The form XObject specified by the **O** entry is subject to the following restrictions; failure to abide by them could result in misalignment of the overlay with the rendered 3D graphics:

- The form XObject is associated with a specific view (not with the camera position defined by the 3D view dictionary). It should only be drawn when the user navigates using the 3D view, not when the user happens to navigate to the same orientation by manual means.
- It should only be drawn if the artwork-to-world matrix has not been altered.
- It may only be specified in 3D view dictionaries in which both a camera-to-world matrix (**MS** and associated entries) and a projection dictionary (the **P** entry) are present.

The **CO** entry specifies the distance from the camera to the *center of orbit* for the 3D view, which is the point around which the camera should rotate when performing an orbit-style navigation. Figure 9.4 illustrates camera positioning when orbiting around the center of orbit.

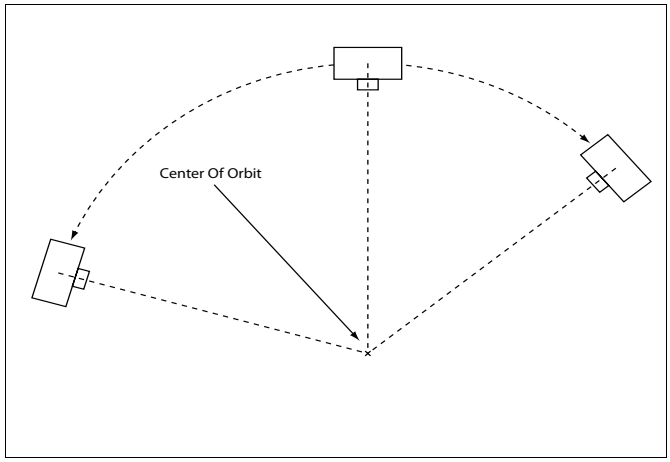


FIGURE 9.4 *Rotation around the center of orbit*

The **LS** entry allows the lighting of the 3D artwork to be changed without changing the artwork itself. This enables consumers to view a given piece of 3D artwork with a variety of lighting options without requiring multiple copies of the 3D artwork stream that differ only in lighting. It also enables artwork with poor lighting

far planes, respectively. A value of **ANF** for **CS** means that the near and far planes are determined automatically based on the objects in the artwork.

The **Subtype** entry specifies the type of projection, which determines how objects are projected onto the near plane and scaled. The possible values are **O** for *orthographic projection* and **P** for *perspective projection*.

For orthographic projectionn, objnects are projected onto the near plane by simply discarding their *z* value. They are scaled from units of the near planne's coordinate system to those of the annotation's targnet coordinate system by the combnined fac tors specified by the **OS** entry annd the **OB** entry.

For perspective projection an givenoordinnate (*x*, *y*, *z*) is projected onto the near plane, defnining a 2D coordinate (x_1, y_1) using the following formulas:

$$x_1 = x \times \frac{n}{z}$$
$$y_1 = y \times \frac{n}{z}$$

where *n* is the *z* coordinate of the near plane.

Scaling with perspective projection is more complicated than for orthographic projection. The **FOV** entry specifies an angle that defines a cone centered along the *z* axis in the camera coordinate system (see Figure 9.5). The cone intersects withn the near plane forming a circular area on the near plane.Figure 9.6 shows this cinrcle an graphics from the position ofn the cameran.

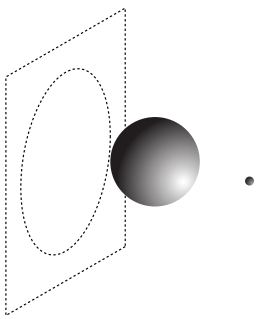
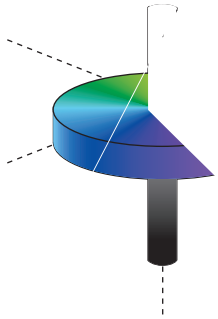


FIGURE 9.5 *Perspective projection of 3D artwork onto the near plane*



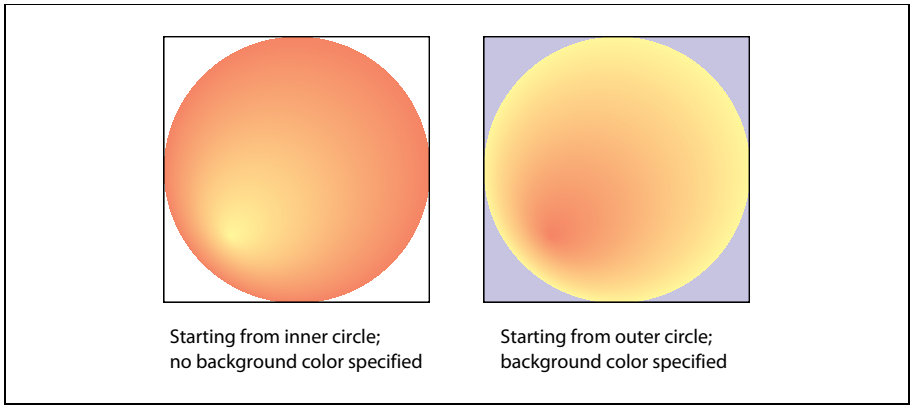


PLATE 12 *Radial shadings depicting a sphere ("Type 3 (Radial) Shadings," page 313)*

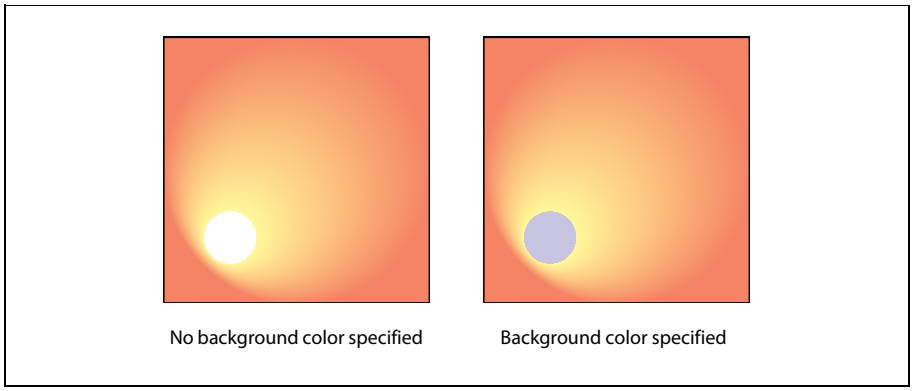


PLATE 13 *Radial shadings with extension ("Type 3 (Radial) Shadings," page 313)*

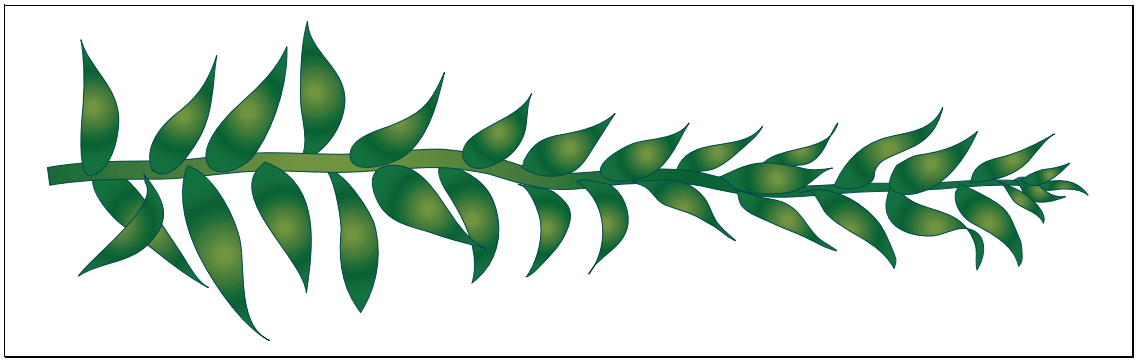
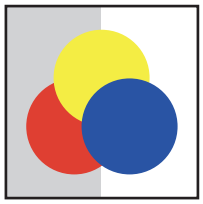
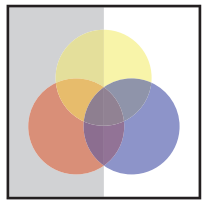
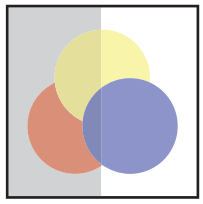


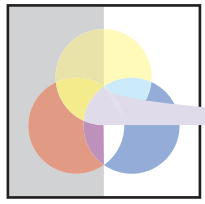
PLATE 14 *Radial shading effect ("Type 3 (Radial) Shadings," page 313)*





Ungrouped objects
Object opacit 01 .5 5. 15 0. Ots 1bjec





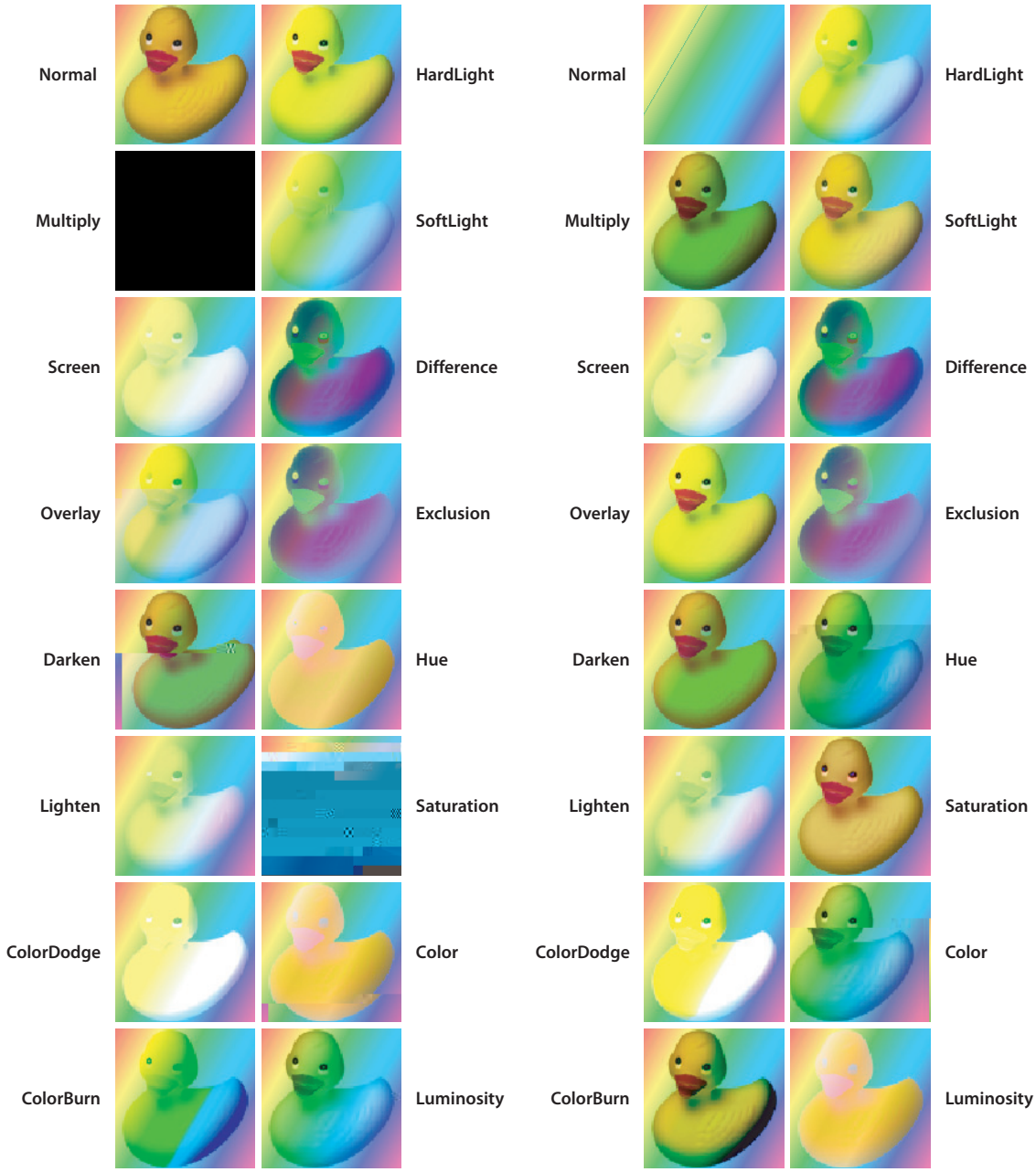


PLATE 18 *RGB blend modes (Section 7.2.4, "Blend Mode," page 520)*