### 14.2.1 Backface Culling

Imagine that you are looking at an opaque sphere in a scene. Approximately half of the sphere will not be visible. The obvious conclusion from this observation is that what is invisible need not be rendered since it does not contribute to the image. Therefore, the back side of the sphere need not be processed, and that is the idea behind backface culling. This type of culling can also be done for whole groups at a time, and so is called clustered backface culling.

All backfacing polygons that are part of a solid opaque object can be culled away from further processing, assuming the camera is outside of, and does not penetrate (i.e., near clip into), the object. A consistently oriented polygon (see Section 12.3) is backfacing if the projected polygon is known to be oriented in, say, a counterclockwise fashion in screen space. This test can be implemented by computing the normal of the projected polygon in two-dimensional screen space: $\mathbf{n} = (\mathbf{v}_1 - \mathbf{v}_0) \times (\mathbf{v}_2 - \mathbf{v}_0)$. This normal will either be $(0, 0, a)$ or $(0, 0, -a)$, where $a > 0$. If the negative $z$-axis is pointing into the screen, the first result indicates a frontfacing polygon. This test can also be formulated as a computation of the signed area of the polygon (see Section A.5.4). Either culling test can be implemented immediately after the screen-mapping procedure has taken place (in the geometry stage). Backface culling decreases the load on the rasterizer since we do not have to scan convert the backfacing polygons. But the load on the geometry stage might increase because the backface computations are done there.

Another way to determine whether a polygon is backfacing is to create a vector from an arbitrary point on the plane in which the polygon lies (one of the vertices is the simplest choice) to the viewer's position.[3] Compute the dot product of this vector and the polygon's normal. A negative dot product means that the angle between the two vectors is greater than $\pi/2$ radians, so the polygon is not facing the viewer. This test is equivalent to computing the signed distance from the viewer's position to the plane of the polygon (see Section A.5.2). If the sign is positive, the polygon is frontfacing. Note that the distance is obtained only if the normal is normalized, but this is unimportant here, as only the sign is of interest. These culling techniques are illustrated in Figure 14.10.

In the article "Backface Culling Snags" [105], Blinn points out that these two tests are geometrically the same. Both compute the dot product between the normal and the vector from a point on the polygon to the eye. In the test that is done in screen space, the eye has been transformed to $(0, 0, \infty)$, and the dot product is thus only the $z$-component of the polygon

[3]For orthographic projections, the vector to the eye position is replaced with the negative view direction, which is constant for the scene.