consider using using the highest possible screen resolution, especially in a horizontal direction, and aim to achieve excellent spatial and temporal anti-aliasing
- ☐ consider adjusting the virtual eye separation to optimize perceived stereoscopic depth while minimizing diplopia or double vision
- ☐

Interaction

- ☐ the default controls should allow for tilt around a horizontal axis and rotation about a vertical axis, but not rotation around the line of sight
- ☐ consider representing system components using geons—simple 3D shaded objects such as spheres, cylinders, cones, and boxes
- ☐ in an interface to specify colors, consider laying out the red–green and yellow–blue channel information on a plane. Use a separate control for specifying the dark–light dimension
- ☐ for two-handed manipulations, the non-dominant hand (usually the left) should be used to control frame-of-reference information, while the dominant hand (usually the right) should be used to make detailed selections or manipulations of data
- ☐ be sure that objects movement, on the screen, is in the same general direction as hand movement
- ☐ for zooming, set a default scaling rate of 3 to 4x (magnification or minification) per second. The rate should be user changeable so that experts can increase it.

Sources

1. Information Visualization: Perception for Design By Colin Ware (Appendix D)