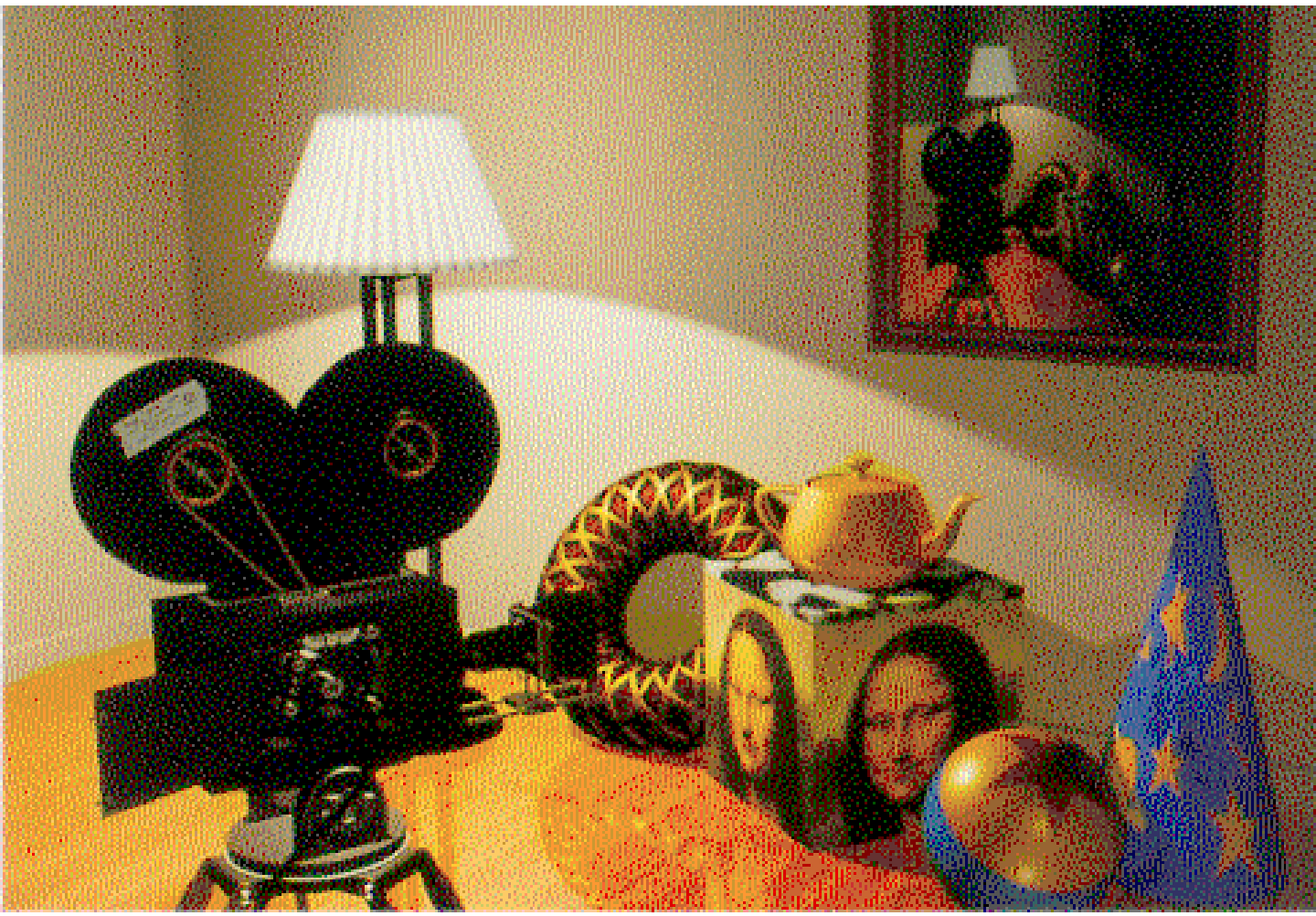
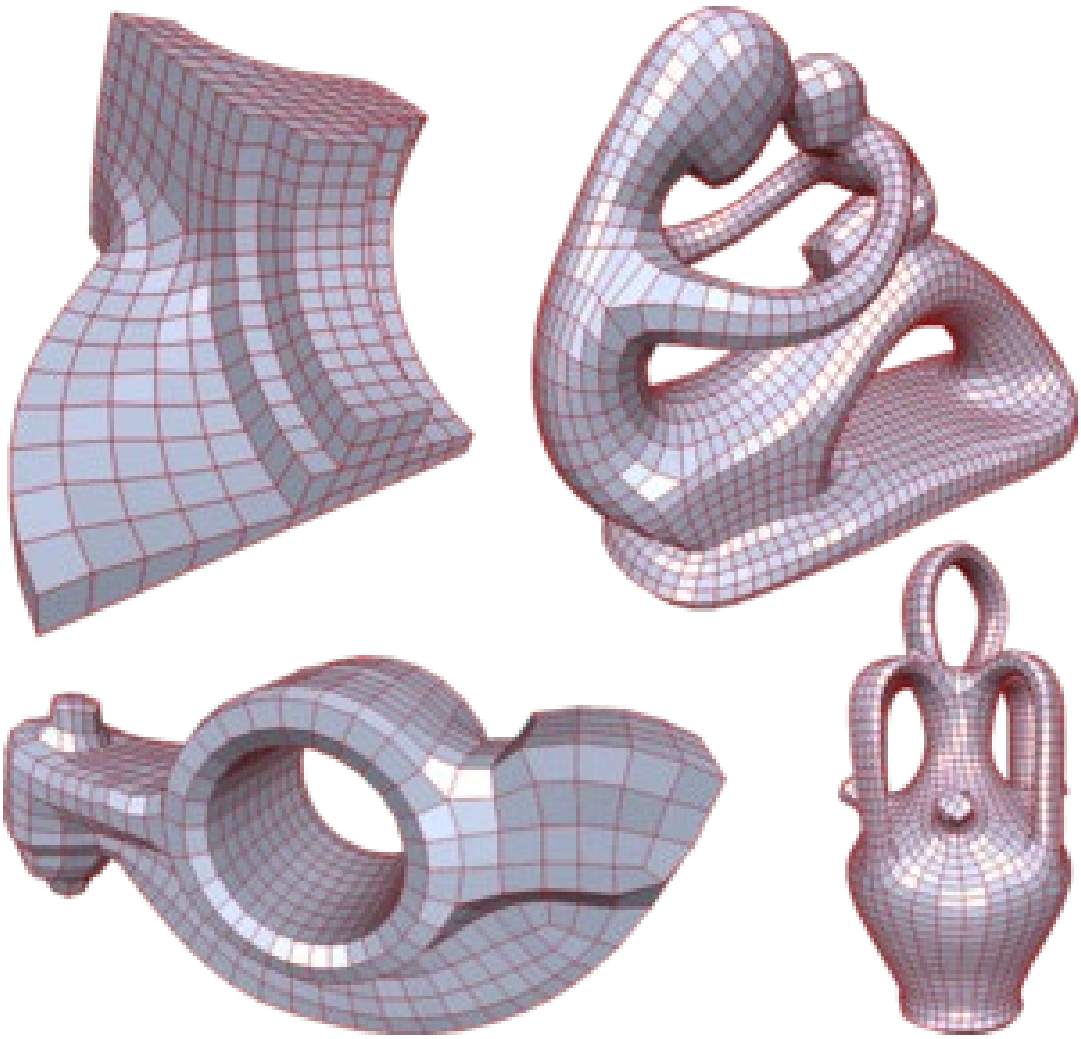
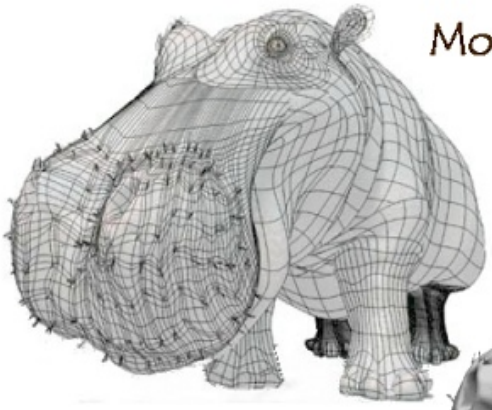
3D Rendering Pipeline
(for direct illumination)



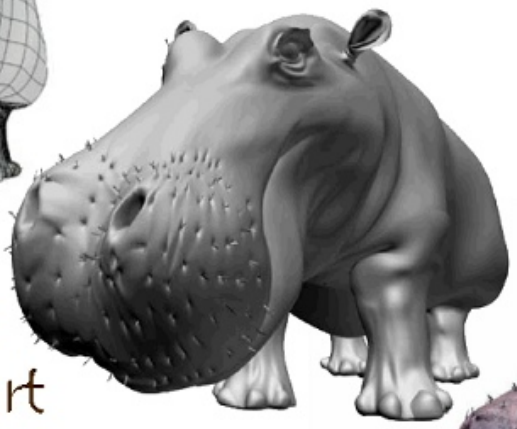


Polygonal Mesh



Model

Model + Shading

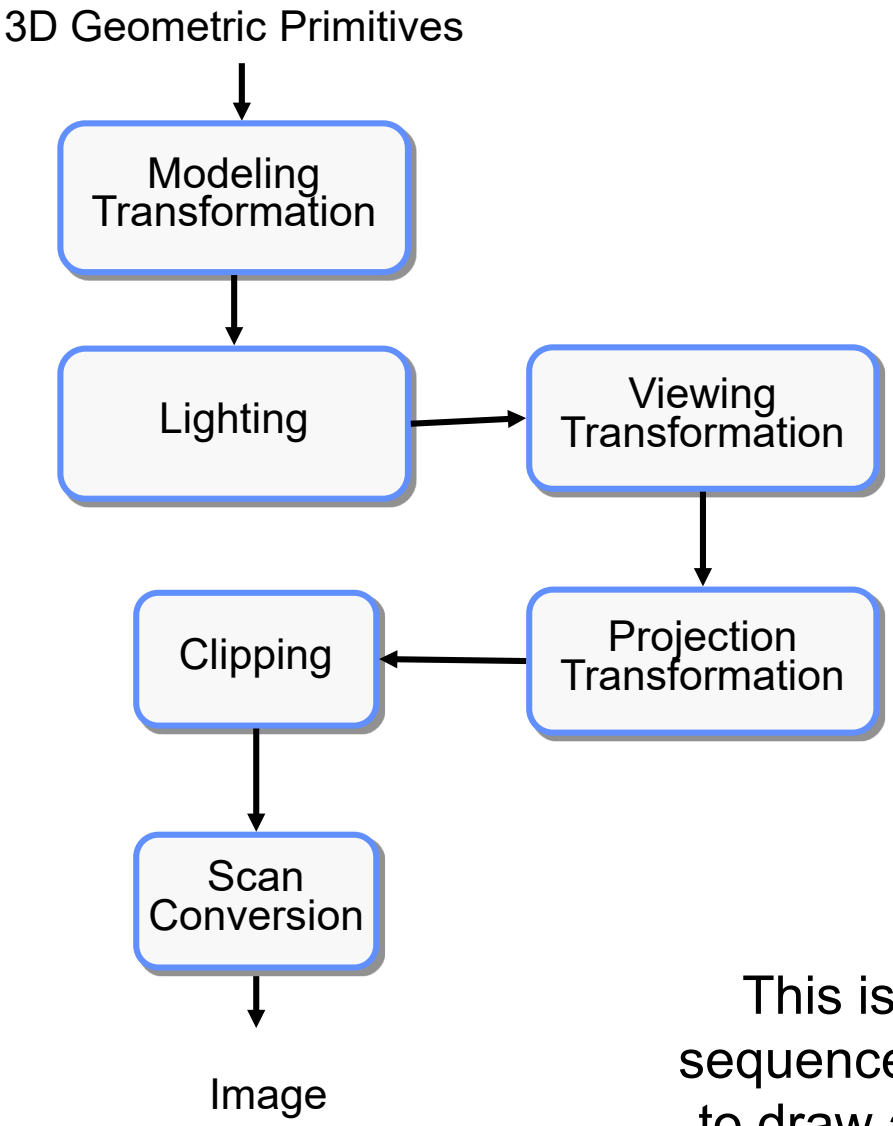


Model + Shading
+ Textures

At what point
do things start
looking real?

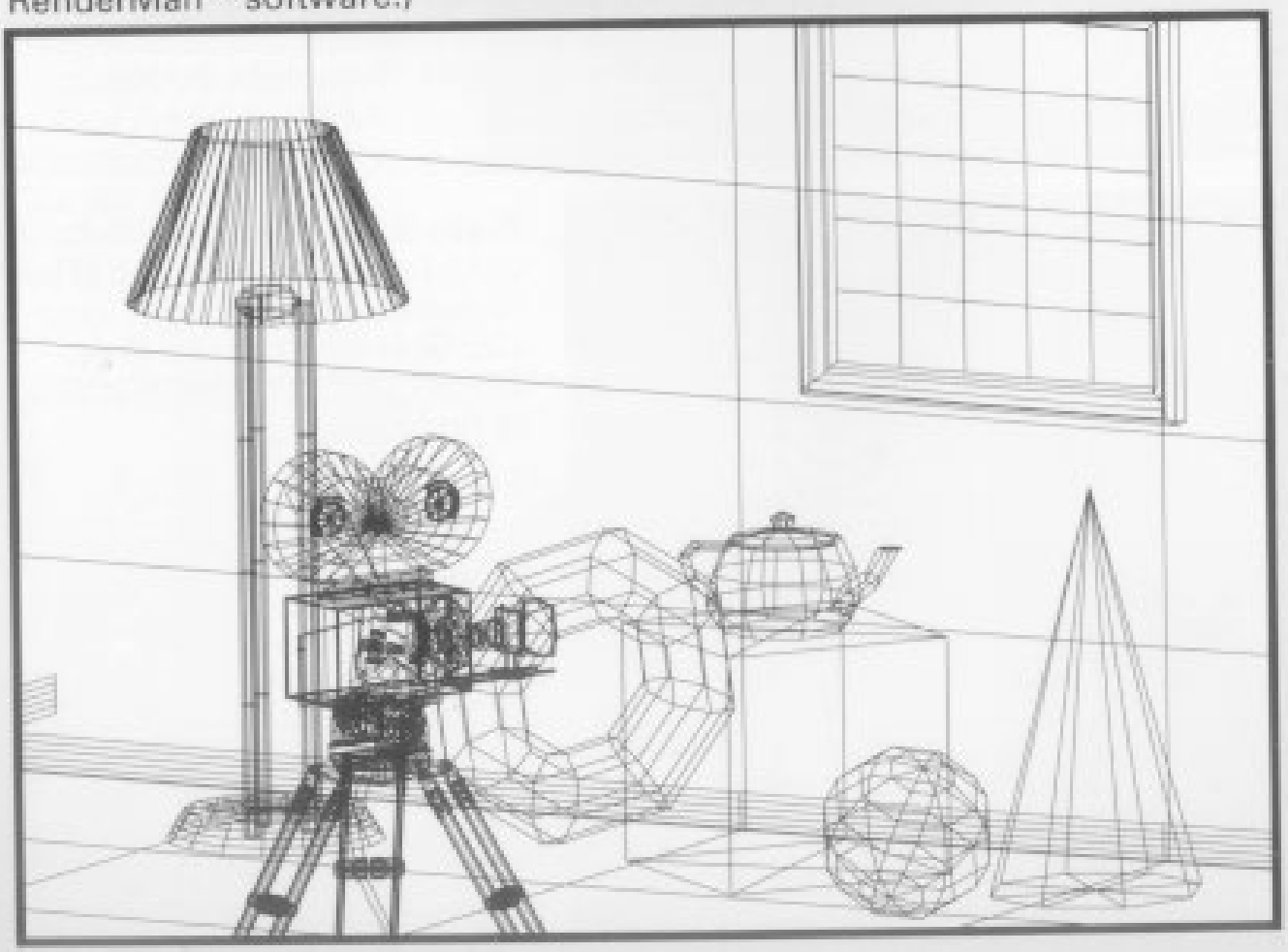
For more info on the computer artwork of Jeremy Birn
see http://www.3drender.com/jbirn/productions.html

3D Rendering Pipeline
(for direct illumination)



This is a pipelined sequence of operations to draw a 3D primitive into a 2D image

Plate II.22 *Shutterbug.* Axonometric projection (Sections 6.1.2 and 14.3.2). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)



Polygonal model generated from spline patches.
Orthographic projection

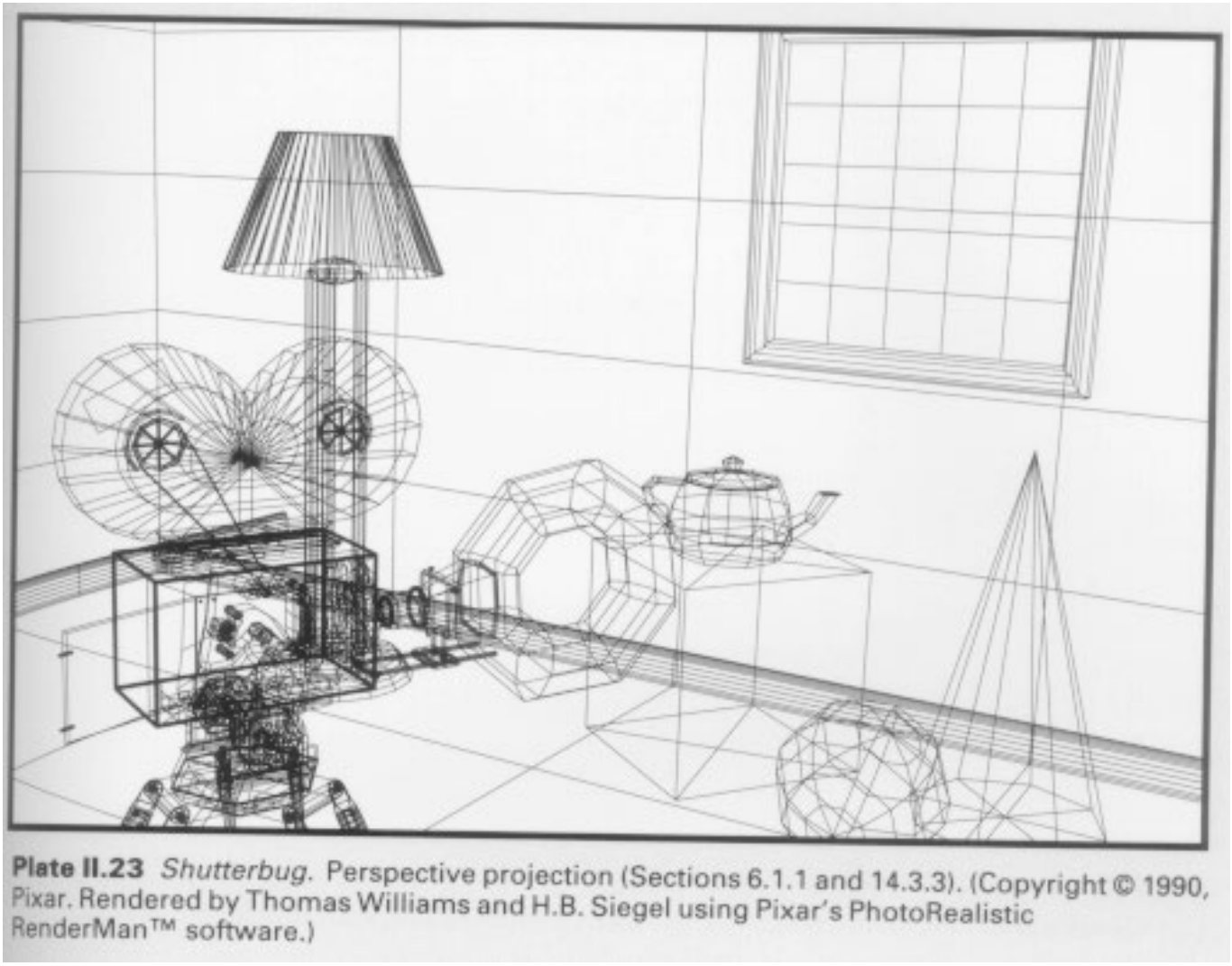
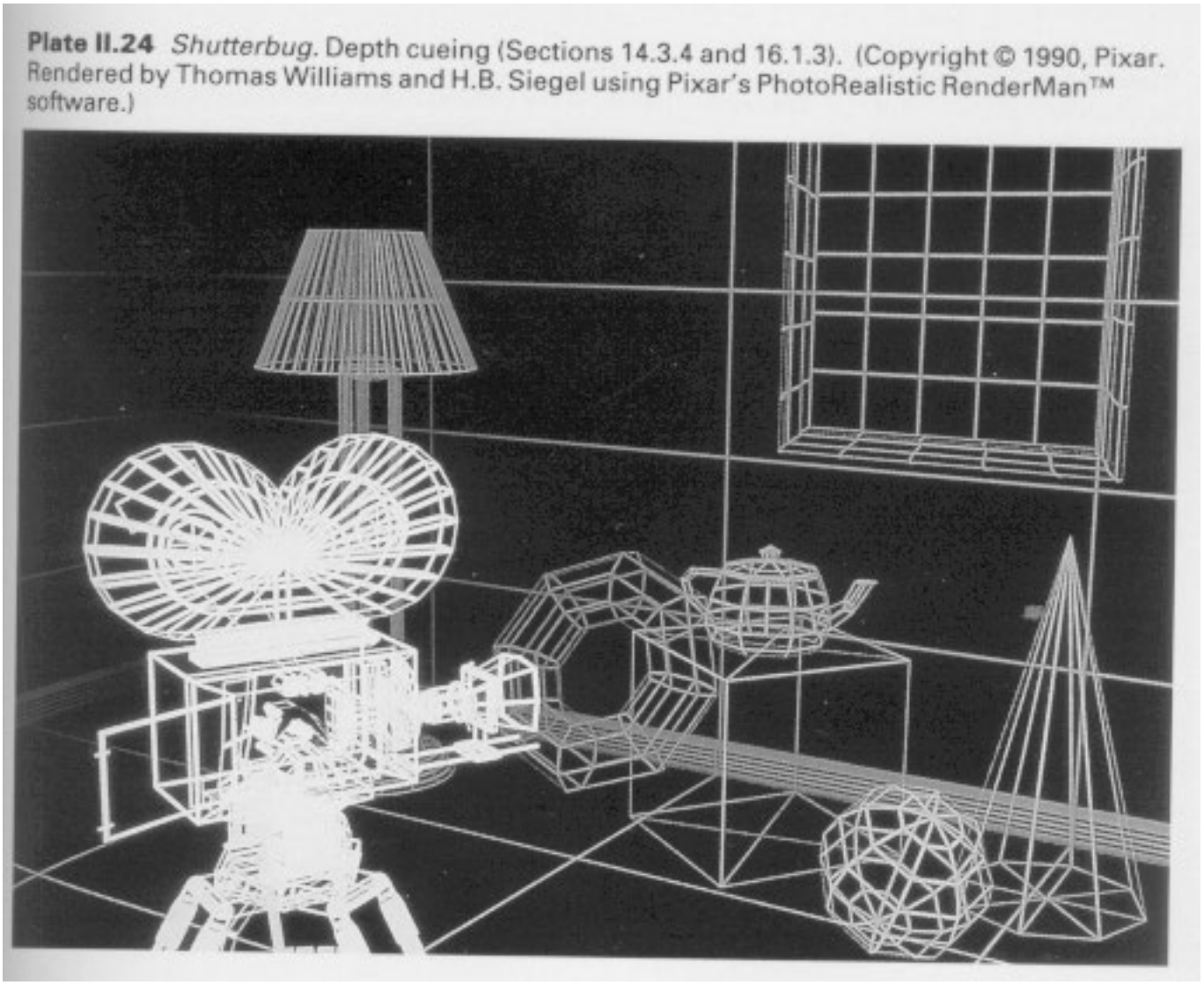


Plate II.23 *Shutterbug.* Perspective projection (Sections 6.1.1 and 14.3.3). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)

Polygonal model generated from spline patches.
Perspective projection



Depth cueing.

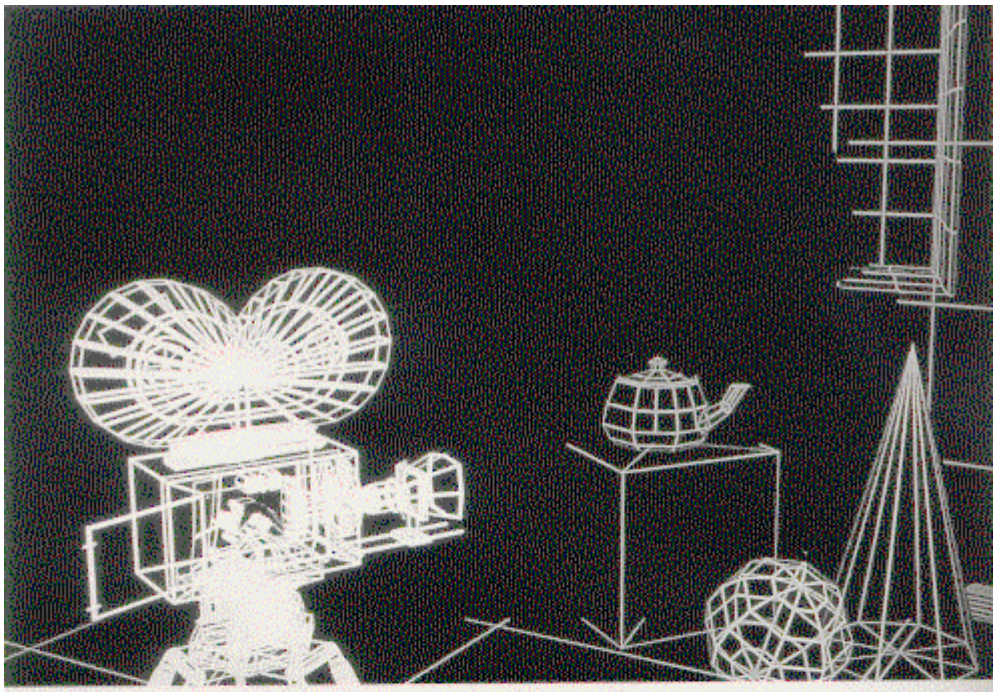
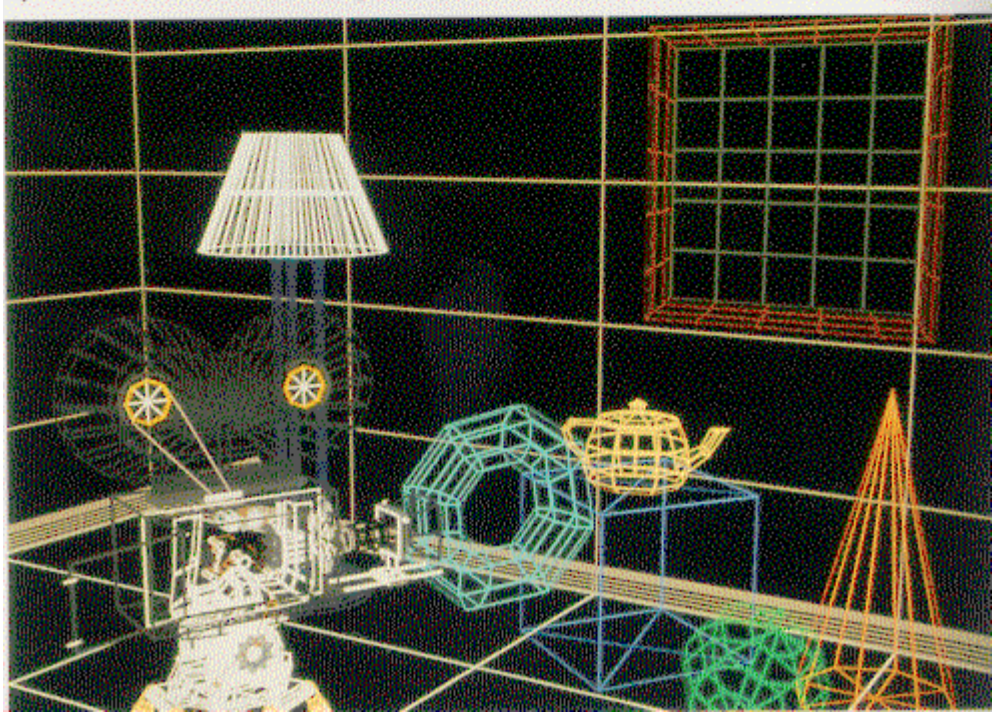


Plate II.25 *Shutterbug.* Depth clipping (Section 14.3.5). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)

Plate II.26 *Shutterbug.* Colored vectors (Section 14.3.7). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)



Up: Depth Clipping. Down: Colored vectors.

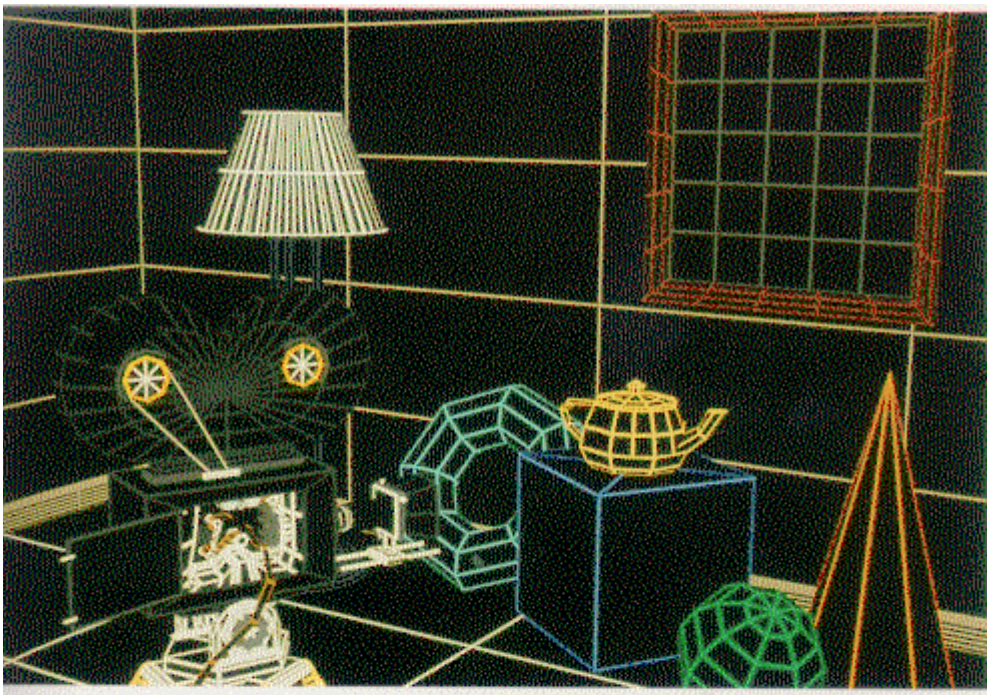
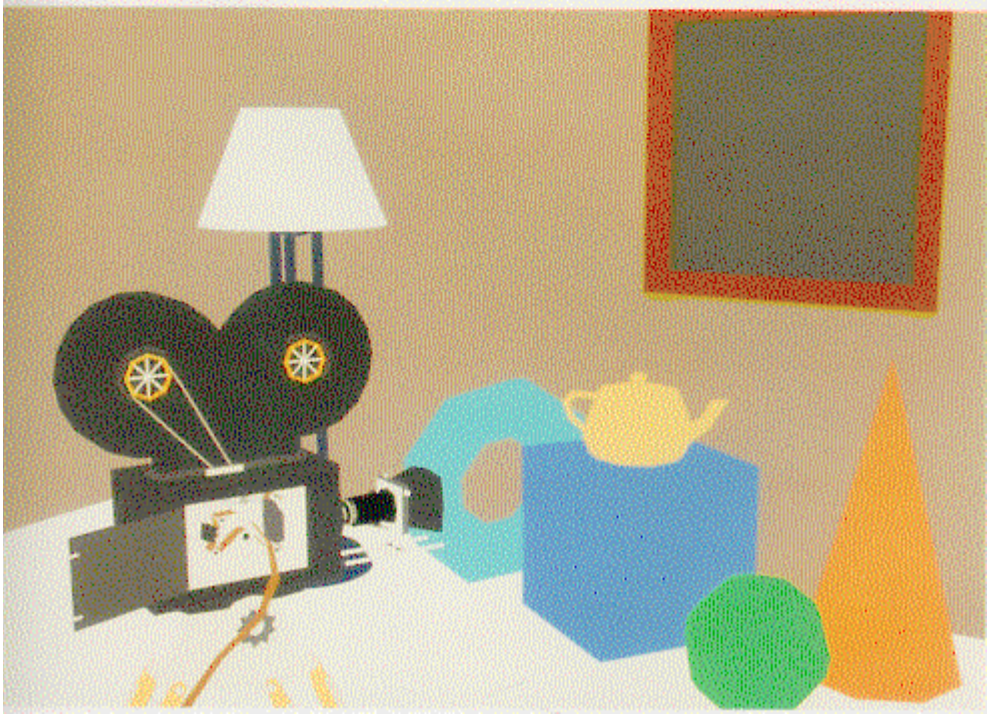
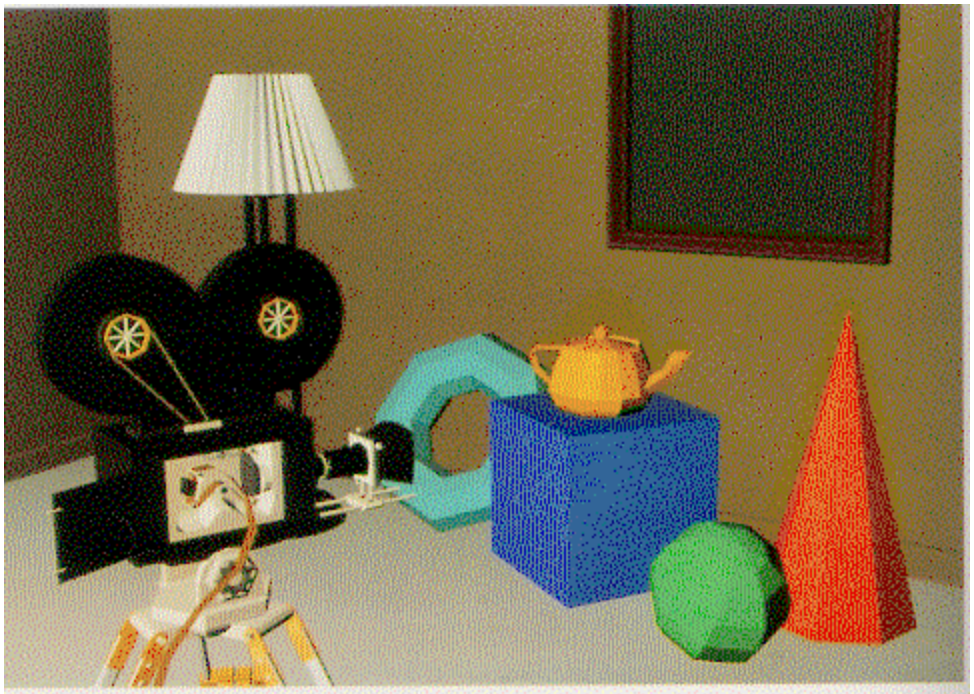


Plate II.27 *Shutterbug.* Visible-line determination (Section 14.3.8). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)

Plate II.28 *Shutterbug.* Visible-surface determination with ambient illumination only (Sections 14.4.1 and 16.1.1). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)

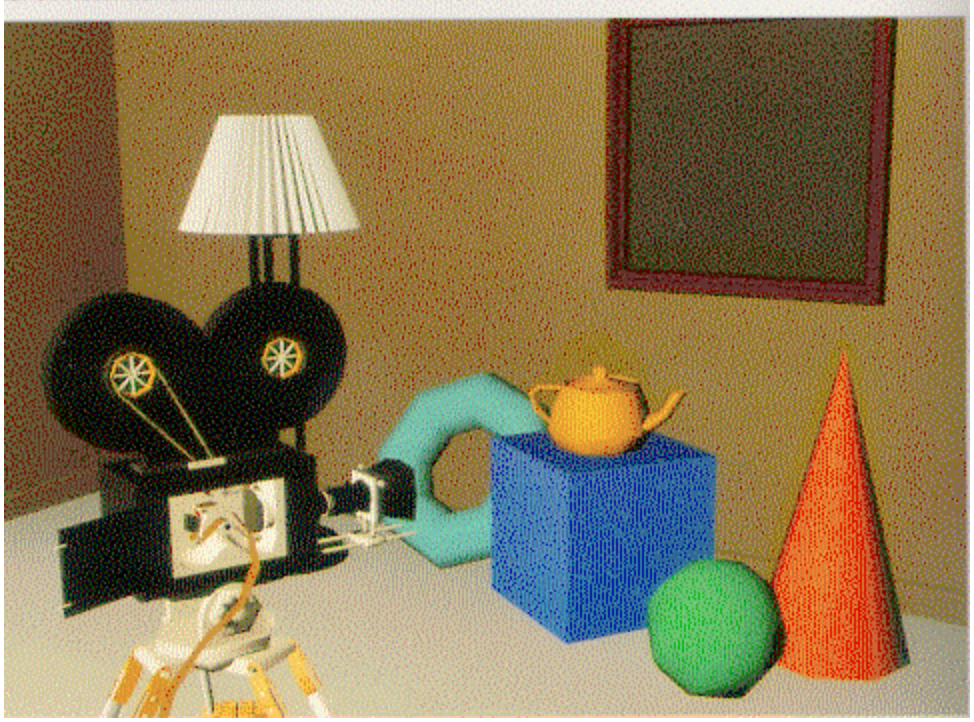


Up: Visible line determination.
Down: Visible surface determination with ambient illumination.



ate II.29 *Shutterbug.* Individually shaded polygons with diffuse reflection (Sections 14.4.2 d 16.2.3). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using ar's PhotoRealistic RenderMan™ software.)

ate II.30 *Shutterbug.* Gouraud shaded polygons with diffuse reflection (Sections 14.4.3 d 16.2.4). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using ar's PhotoRealistic RenderMan™ software.)



Up: Individually shaded polygon with diffuse reflection.
Down: Gouraud shaded polygon with diffuse reflection.

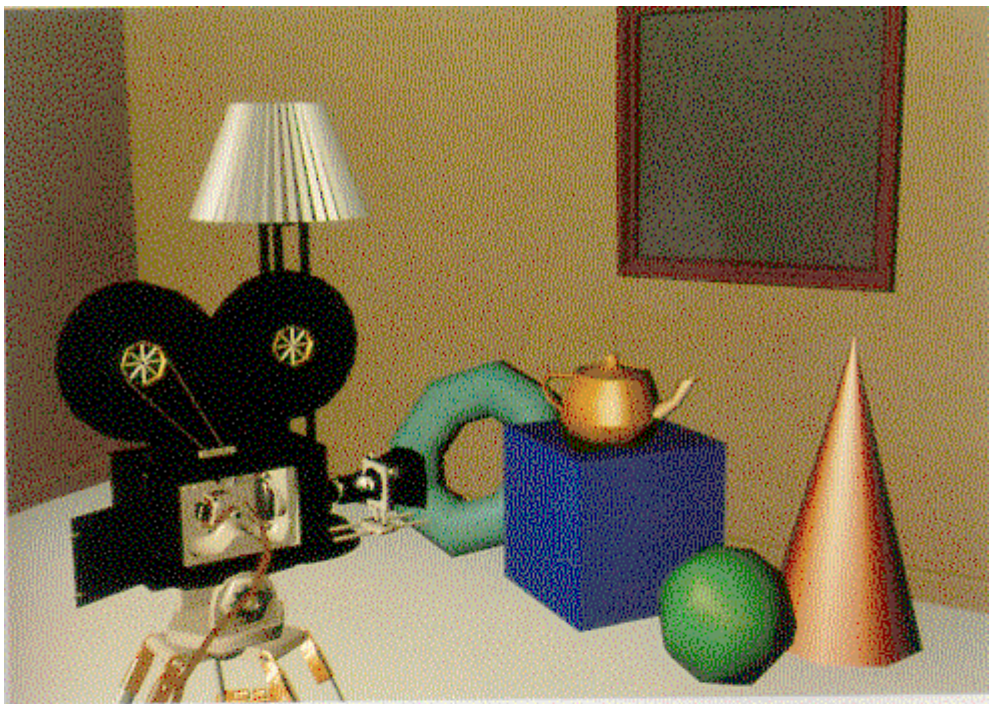
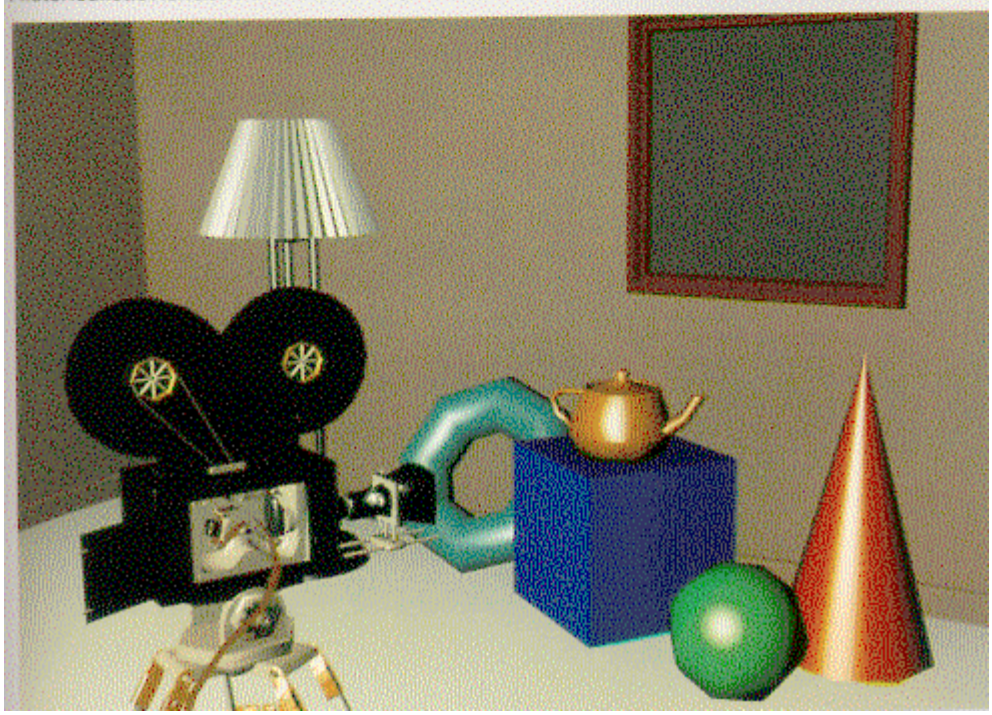


Plate II.31 *Shutterbug.* Gouraud shaded polygons with specular reflection (Sections 14.4.4 and 16.2.5). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)

Plate II.32 *Shutterbug.* Phong shaded polygons with specular reflection (Sections 14.4.4 and 16.2.5). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)



Up: Gouraud shaded polygon with specular reflection.
Down: Phong shaded polygon with specular reflection.

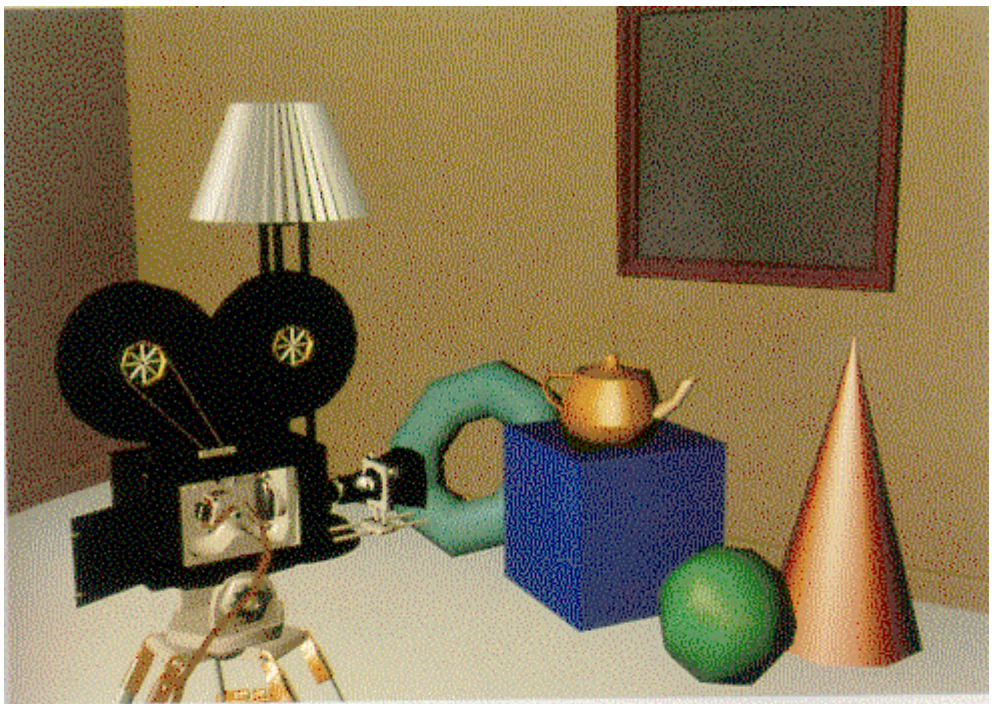
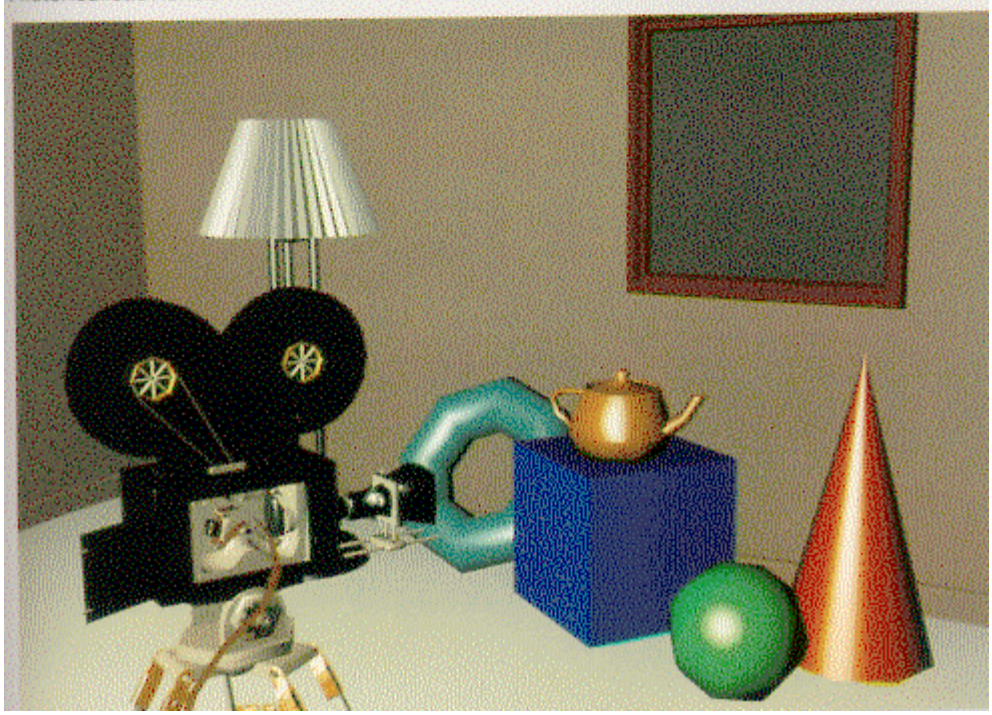


Plate II.31 *Shutterbug.* Gouraud shaded polygons with specular reflection (Sections 14.4.4 and 16.2.5). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)

Plate II.32 *Shutterbug.* Phong shaded polygons with specular reflection (Sections 14.4.4 and 16.2.5). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)



Up: Gouraud shaded polygon with specular reflection.
Down: Phong shaded polygon with specular reflection.

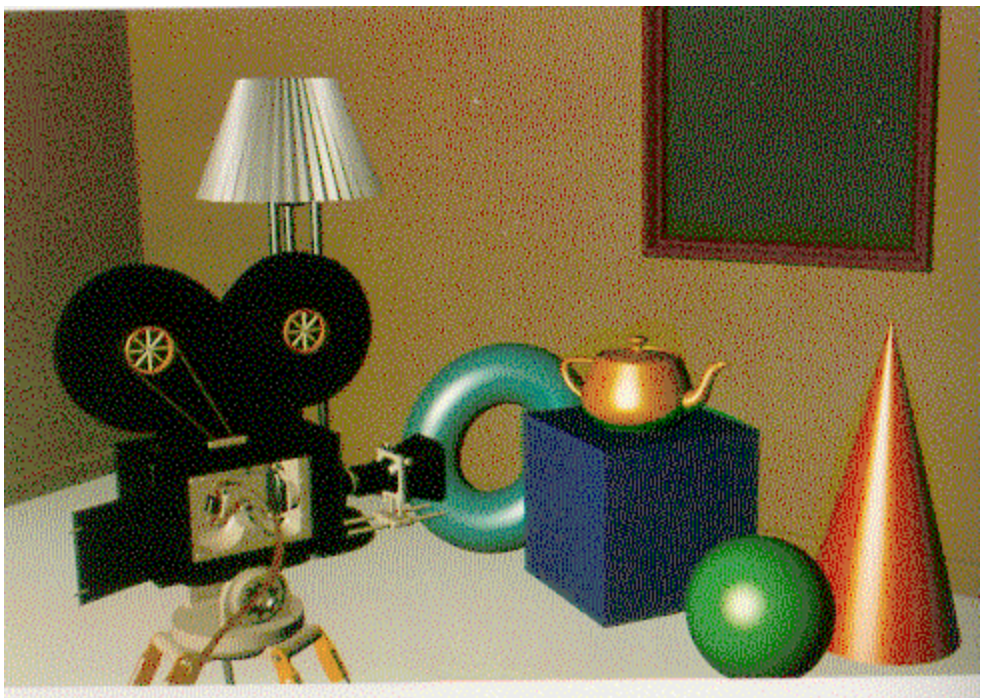
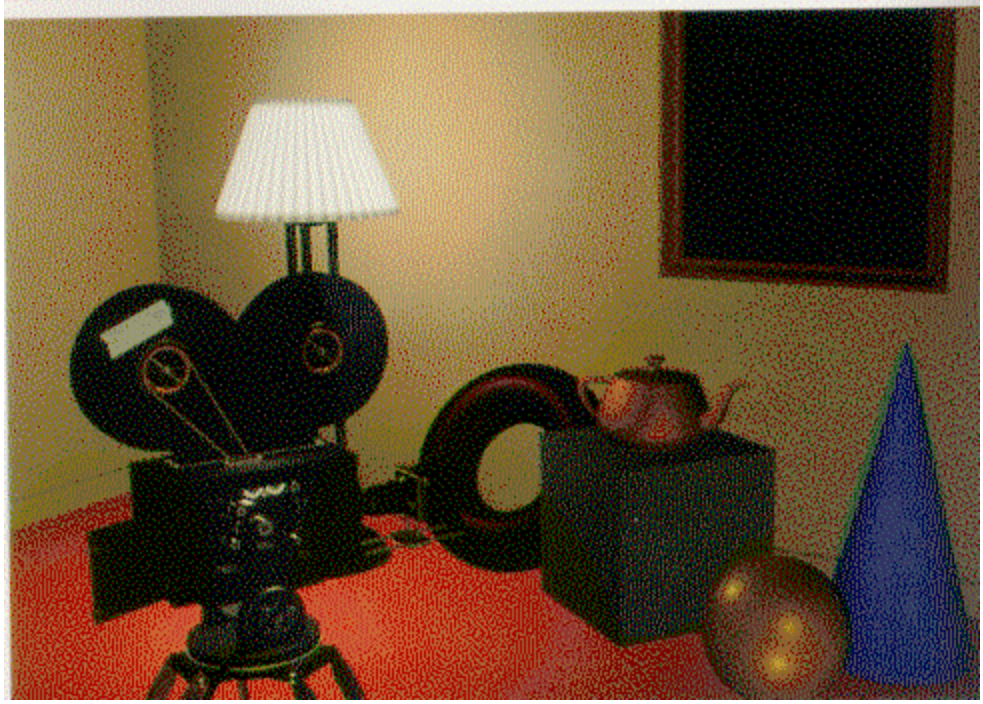


Plate II.33 *Shutterbug.* Curved surfaces with specular reflection (Section 14.4.5). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)

Plate II.34 *Shutterbug.* Improved illumination model and multiple lights (Sections 14.4.6 and 16.1). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)



Up: Curved surfaces with specular reflection.
Down: multiple lights.

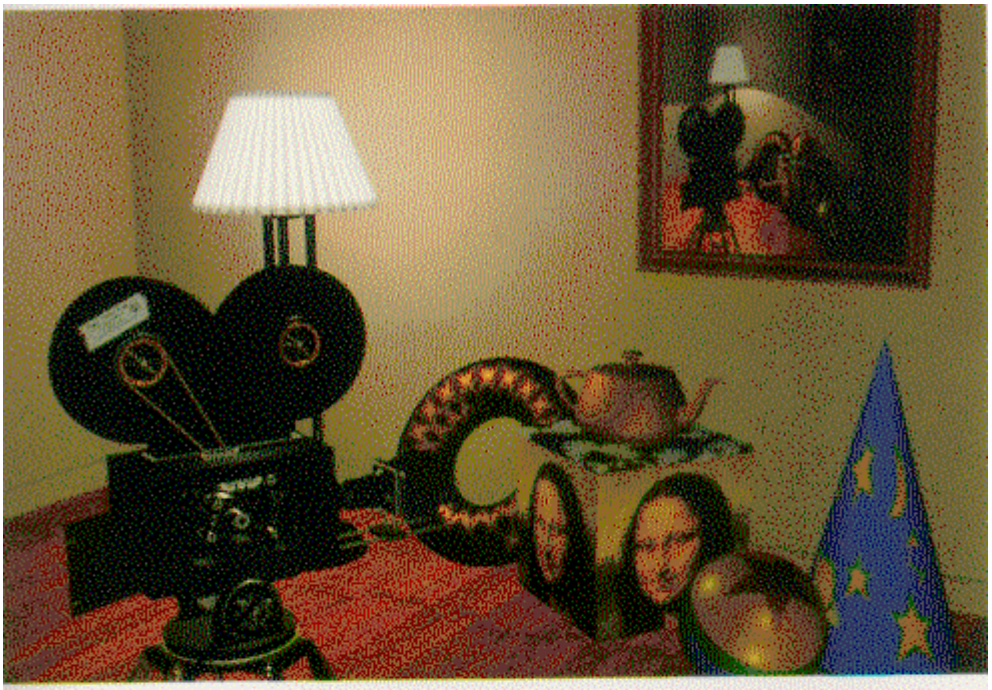
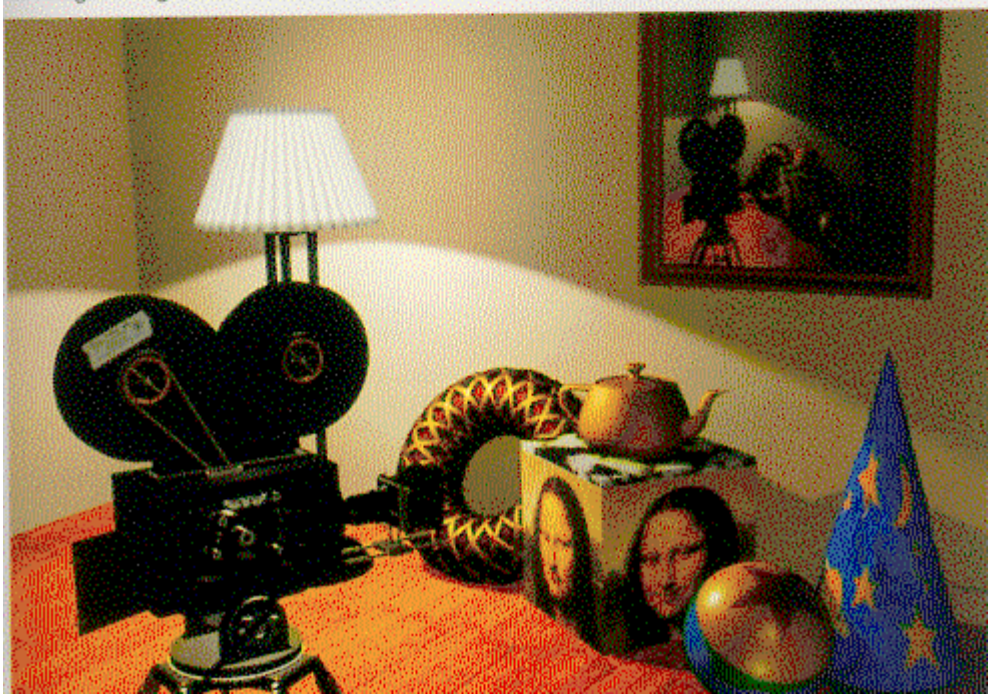
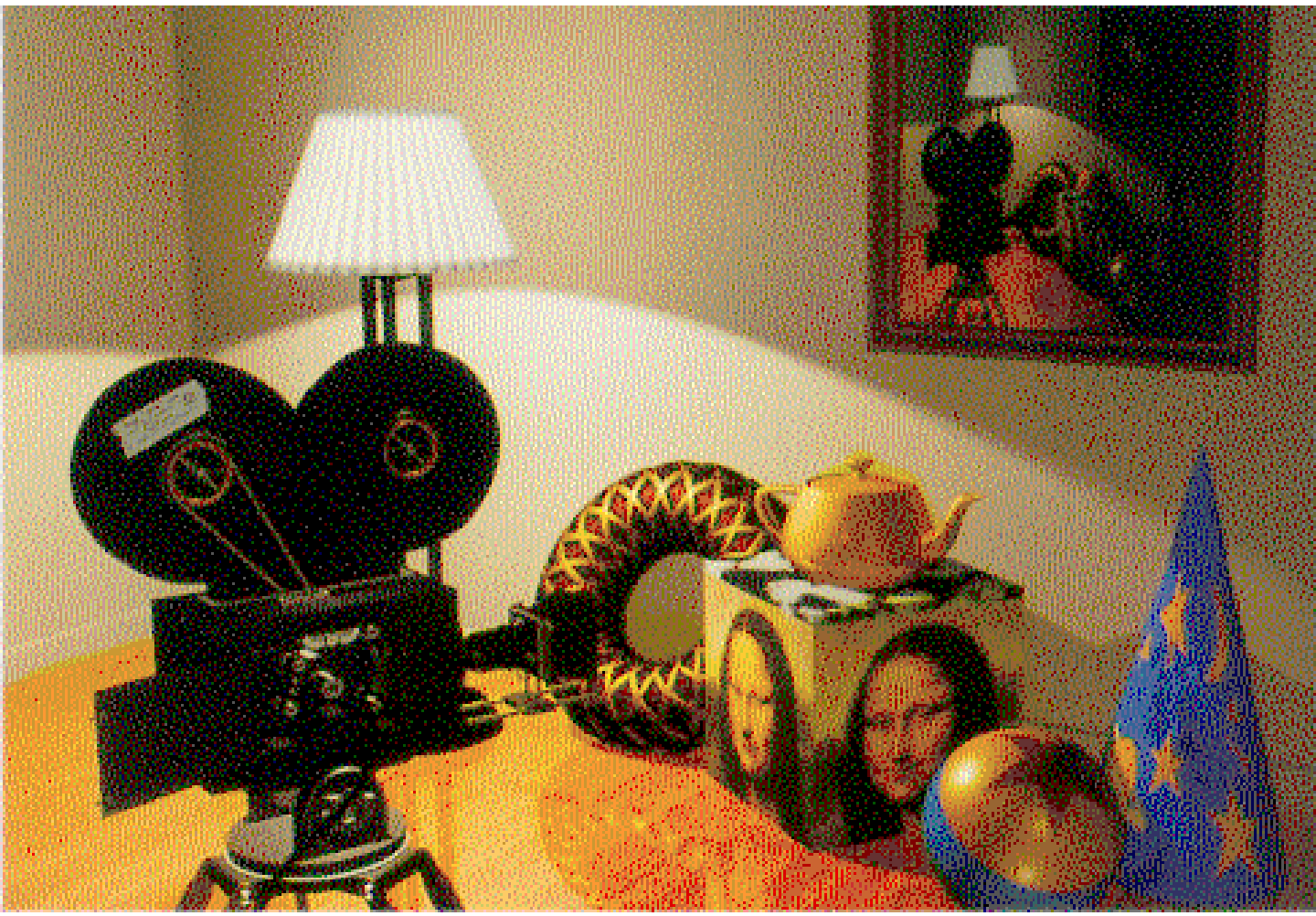


Plate II.35 *Shutterbug.* Texture mapping (Sections 14.4.7, 16.3.2, and 17.4.3). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)

Plate II.36 *Shutterbug.* Displacement mapping (Sections 14.4.7 and 16.3.4) and shadows (Sections 14.4.8 and 16.4). (Copyright © 1990, Pixar. Rendered by Thomas Williams and H.B. Siegel using Pixar's PhotoRealistic RenderMan™ software.)

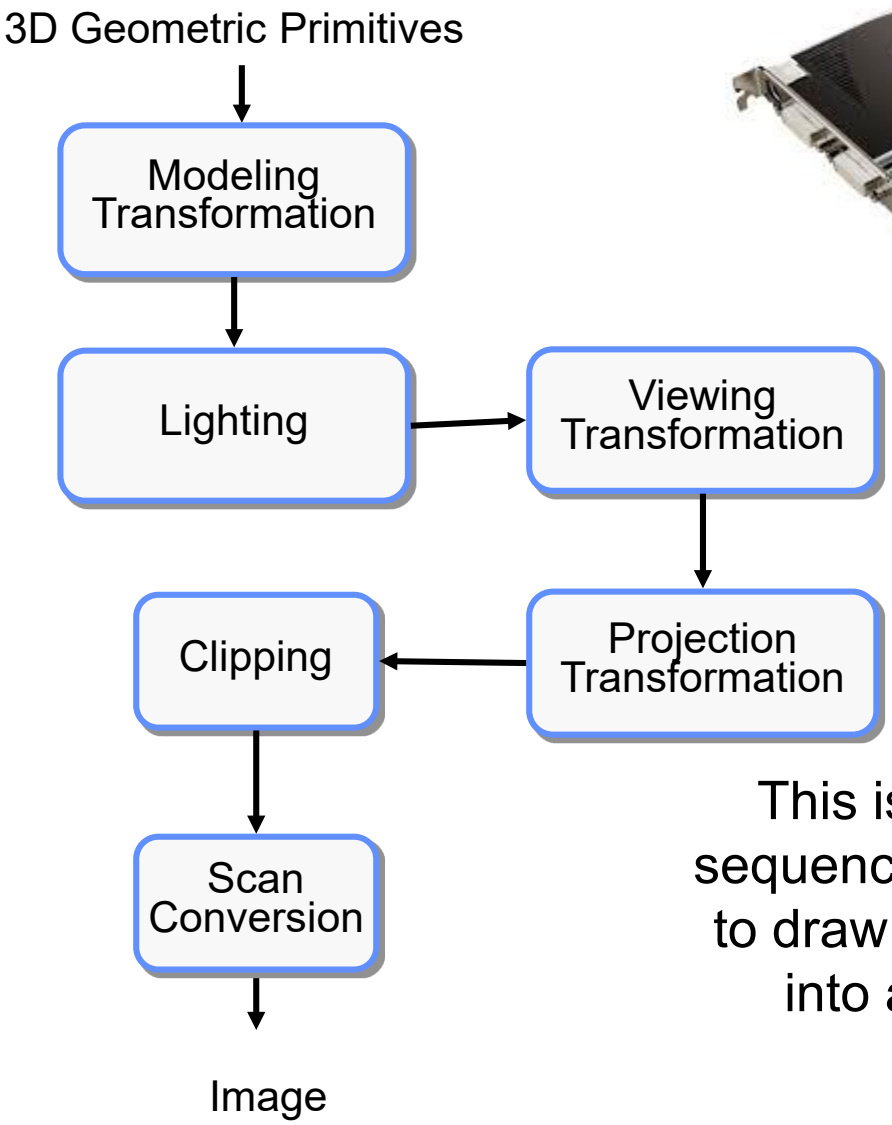


Up: Texture mapping.
Down: shadows.



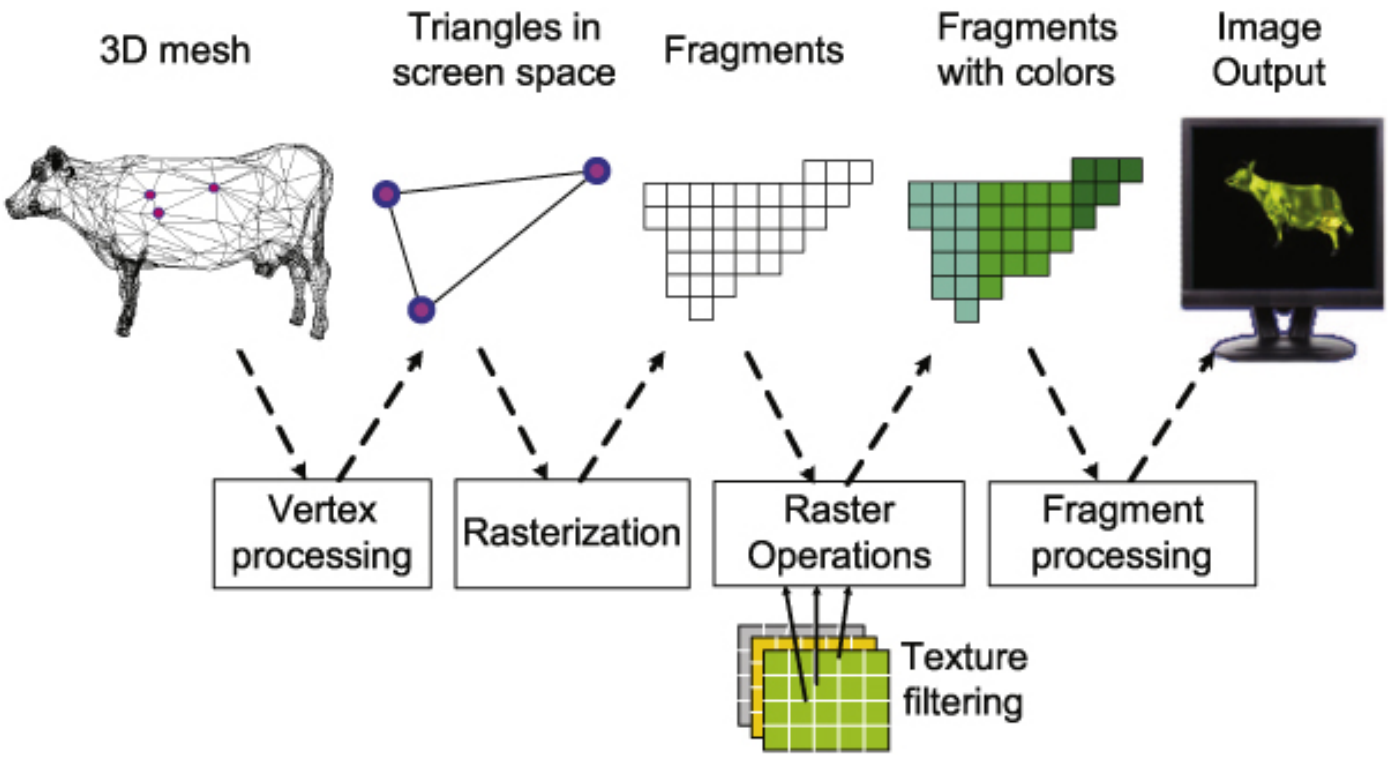
Final image

3D Rendering Pipeline
(for direct illumination)



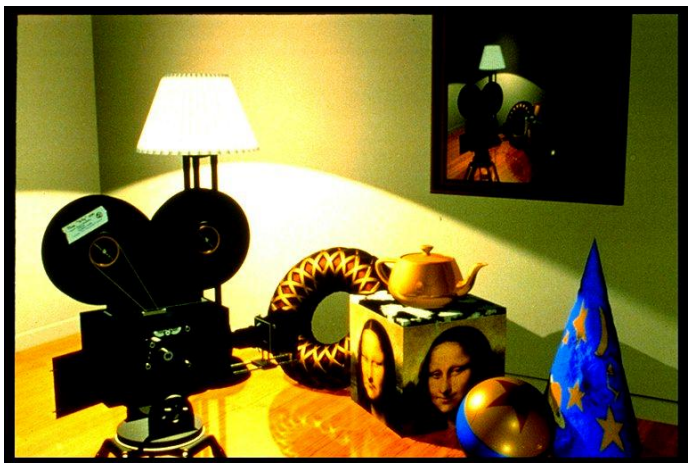
This is a pipelined sequence of operations to draw a 3D primitive into a 2D image

Vertex and Fragment Processing

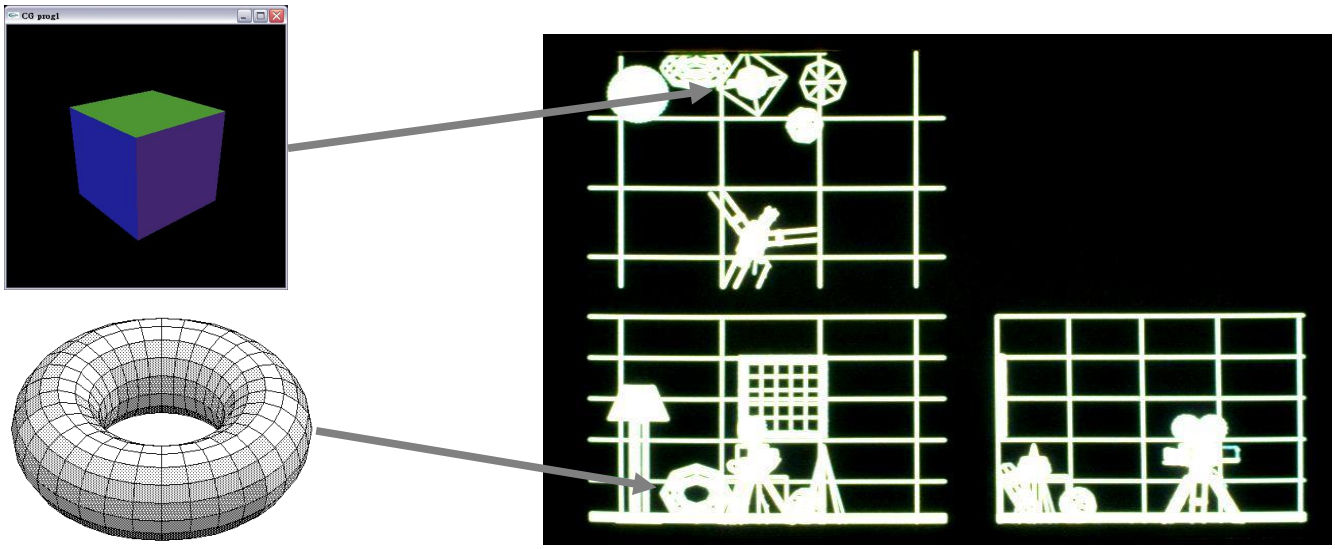


An example thro' the pipeline…

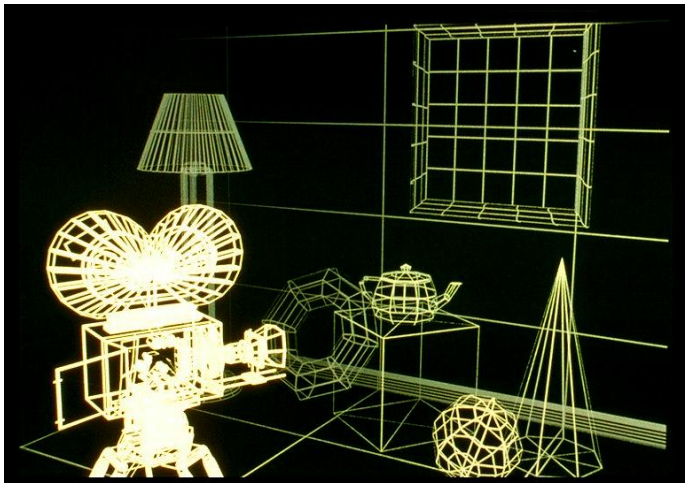
The scene we are trying to represent:

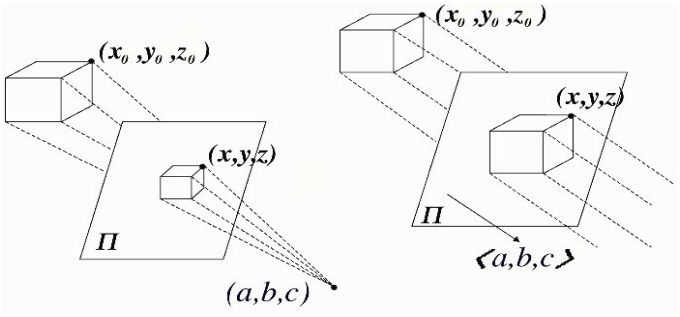


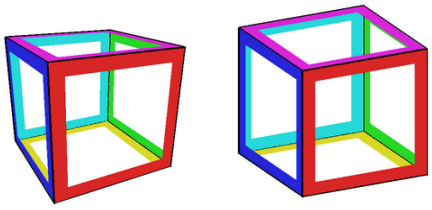
Model Transformations



Perspective Projection

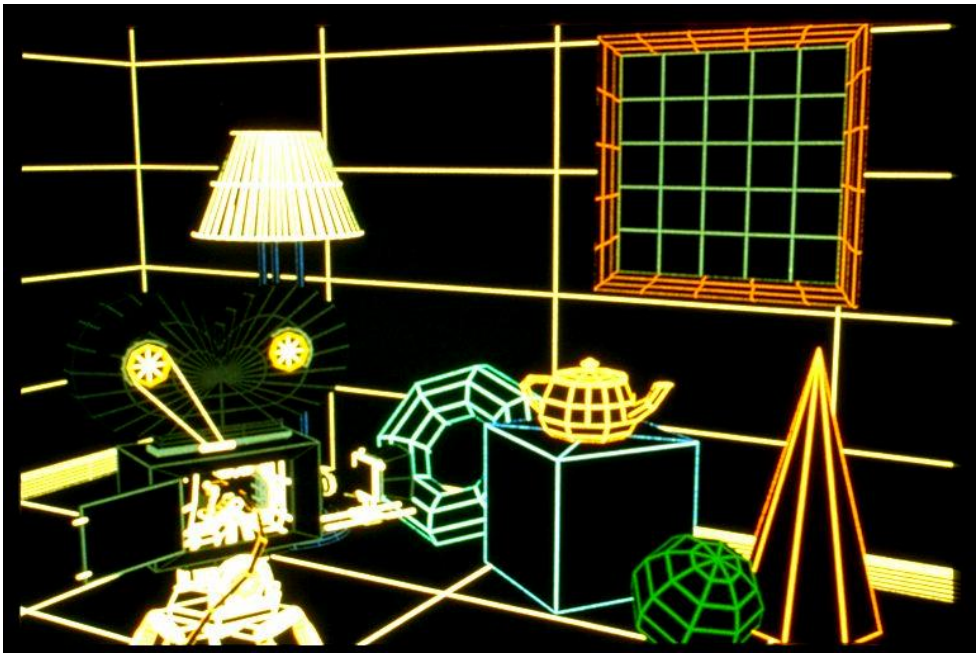




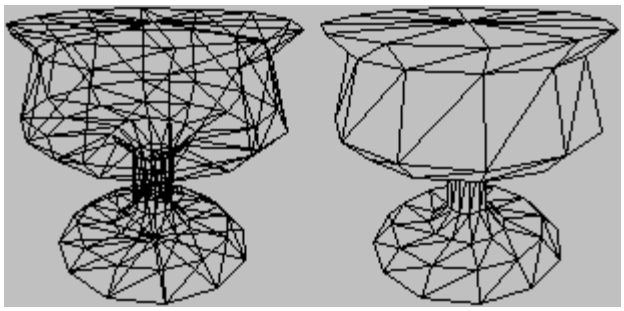


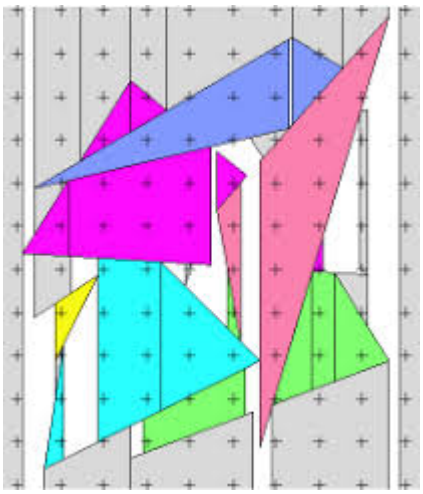
Hidden Surface Removal

Objects occluded by other objects must not be drawn



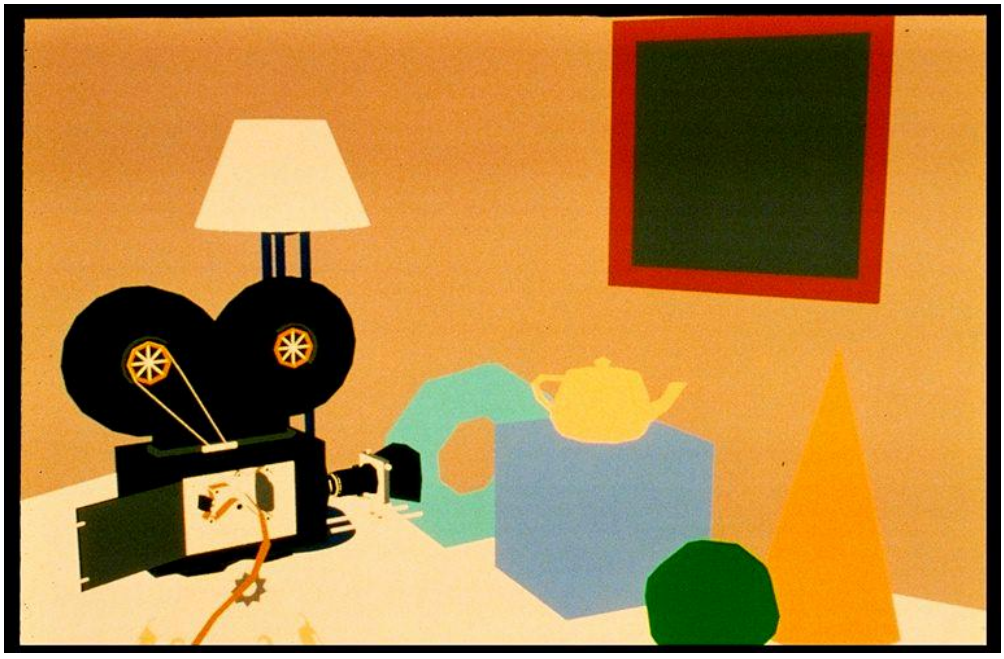
Hidden Surface Removal

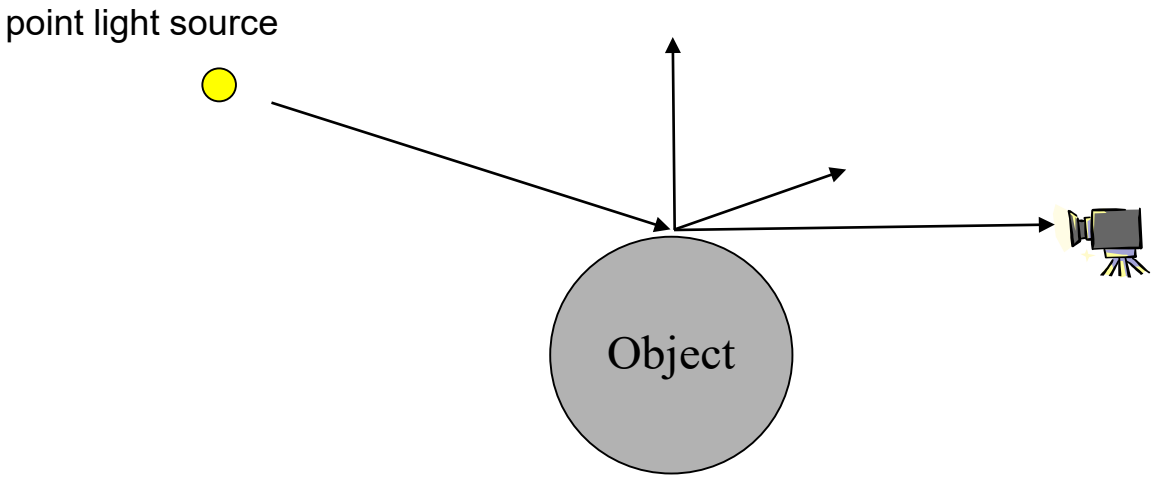




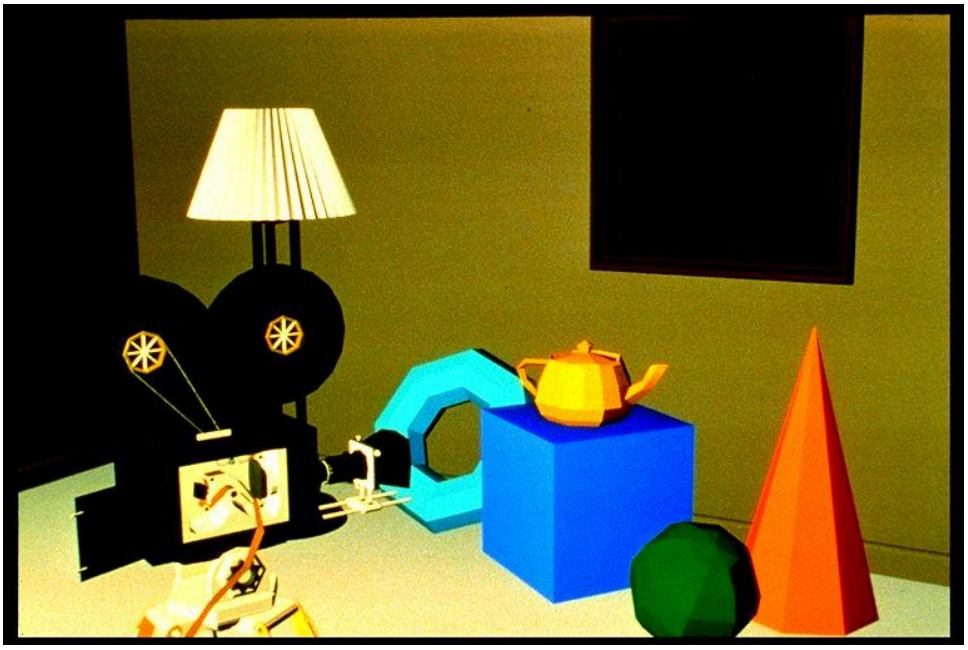
Shading : Constant Shading - Ambient

Objects colours by its own colour



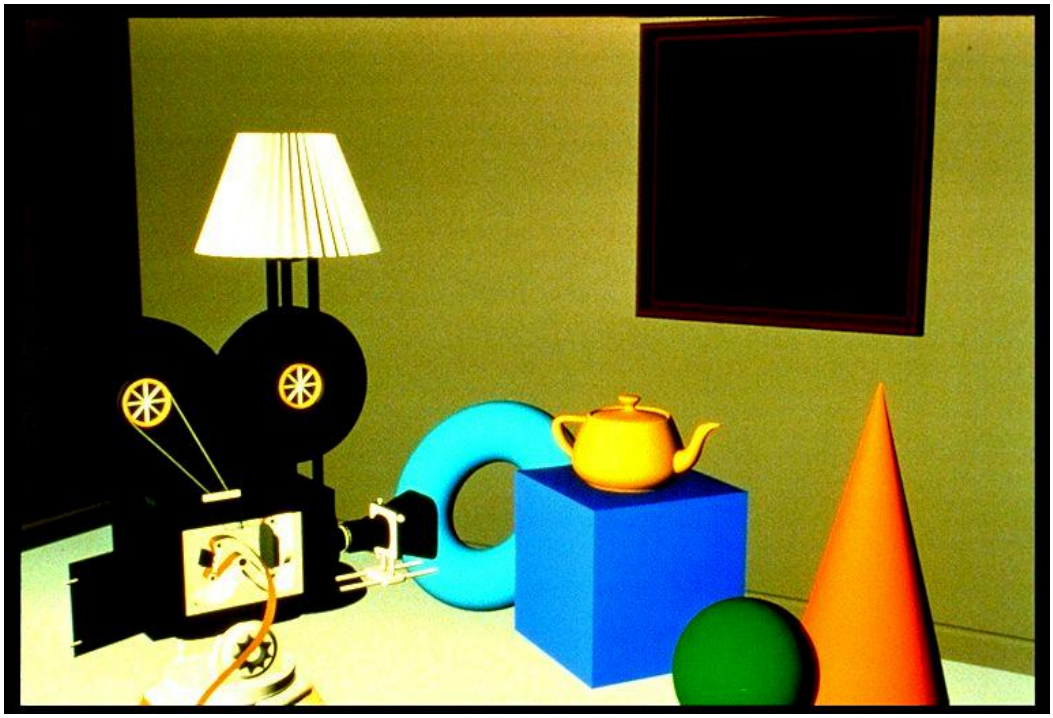


Shading – Flat Shading



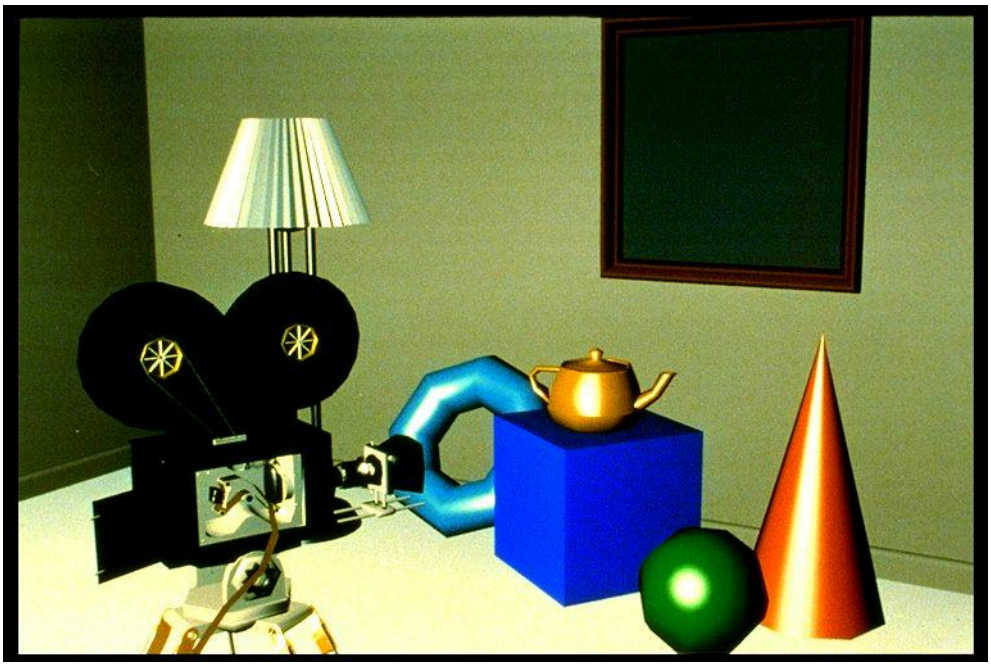
Gouraud shading, no specular highlights

Lighting calculation per vertex

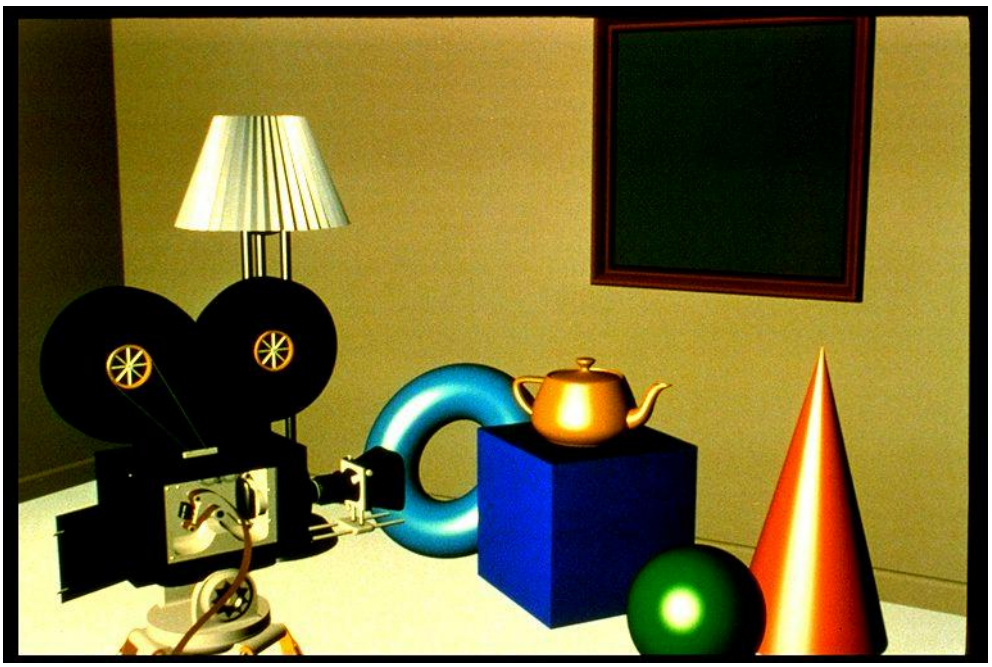


Specular highlights added

Light perfectly reflected in a mirror-like way



Phong shading

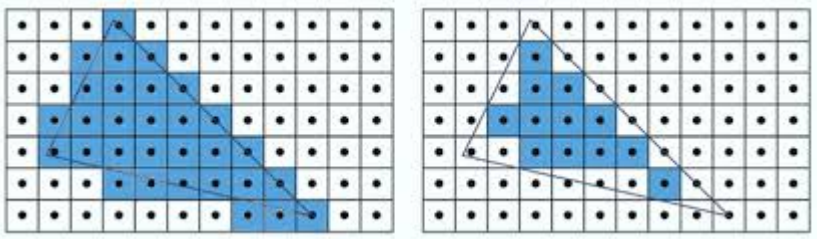


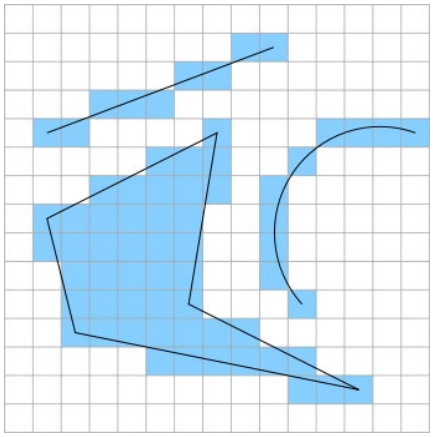
Rasterization

Converts the vertex information output by the geometry pipeline into pixel information needed by the video display

Aliasing: distortion artifacts produced when representing a high-resolution signal at a lower resolution.

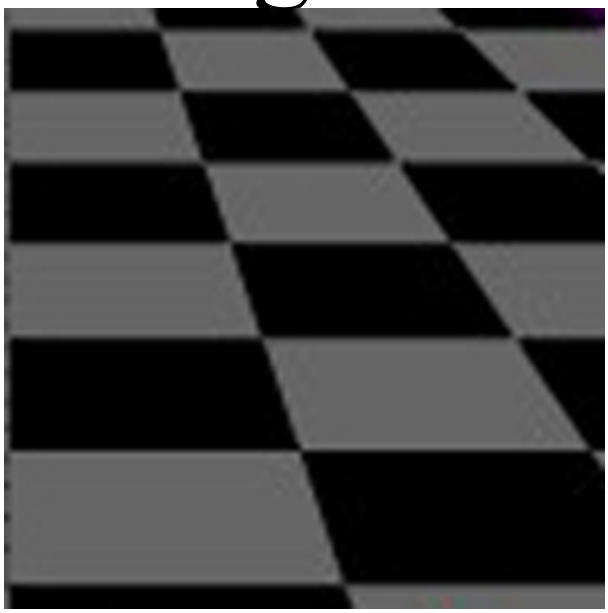
Anti-aliasing : technique to remove aliasing



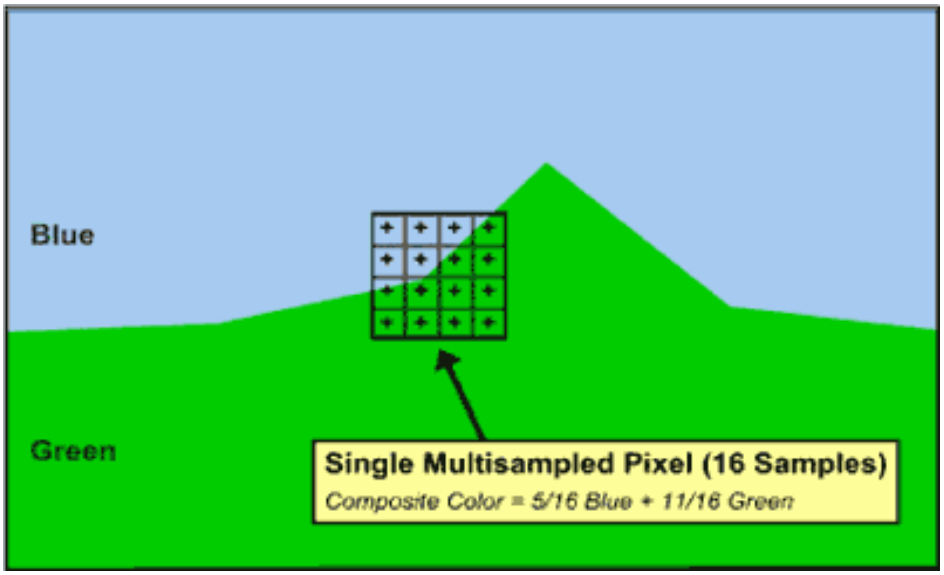


Anti-aliasing

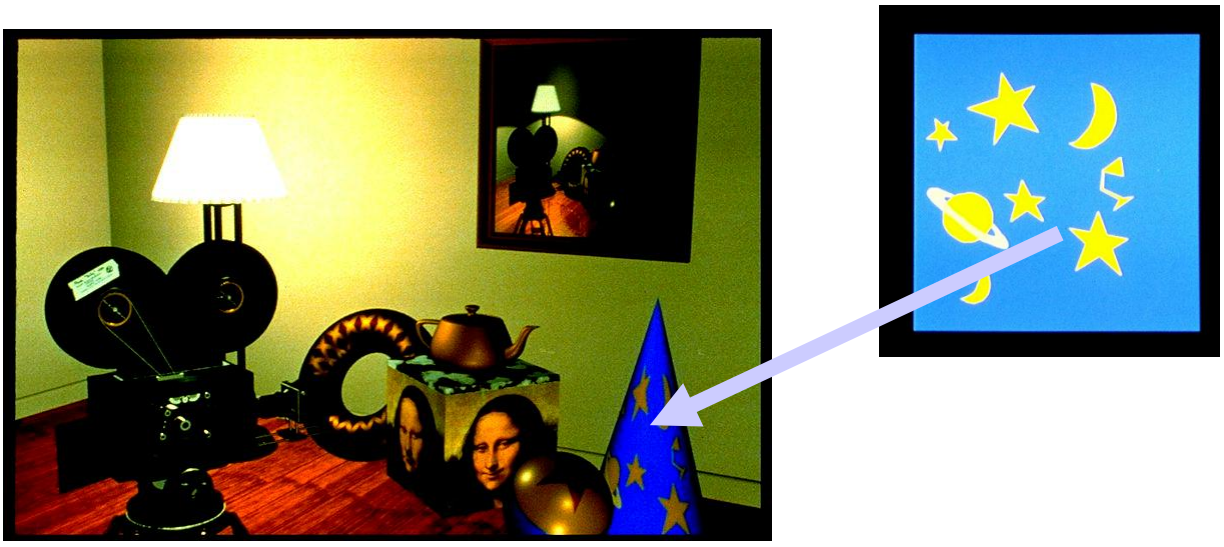
Aliased polygons (jagged edges)



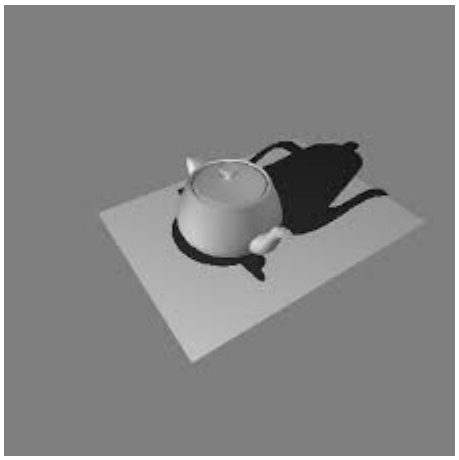
Anti-aliased polygons

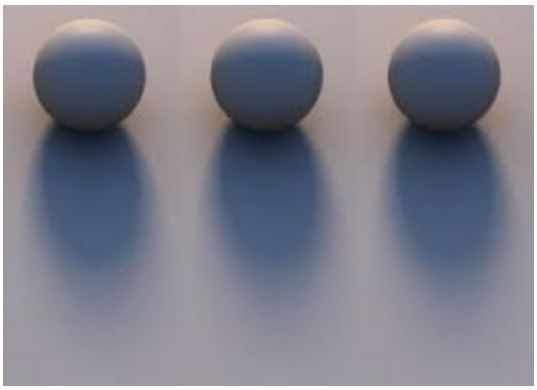


Texture mapping

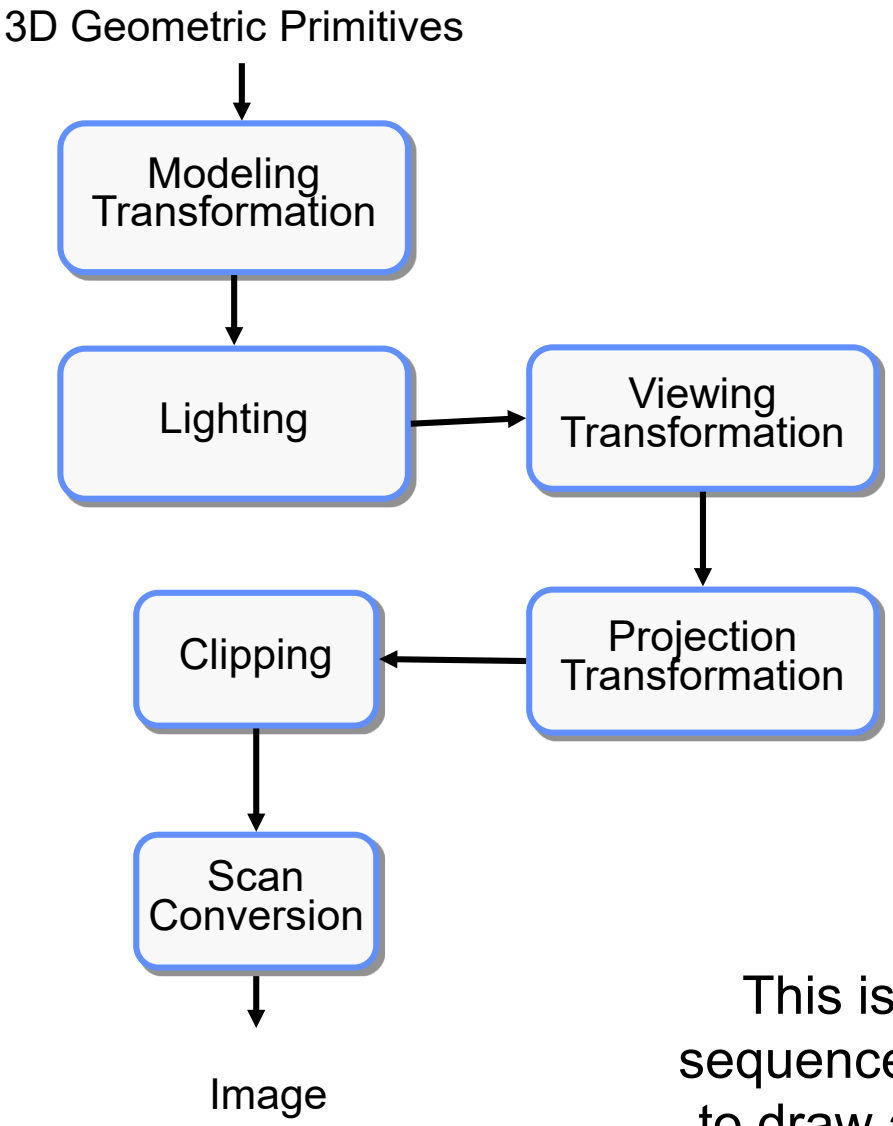


Shadow??





3D Rendering Pipeline
(for direct illumination)



This is a pipelined sequence of operations to draw a 3D primitive into a 2D image