



Lighting (cont'd)

CS 355: Interactive Graphics and Image Processing

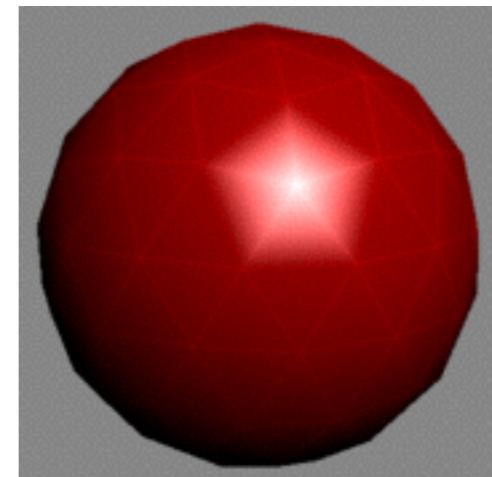
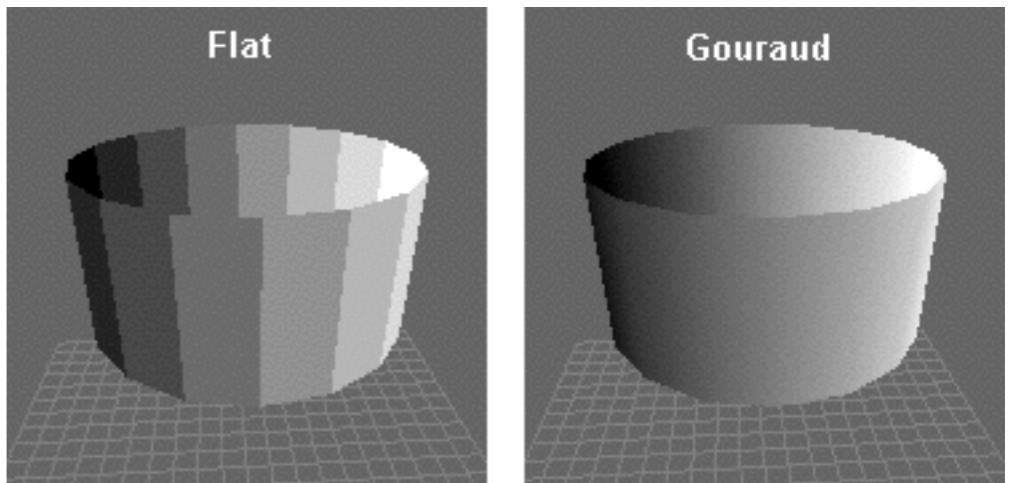
Flat Shading

- The entire polygon has the same normal, so it's all colored the same
- Leads to “flat shading”



Gouraud Shading

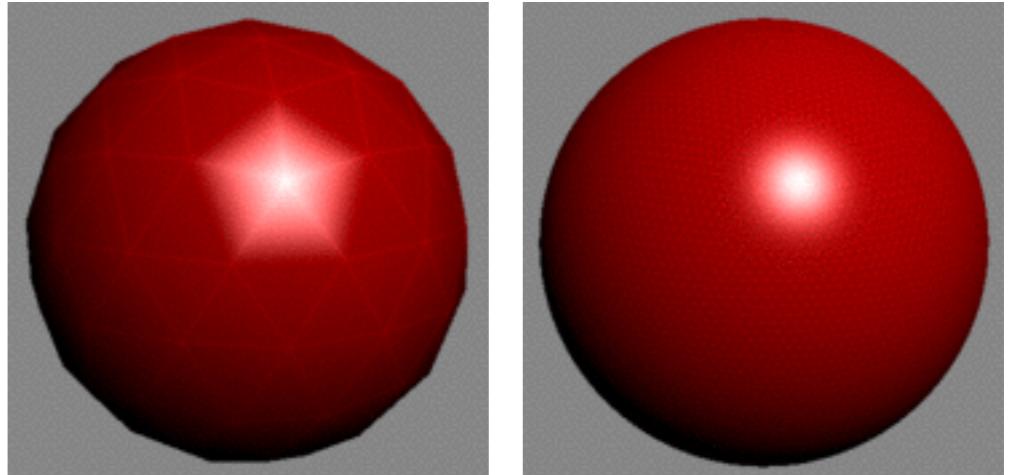
- Simple idea:
 - Compute shading at edges/vertices and interpolate
 - Works well for diffuse
 - Doesn't work as well for specular



Henri Gouraud, 1971

Phong Shading

- Key idea:
 - Instead of interpolating the shading, *interpolate the normals*
 - Compute shading on a per-pixel basis using the interpolated normal



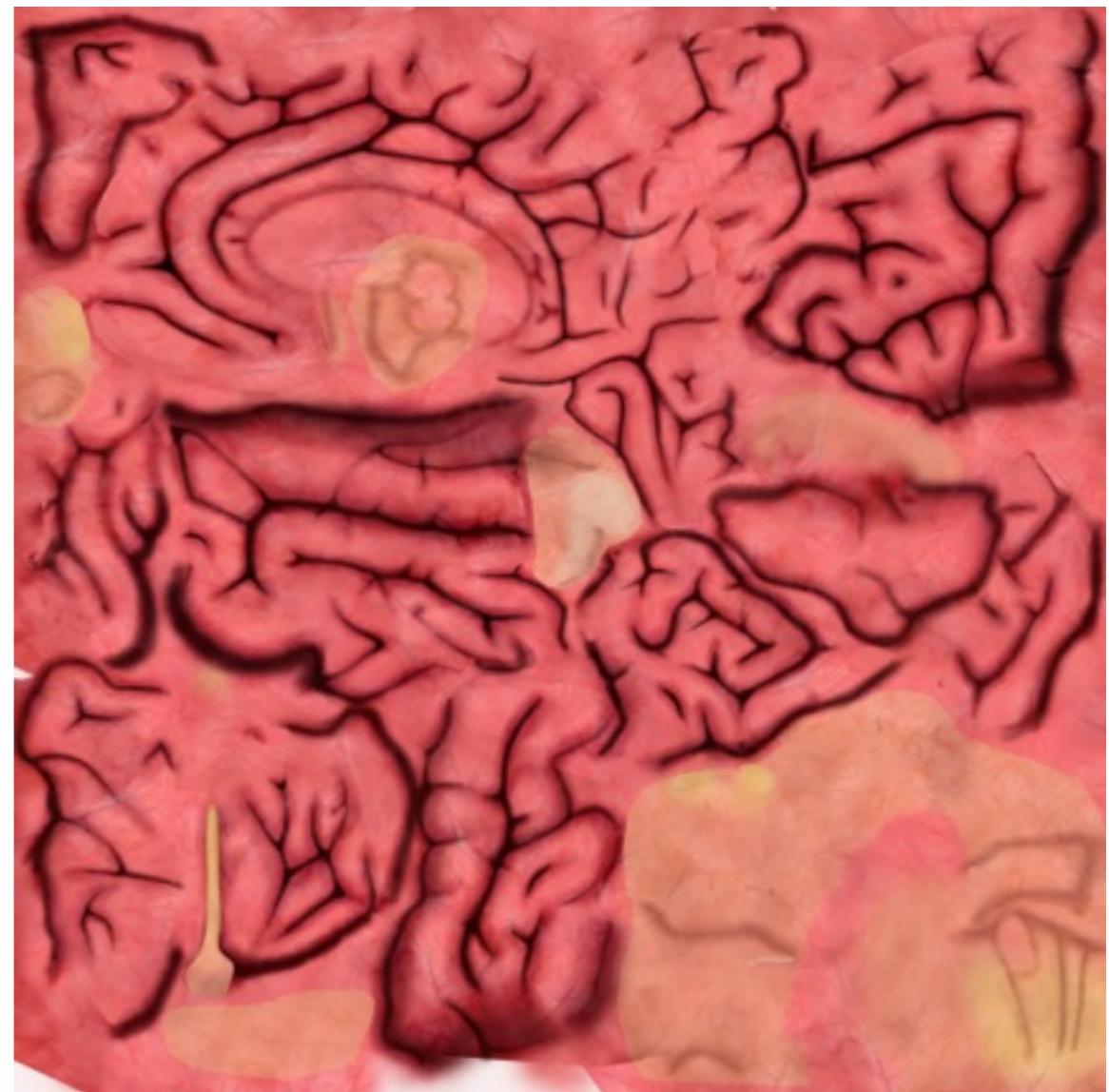
Bui Tan Phong, 1973

Texture Maps



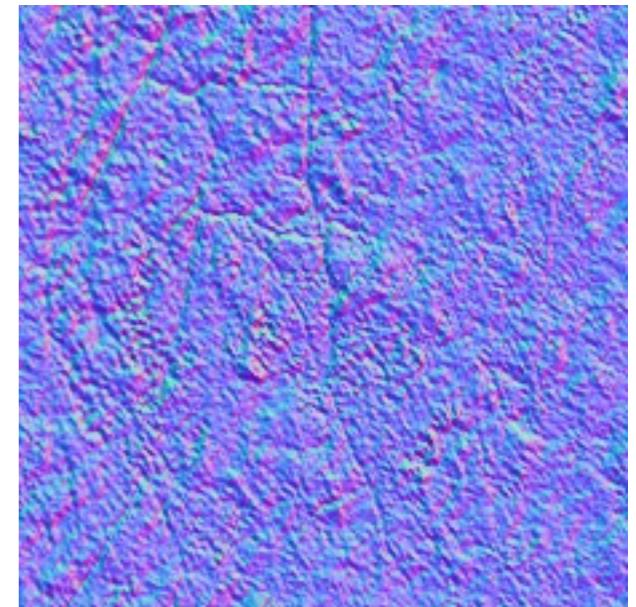
Texture Maps

- Reflectance across a surface varies with position
- Map each vertex (x,y,z) to a point (u,v) in an image
- Interpolate across the polygon to interpolate the corresponding (u,v) positions in the image



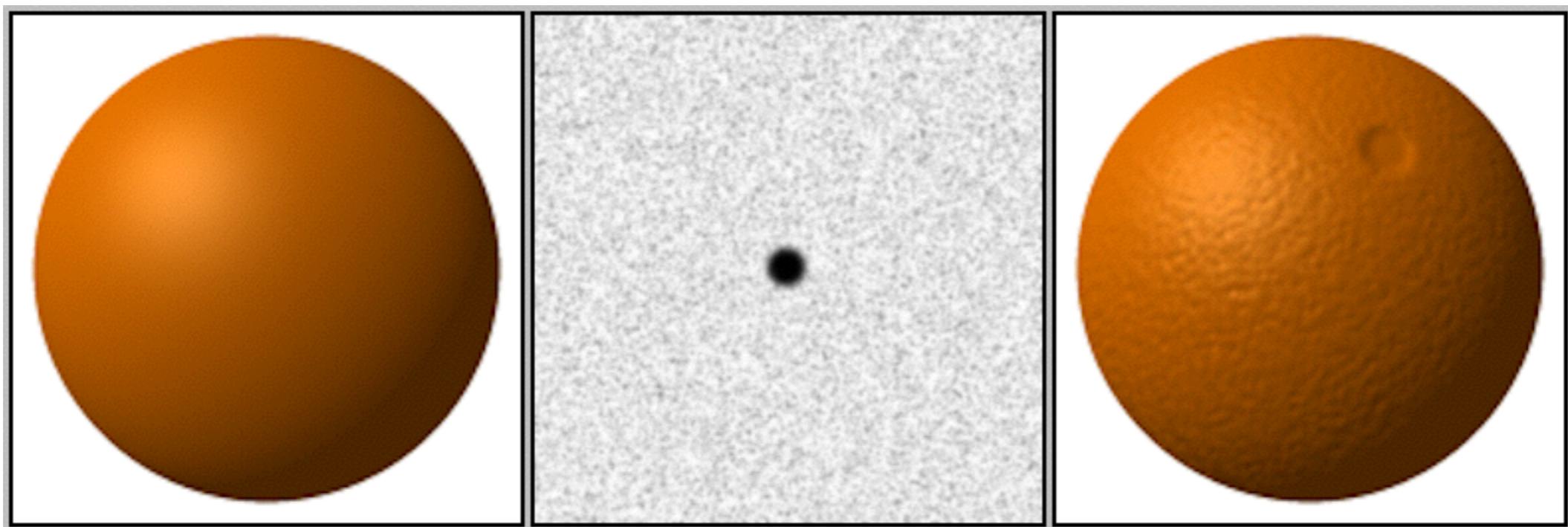
Bump Maps

- Texture maps are only reflectance
- They don't respond to changes in the lighting ("painted on")
- Idea: use a *normal map*

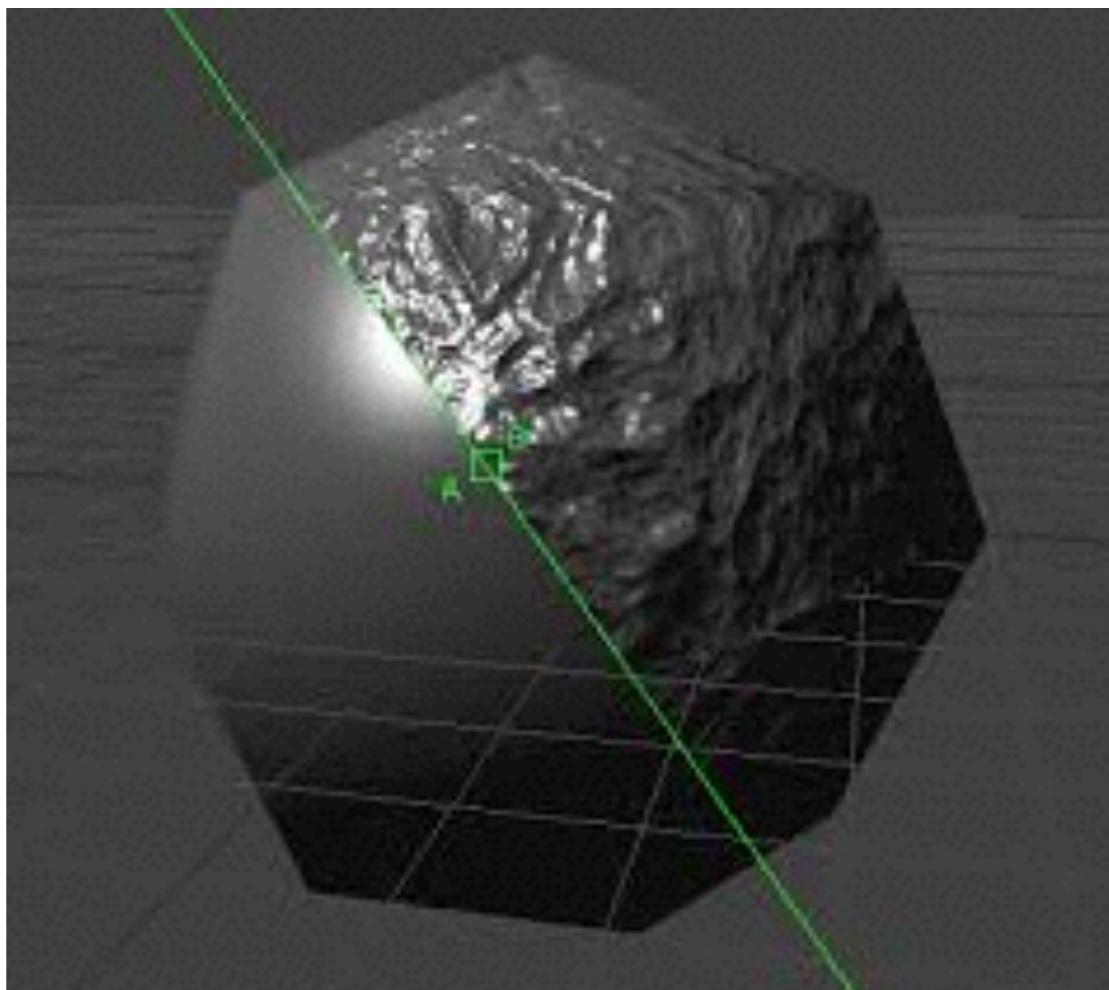


Jim Blinn, 1978

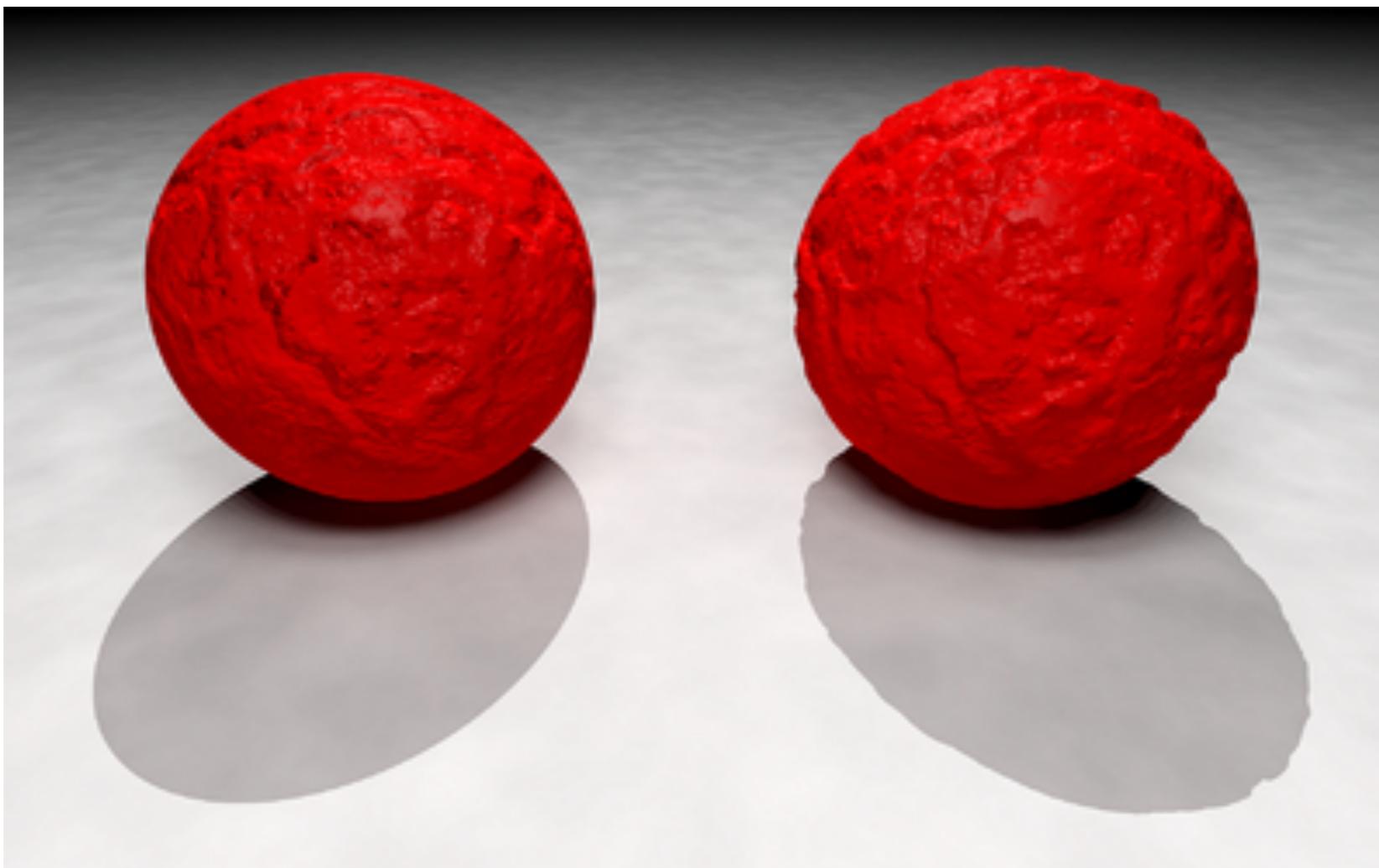
Bump Maps



Bump Maps



Bump Maps



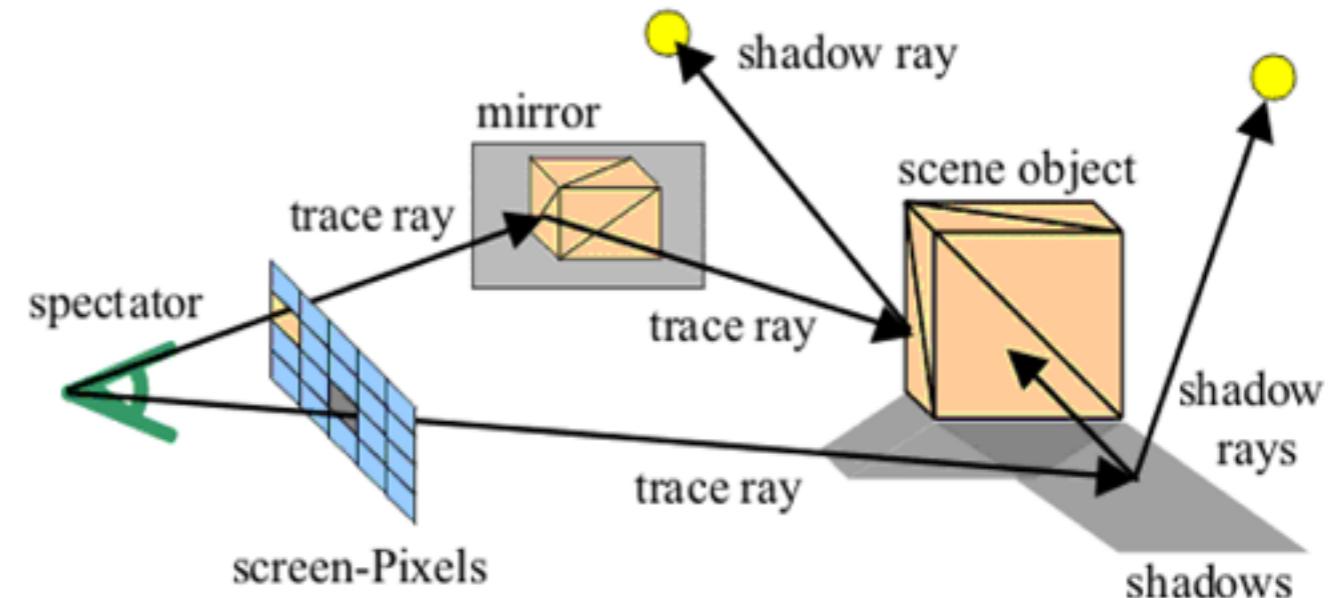
Ray Tracing

- What about things like
 - Reflections?
 - Refraction through transparent materials?



Ray Tracing

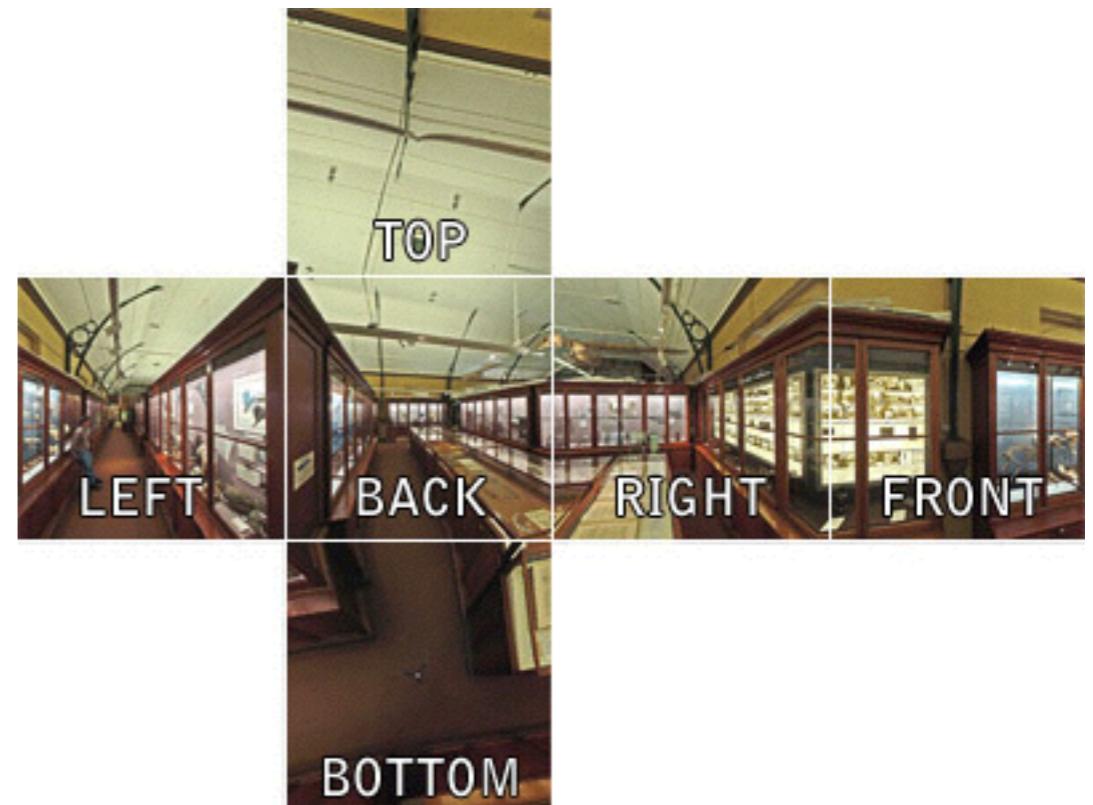
- Shoot a ray out through the pixel on the imaging plane
- When it hits something, recursively shoot more rays:
 - Towards light source(s) — direct lighting
 - Reflection ray (if applicable)
 - Refraction ray (if applicable)



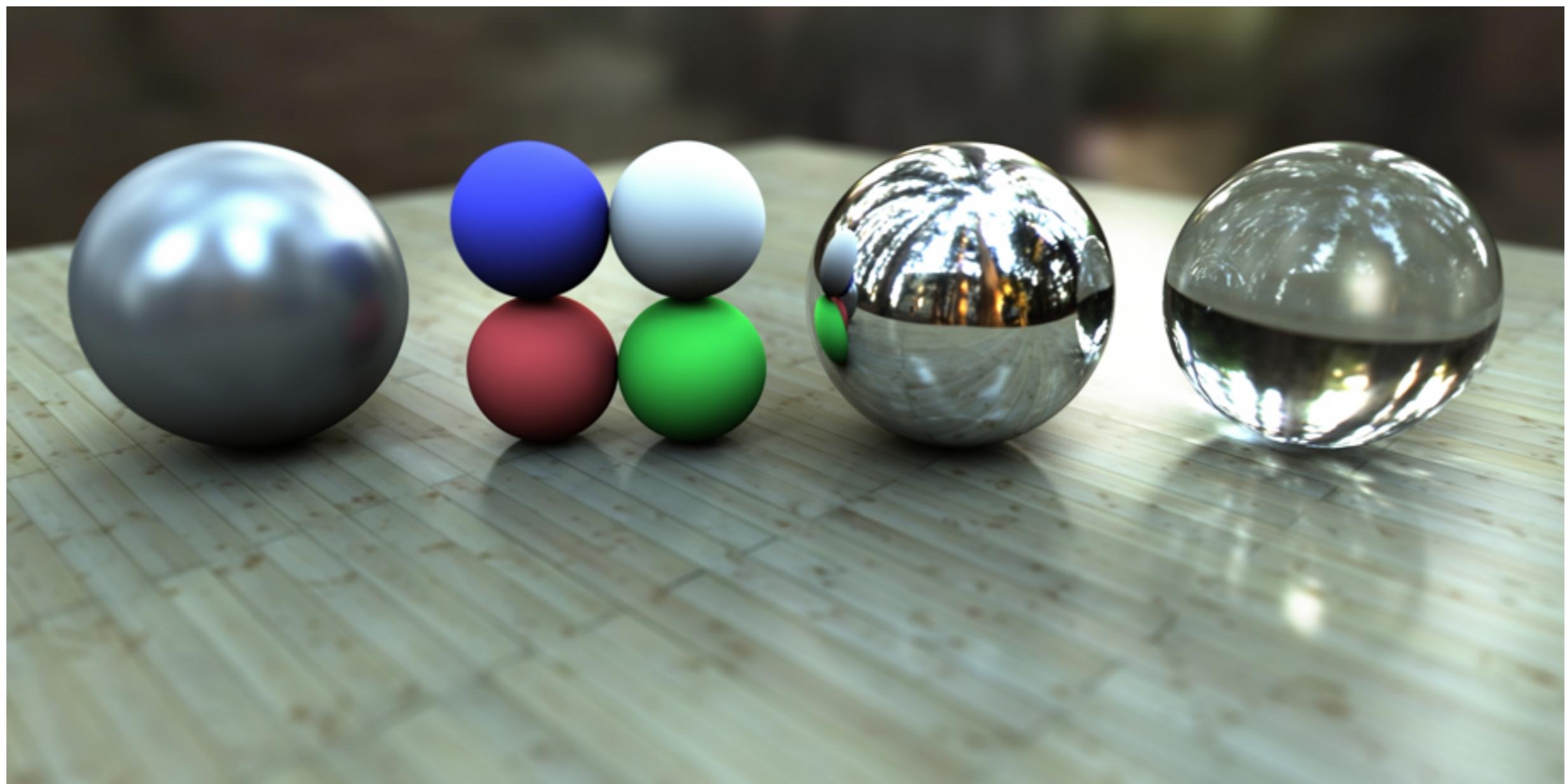
Turner Whitted, 1980

Environment Maps

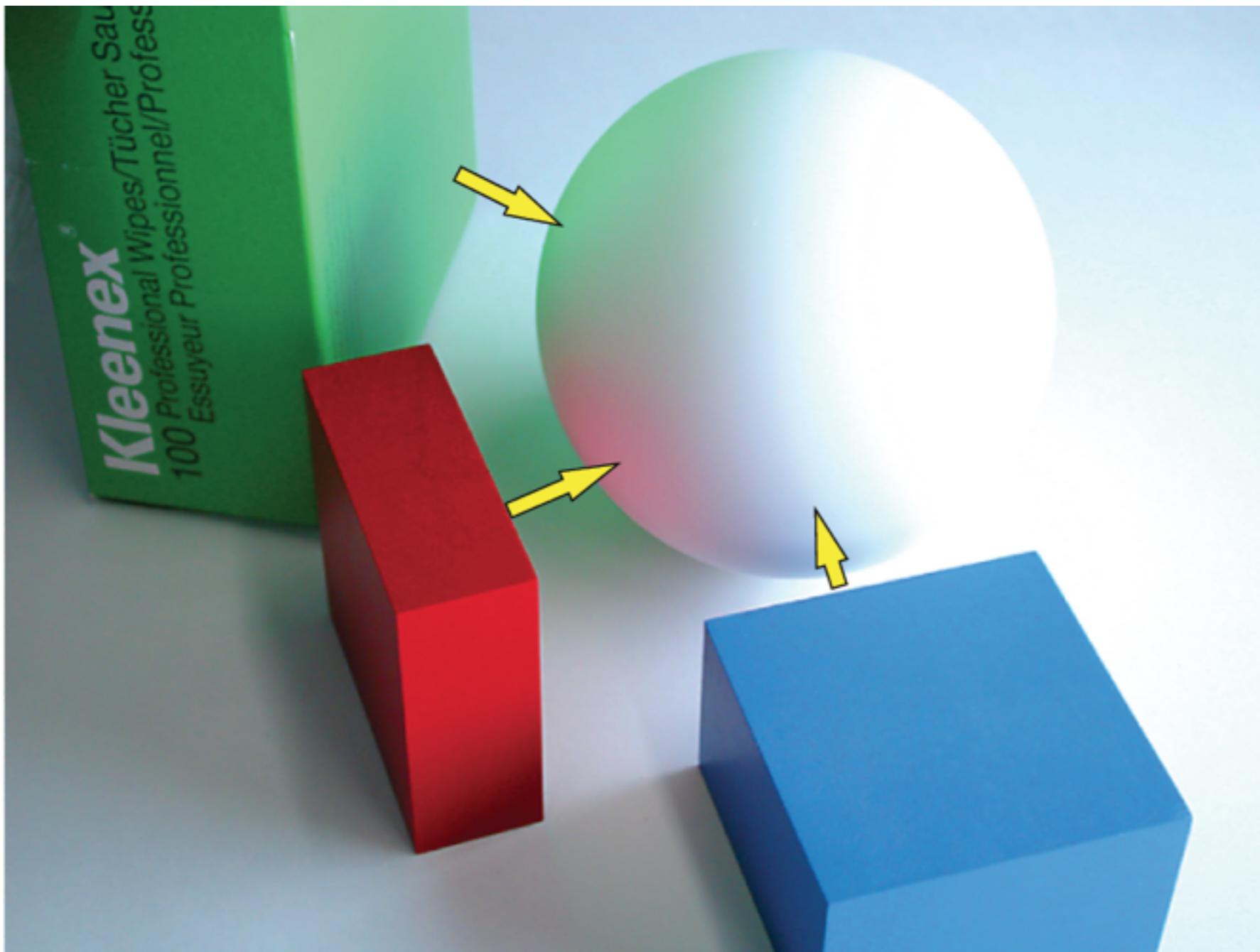
- What about rays that exit the scene?
- Can wrap the entire scene in an *environment map*
- Square, spherical, etc.



Environment Maps

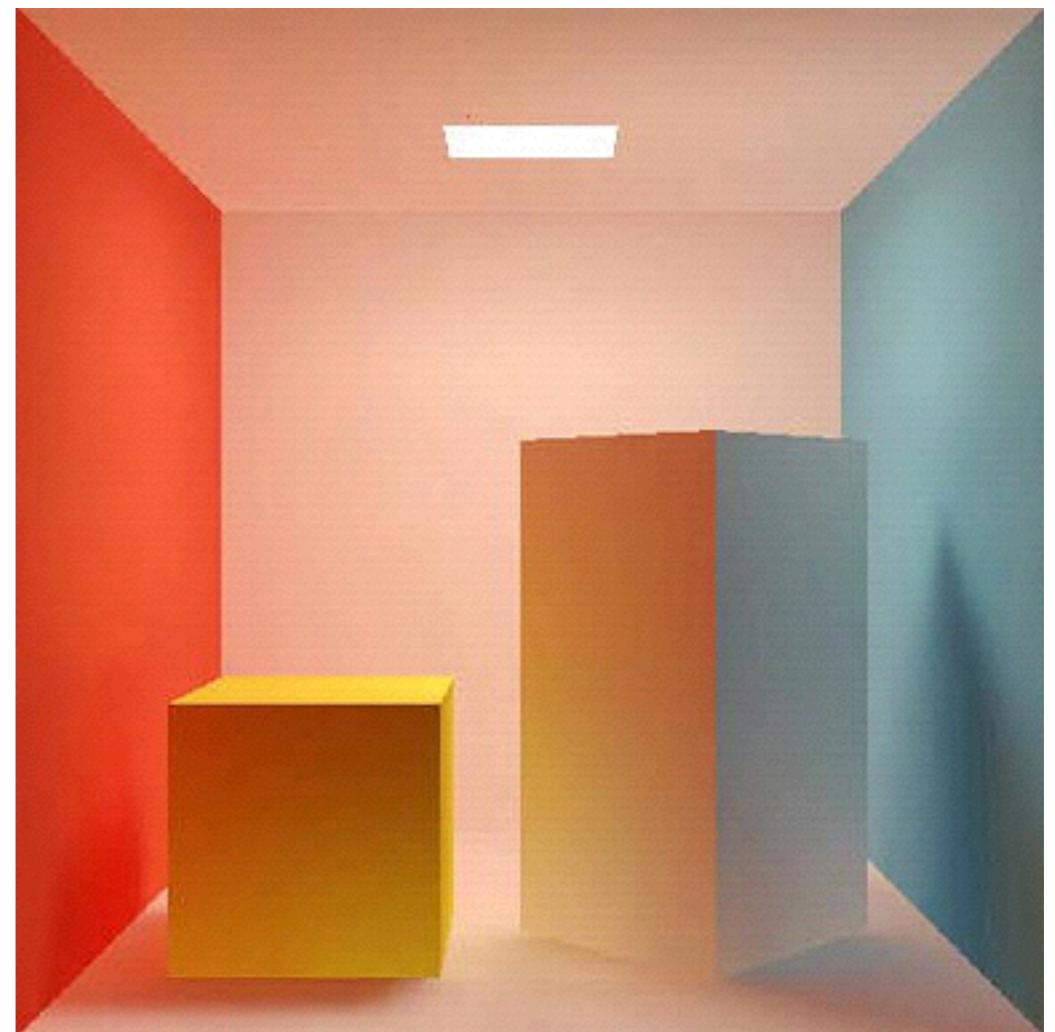


Diffuse Interreflections



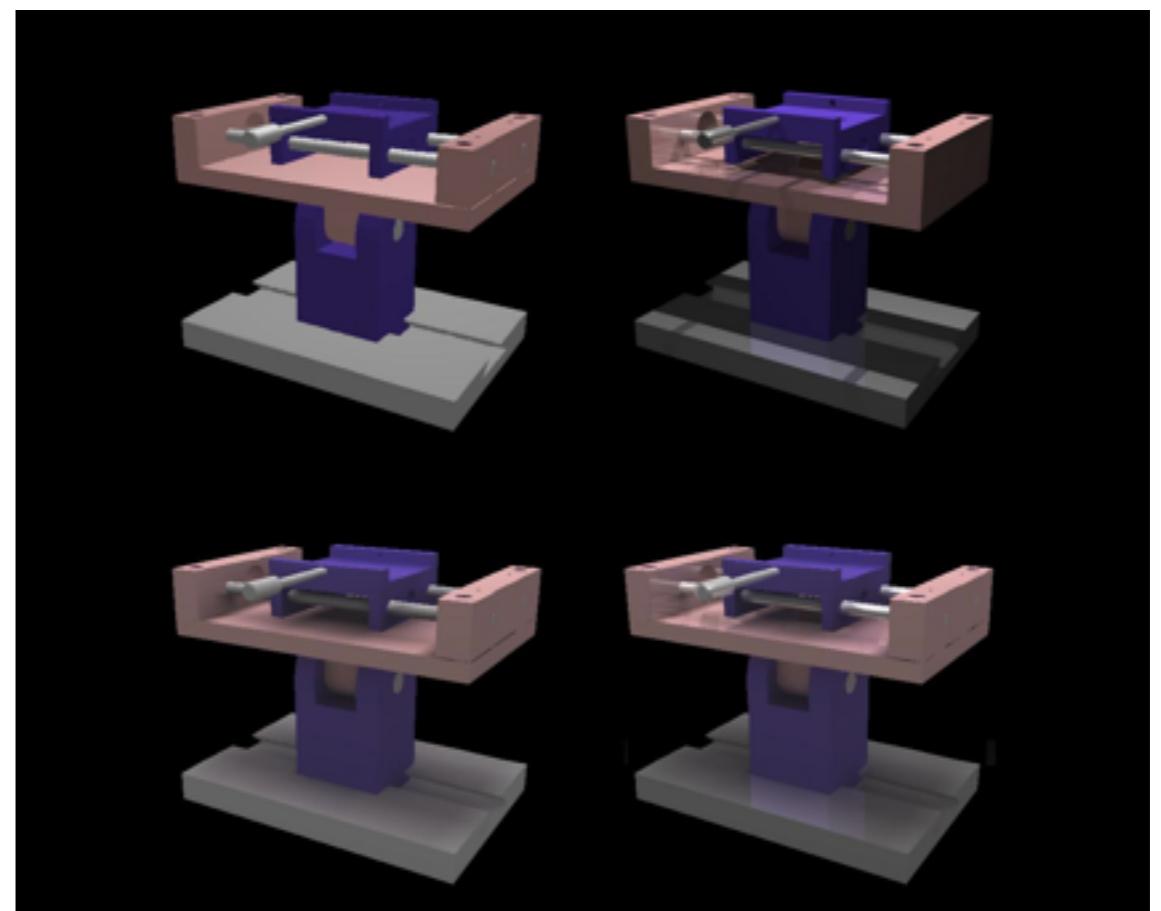
Radiosity

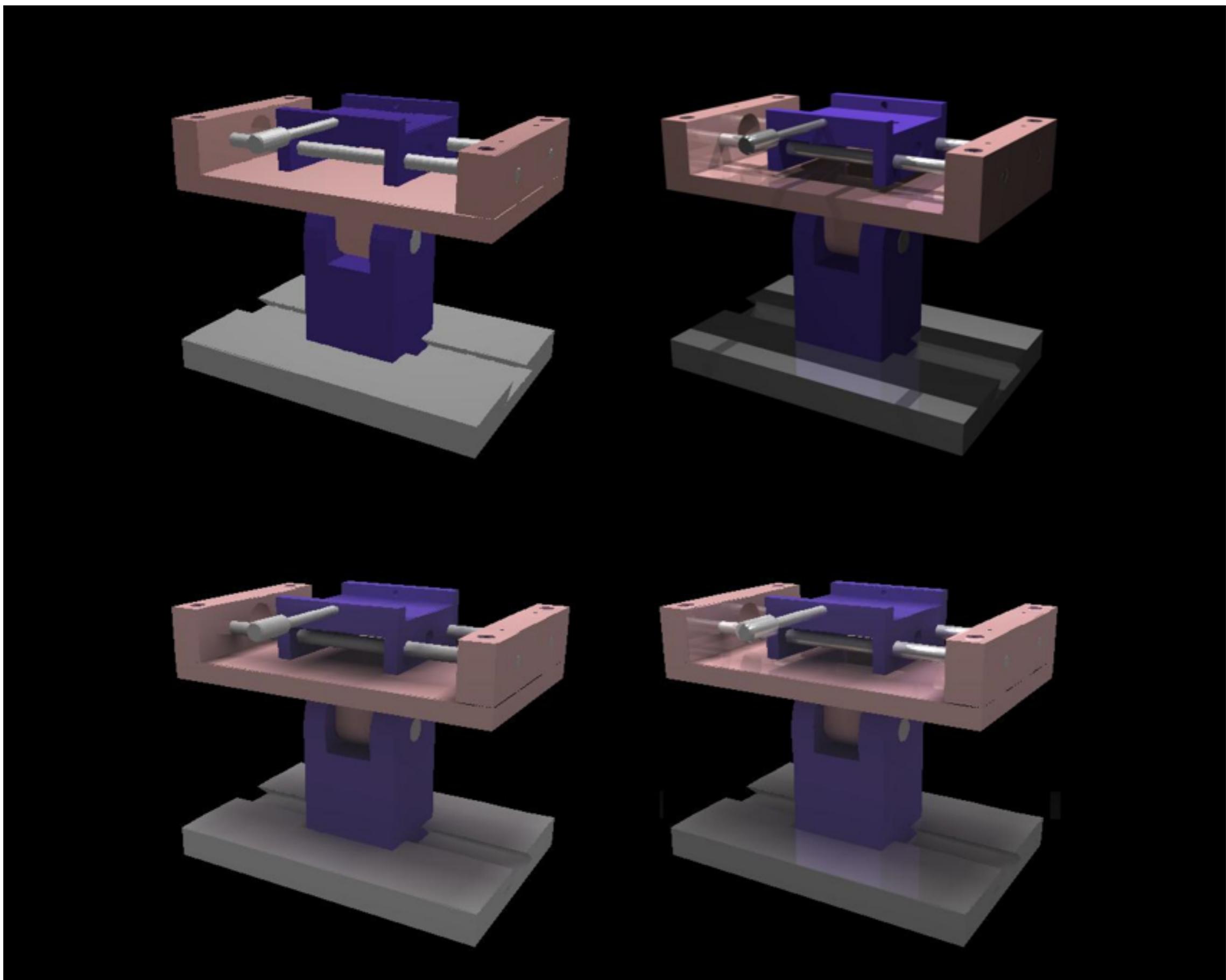
- Math involves integrals over all angles of light coming into and off of a surface
- Approximated using *importance sampling*
- Effectively traces lots and lots of rays—very compute intensive



Combining Approaches

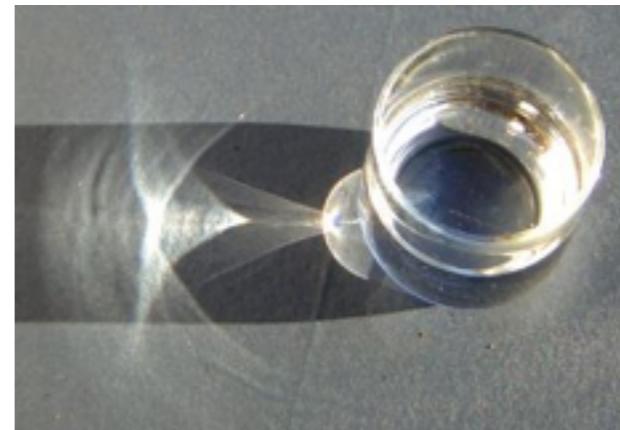
- Ray tracing is good for specular reflections, refraction, etc.
- Radiosity is good for diffuse interreflections
- Can combine methods to get both





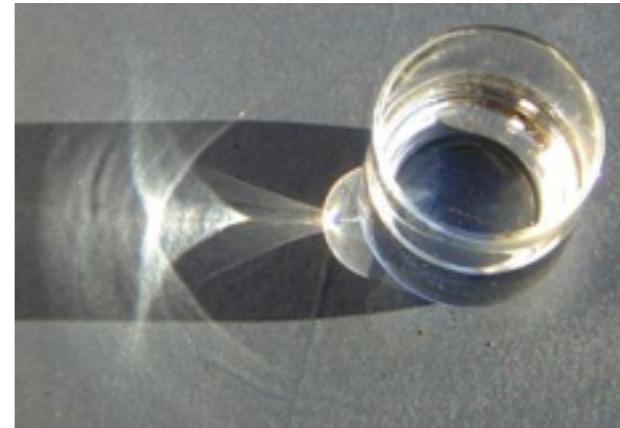
Forward Rendering

- Some phenomena can't be modeled well by "backward" methods like ray-tracing, radiosity
- Some require "forward" rendering of the light from the light source
- One example of these is "caustics"



Forward Rendering

- A number of forward or hybrid methods used:
 - Path tracing
 - Metropolis light transport
 - Photon mapping
- All try to *approximate* the “rendering equation”
(Jim Kajiya, 1986)



Coming up...

- Interpolation (in general)
- Curves and surfaces