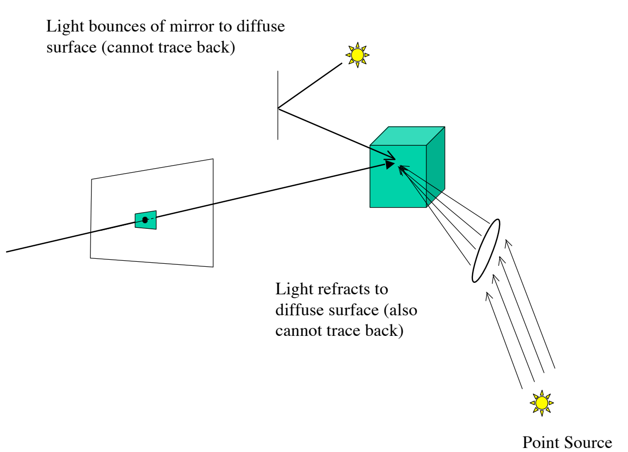
Quiz Alert

- Nov 27

Illumination effects

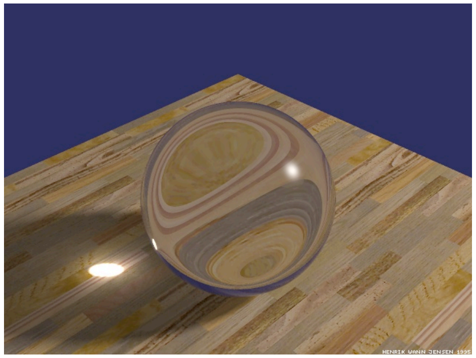
- Caustics:
  - refraction or reflection causes light to be "collected" in some regions.
- Specular-> diffuse transfer
  - source reflected in a mirror
- Can't render this by tracing rays from the eye - how do they know how to get back to the source?



Illumination effects (cont)

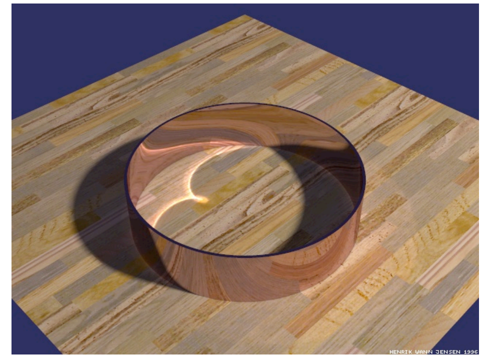
- To get the effect of light reflected and refracted from sources onto diffuse surfaces, we can trace rays **from** the light **to** the first diffuse surface
  - leave a note that illumination has arrived - an illumination map, or photon map
  - sometimes referred to as the forward ray
  - now retrieve this note by tracing eye rays
- Issues
  - efficiency (why trace rays to things that might be invisible?)
  - aliasing (rays are spread out by, say, curved mirrors)

Refraction caustic



Henrik Jensen, http://www.gk.dtu.dk/~hwj

Reflection caustic



Henrik Jensen, http://www.gk.dtu.dk/~hwj

Refraction caustics

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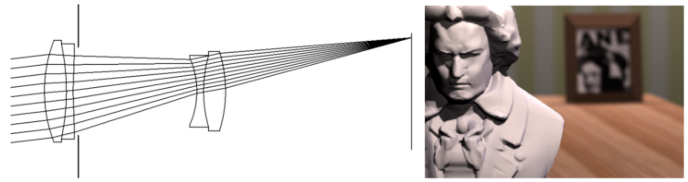
Lens Effects

Note that a ray tracer very elegantly deals with the projection geometry that we struggled with in earlier lectures which was based on a very simple and “ideal” camera model

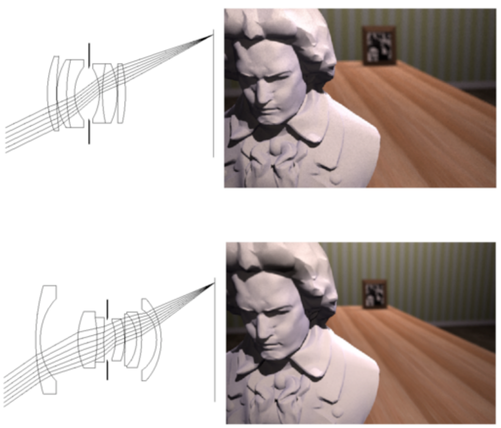
We can go further and introduce a more interesting or realistic camera model

from
A Realistic Camera Model for Computer Graphics
Craig Kolb, Don Mitchell, and Pat Hanrahan
Computer Graphics (Proceedings of SIGGRAPH '95), ACM SIGGRAPH, 1995, pp. 317-324



Note limited depth of field, just like a real lens

from
A Realistic Camera Model for Computer Graphics
Craig Kolb, Don Mitchell, and Pat Hanrahan
Computer Graphics (Proceedings of SIGGRAPH '95), ACM SIGGRAPH, 1995, pp. 317-324



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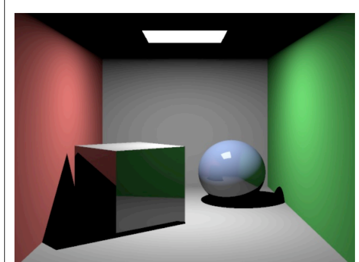
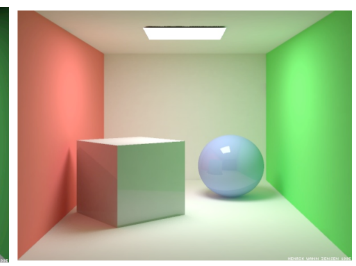
Radiosity



Ray-traced Cornell box, due to Henrik Jensen, http://www.gk.dtu.dk/~hwj



Radiosity Cornell box, due to Henrik Jensen, http://www.gk.dtu.dk/~hwj, rendered with ray tracer

Radiosity

Want to capture the basic effect that surfaces illuminate each other

Again, following every piece of light from a diffuse reflector is impractical--but combinations of brute force and clever hacks can be done

Another approach: Radiosity methods

Radiosity

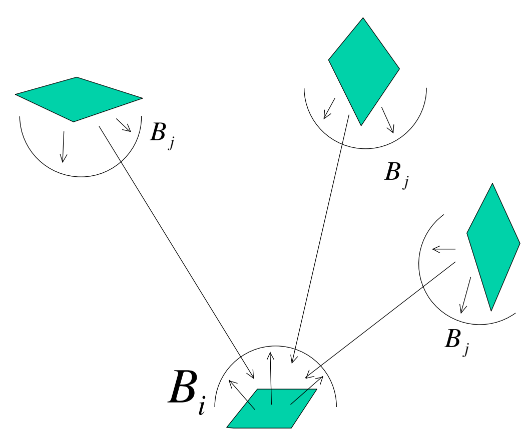
Think of the "world" as a bunch of patches. Some are sources, (and reflect), some just reflect. Each sends light towards all the others.

Consider one color band at a time (some of the computation is shared among bands).

Each surface, i, *radiates* reflected light, B_i , per unit area.

Each surface, *emits* light E_i (if it is not a source, this is 0).

Denote the albedo of surface i as ρ_i



Radiosity equation

$$B_i = E_i + \rho_i \sum_j F_{j\to i} B_j \frac{A_j}{A_i}$$

The form factor $F_{j\to i}$

is the fraction of light leaving dA_j arriving at dA_i taking into account orientation and obstructions

Useful relation

$$A_i F_{i \to j} = A_j F_{j \to i}$$

The equation now becomes

$$B_i = E_i + \rho_i \sum_j F_{i \to j} B_j$$

Rearrange to get

$$B_i - \rho_i \sum_j F_{i \to j} B_j = E_i$$

In matrix form

$$\begin{bmatrix} 1-\rho_1 F_{1\to 1} & -\rho_1 F_{1\to 2} & \dots & -\rho_1 F_{1\to n} \\ -\rho_2 F_{2\to 1} & 1-\rho_2 F_{2\to 2} & & -\rho_2 F_{2\to n} \\ & & & \\ -\rho_n F_{n\to 1} & -\rho_n F_{n\to 2} & & 1-\rho_n F_{n\to n} \end{bmatrix} \begin{bmatrix} B_1 \\ B_2 \\ \\ B_n \end{bmatrix} = \begin{bmatrix} E_1 \\ E_2 \\ \\ E_n \end{bmatrix}$$

So, in theory, we just compute the Bi's by solving this (large!) matrix equation.

Optional

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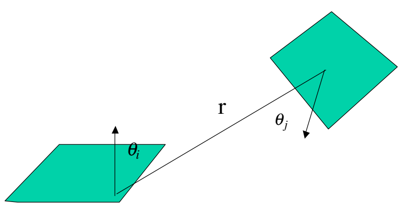
The fun part: Computing the $F_{i \to j}$

Without obstruction $dF_{dj \to di} = \frac{\cos\theta_i \cos\theta_j}{\pi r^2} dA_j$



Fancy methods exist for of computing and/or approximating storing form factors (e.g. hemisphere and hemicube methods)