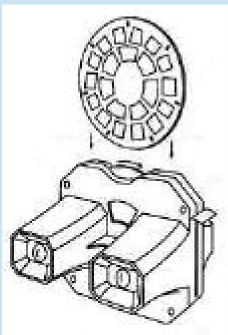
CPSC 453:
Shading

(Chapter 6.1-6.5, 6.7-6.10)

Mark Matthews
matthews@cpsc.ucalgary.ca
Office Hours: 3:15-4:00PM TR
Office: 680J
www.cpsc.ucalgary.ca/~sheelagh/courses/453

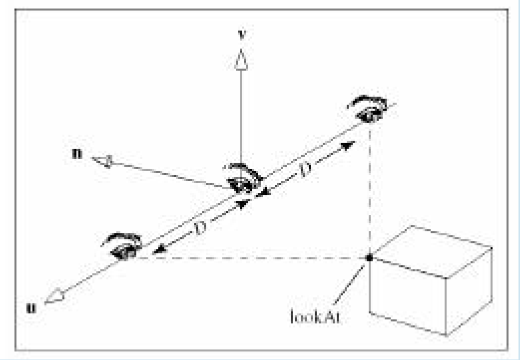
3D Viewing

- So Far, only single camera views
- How can we give our images more depth?
- Stereo viewing (2 eye)



Producing a Stereo View

- Begin with a regular camera (single “look at” and eye)
- Establish a camera frame (u,v,w)
- Define the left & right eyes along the u direction



A Simple 3D Effect

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Why Shading?

- Reveals 3D information about the scene

How light interacts

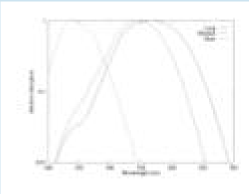
- Incident light on a surface can be:
  - reflected, to an observer
  - absorbed, becoming heat
  - transmitted, to the object interior
- A percentage is lost to each effect

Reflected Light

- Diffuse Surfaces
  - reflects light equally in all directions
  - Usually the source of color
  - “Matte” finishes
- Specular Reflections
  - reflects light in a preferred direction
  - Usually colorless (white)
  - “Glossy” finishes

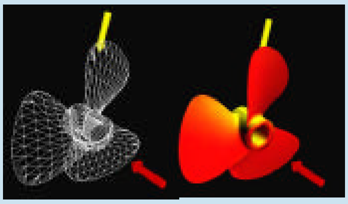
Color

- Color is actually a continuous function $I(\lambda)$
- Color is a complex science
- However, we only consider 3 components:
  - $I = (I_r, I_g, I_b)$
  - red, green and blue
  - Each a scalar value
- Three similar but independent computations



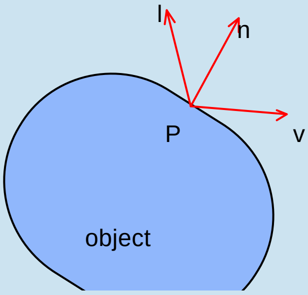
Our Goal

- Input
  - a polygon mesh
  - the position of the light source
  - intensity values of the light
- Output
  - the light intensity from any point on the object



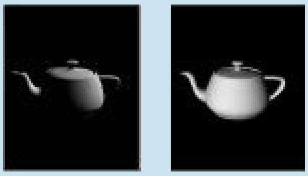
Vectors

- To compute the intensity at a point P, we need 3 vectors:
  - the unit normal vector n
  - the unit vector v, from P to the viewer
  - the unit vector l, from P to the light



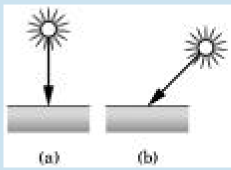
Diffuse Reflection

- A diffuse reflector scatters light equally in all directions
- ie. same appearance in all directions
- Therefore, viewer independent
- Dependent upon:
  - Light position
  - Surface properties

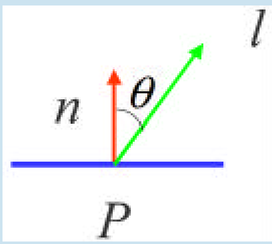


- Rougher Surface ?   more diffuse
- Known as a *Lambertian* model

Lamberts Law



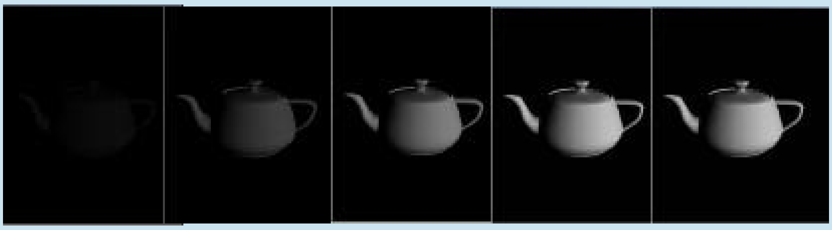
- L_d diffuse light from source
- I_d diffuse reflection from P
- $0 \leq K_d \leq 1$ diffuse reflection coefficient
- $I_d = K_d\,(l \cdot n)\,L_d$
- K_d relates to the surface of the material



Diffuse Coefficient

- K_d is usually determined by trial and error
- Examples:

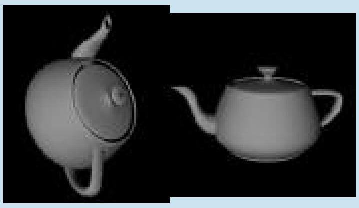
K_d=0.05 K_d=0.25 K_d=0.50 K_d=0.75 K_d=1.00



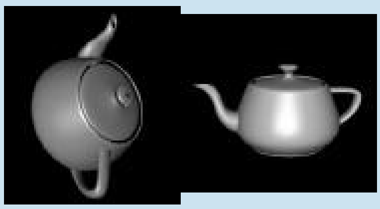
- In practice K_d has components for red, green and blue

Specular Reflection

- Diffuse Reflection: rough surface, no highlights

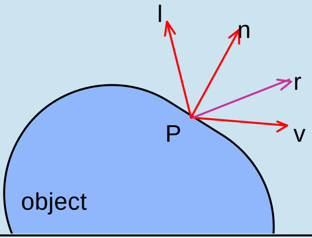


- Specular Reflection: shiny smooth surface with highlights
- Specular highlights *are* view dependent.

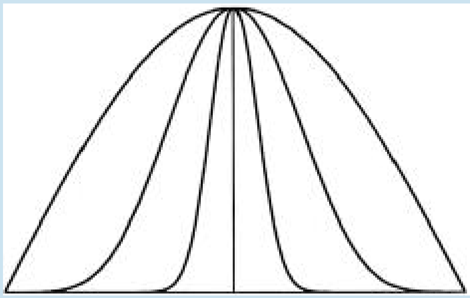


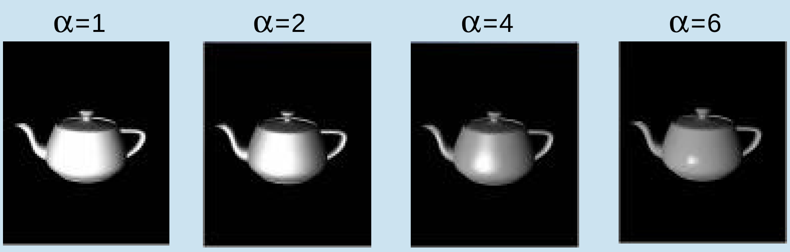
Phongs Model for Specular Reflection

- r is the reflection of l off the surface
  (need n to compute)
- L_s specular light from source
- $0 \leq K_s \leq 1$ specular reflection coefficient
- $I_s = K_s (r \cdot v)^{\alpha} L_s$
- α is the shinyness coefficient



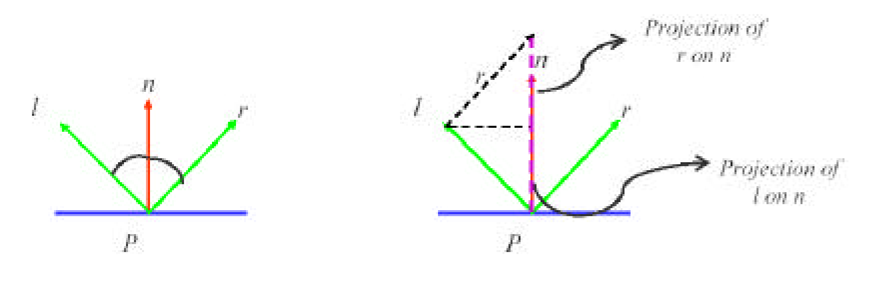
Shininess Coefficient





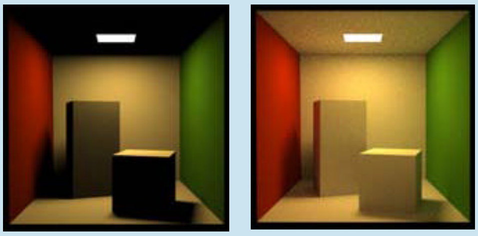
How to Compute r

- l and n are the given vectors
  - The angle of incidence is equal to the angle of reflection
  - l, n, r lie in the same plane
- solving we obtain r = 2(n·l)n-l



Ambient Light

- Our “physical rules” are oversimplified
- We don’t consider indirect global illumination



- We approximate these effects with ambient light
- A.K.A. a hack.

Ambient Light Specification

- Not situated in any one point
- $I_a = K_a L_a$
- L_a the amount of ambient light in an environment
- I_a the amount of ambient light emanating from a point
- $0 \le K_a \le 1$ ambient light coefficient

K_a=0.0

K_a=0.5

K_a=1.0