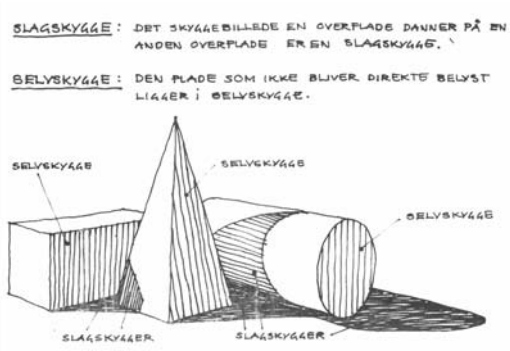
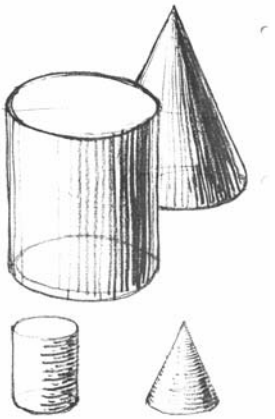
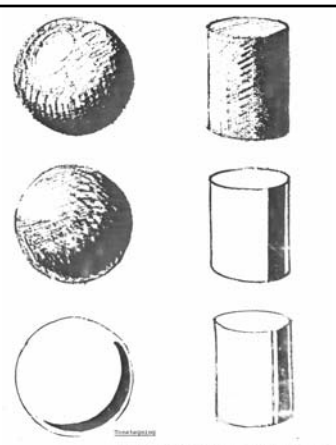
Local Illumination
Phong's model

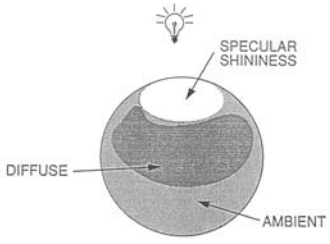
Niels Jørgen Christensen
DTU . Compute

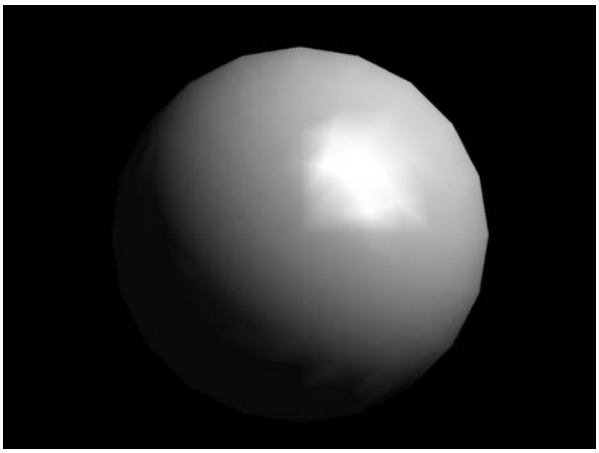
Shadows: Cast – "Self"

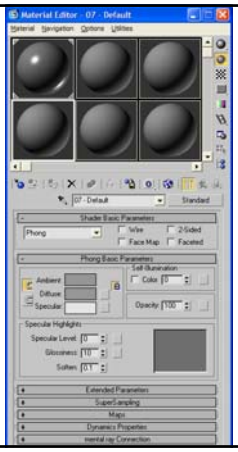




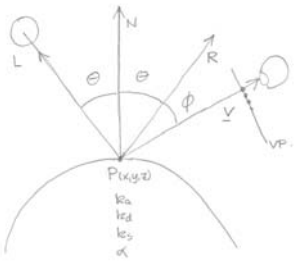




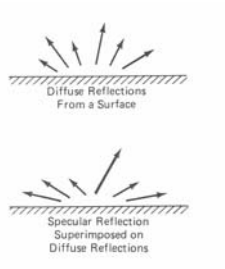




Local Illumination - Point P



Light – Material Interaction



Phong Equation – simple 1

I Intensity =
I_a Ambient
I_d Diffuse
I_s Specular

k reflection coefficient
α *shininess*
L Light source intensity

$$I = I_a + I_d + I_s$$
$$= L_a k_a + L k_d \cos\theta + L k_s \cos^{\alpha}\phi$$

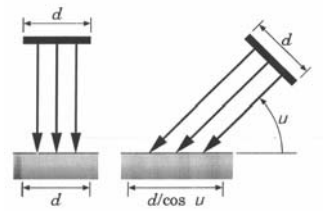
Phong Equation – simple 2

$$I = I_a + I_d + I_s$$

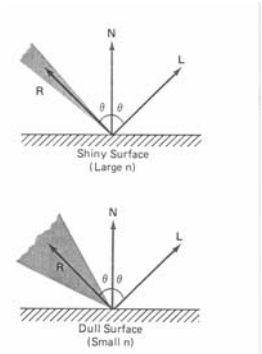
$$= L_a k_a + L k_d \cos\theta + L k_s \cos^{\alpha}\phi$$

$$= L_a k_a + L k_d (\mathbf{l}\cdot\mathbf{n}) + L k_s (\mathbf{r}\cdot\mathbf{v})^{\alpha}$$

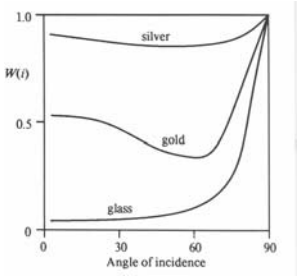
Diffuse reflection - Lambert`s Law



Specular reflection - Not-perfect



k_s is not constant – W(θ)



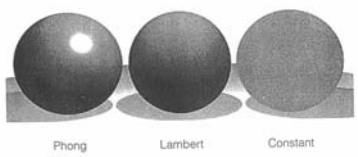
Phong equation – Attenuation f_{att}

$$I = I_a + I_d + I_s$$

$$= L_a k_a + f_{att}(L_d k_d \cos\theta + L_s k_s \cos^{\alpha}\phi)$$

$$= L_a k_a + \frac{1}{A + Bd + Cd^2}(L_d k_d \cos\theta + L_s k_s \cos^{\alpha}\phi)$$

d distance (light, object point P)

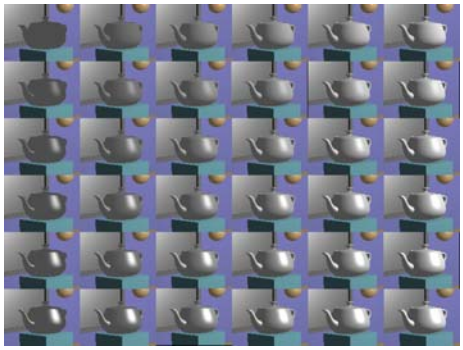


Ambient

Ambient + Diffuse

Amb + diff + spec

Phong Shading



Extensions

- Self emitter
- Attenuation
- Global, local ambient
- Spotlight

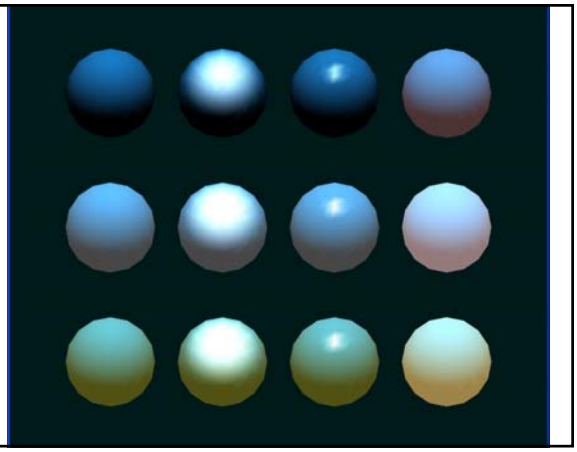
Phong – Angel - OpenGL

$$I = I_a + I_d + I_s = L_a k_a + f_{att}(L_d k_d \cos\theta + L_s k_s \cos^{\alpha}\phi)$$

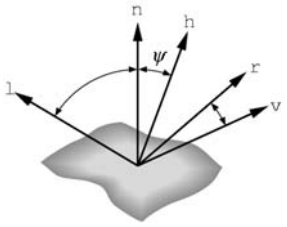
$$I = I_e + I_{ag} + [I_a + I_d + I_s]$$

$$= L_e + L_{ag} k_a + S_{spot} f_{att}\left[L_a k_a + L_d k_d \cos\theta + L_s k_s \cos^{\alpha}\phi\right]$$

$$= L_e + L_{ag} k_a + (\mathbf{s}\cdot\mathbf{l})^e \frac{1}{a + bd + cd^2}\left[L_a k_a + L_d k_d (\mathbf{l}\cdot\mathbf{n}) + L_s k_s (\mathbf{r}\cdot\mathbf{v})^{\alpha}\right]$$



Blinn- Phong - h Half vector

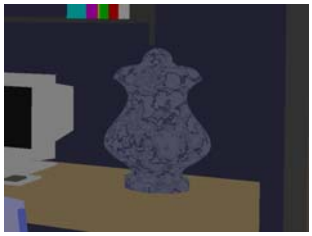


Light Sources

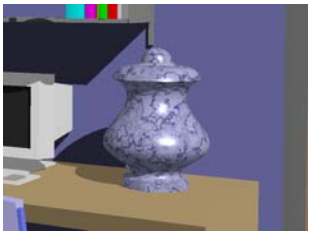
- Ambient
- Parallel – Distant
- Point
- Spot light

- Attenuation
- Fog

Ambient



Parallel - Distant

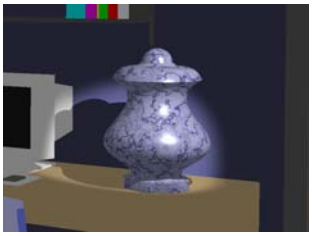


Point

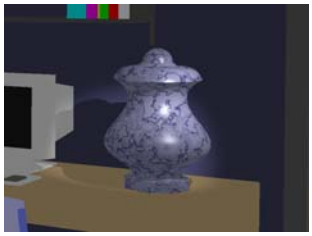
Point – at Eye

Spot Light - 30

Spot Light – drop off 5



Spot Light- beam distribution



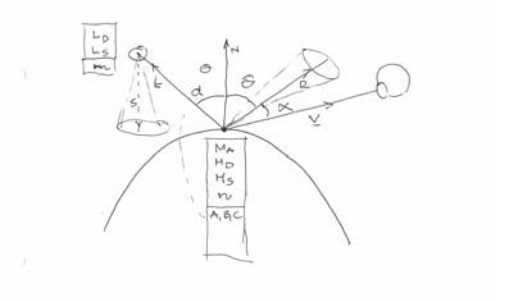
Attenuation – no

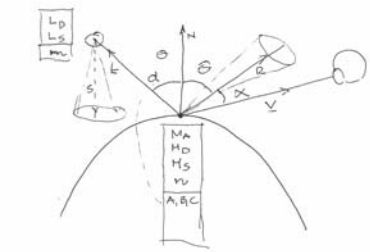
Attenuation – 1/d

Attenuation – 1/d*d

Fog

Different notation - in many textbooks





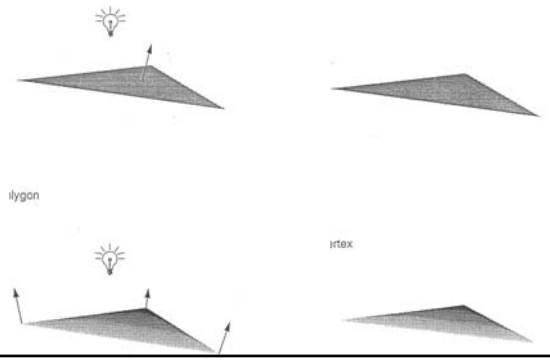
$$E = E_a + E_b + E_s$$

$$= L_{Ag} M_A + (\mathbf{S}\cdot\mathbf{L})^m \frac{L_A M_A + L_D M_D(\mathbf{N}\cdot\mathbf{L}) + L_S M_S(\mathbf{R}\cdot\mathbf{V})^n}{A + Bd + Cd^2}$$

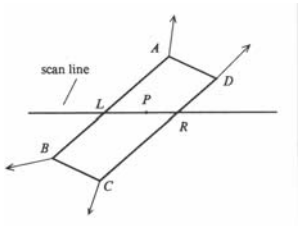
Faster Rendering – Shading Methods

- Flat shading:
  - One normal/surface
  - Same color for whole surface
  - Phong equation one time for whole surface
- Gouraud shading = Smooth shading
  - One normal/vertex -
  - Linear interpolation of color
  - Phong equation used for every vertex
- Phong shading
  - not the same as Phong equation
  - Interpolation of normals
  - Phong equation used for every point

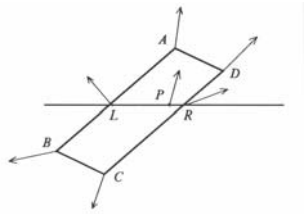
Flat & Gouraud shading



Gouraud Shading



Phong Shading

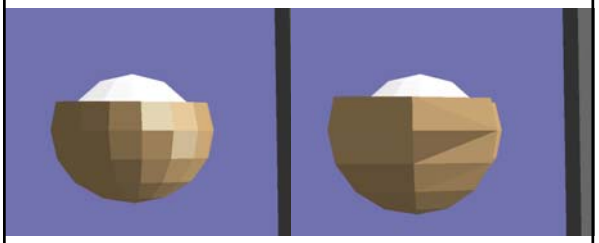


Flat Shading

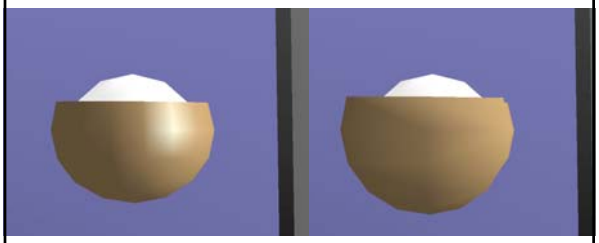
Gouraud Shading

Phong Shading

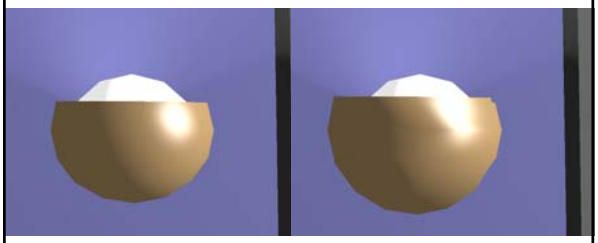
Flat Shading



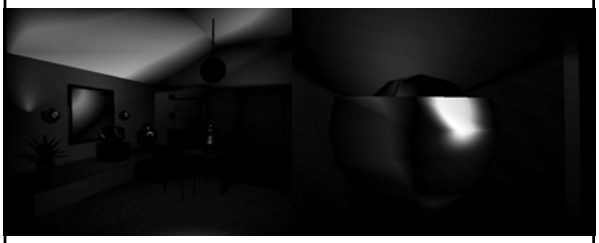
Gouraud Shading



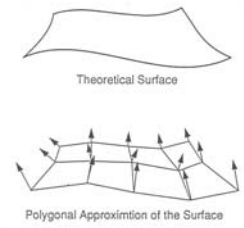
Phong Shading

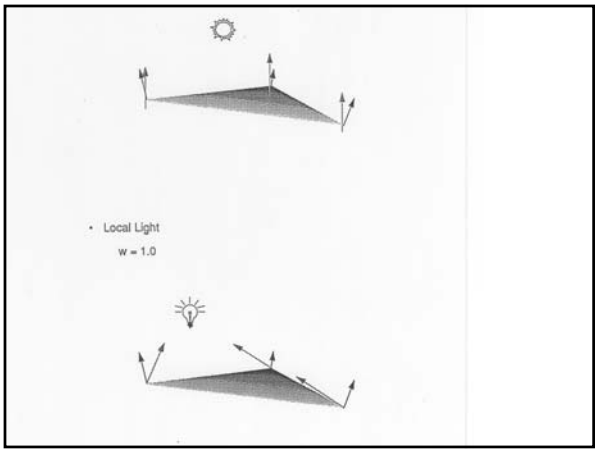


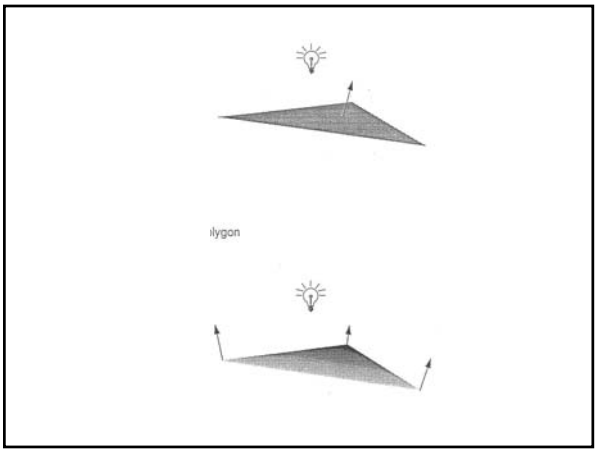
Difference P-G



Point – Distant lightsource







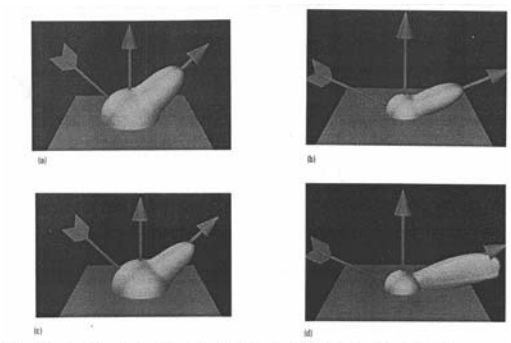
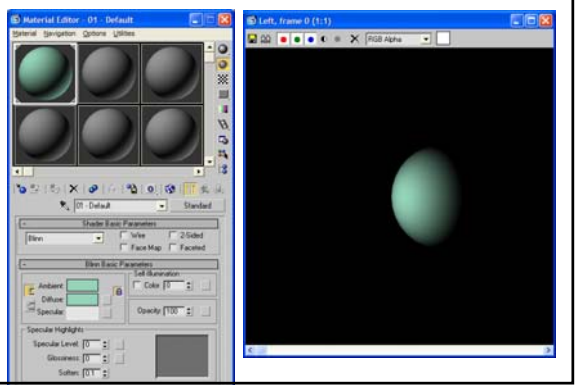
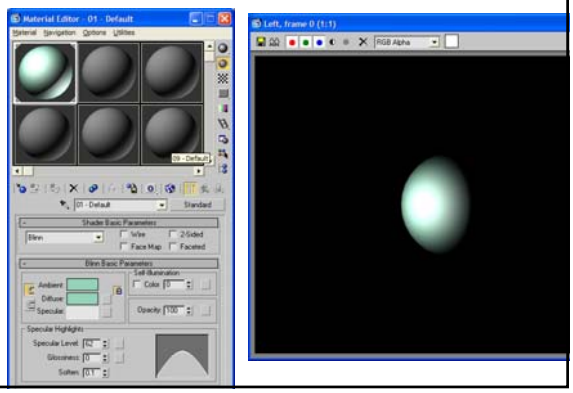
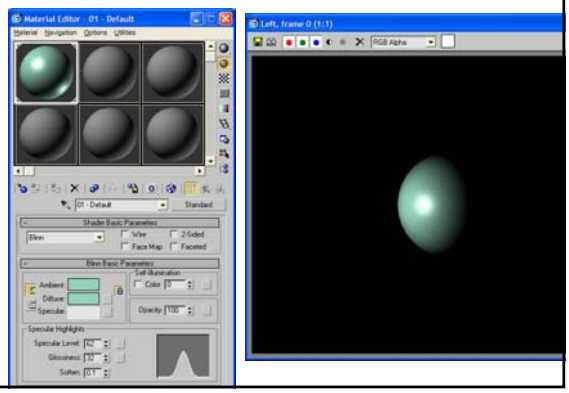
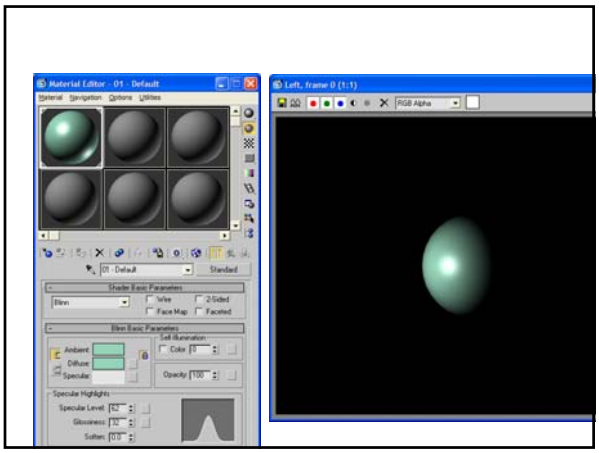


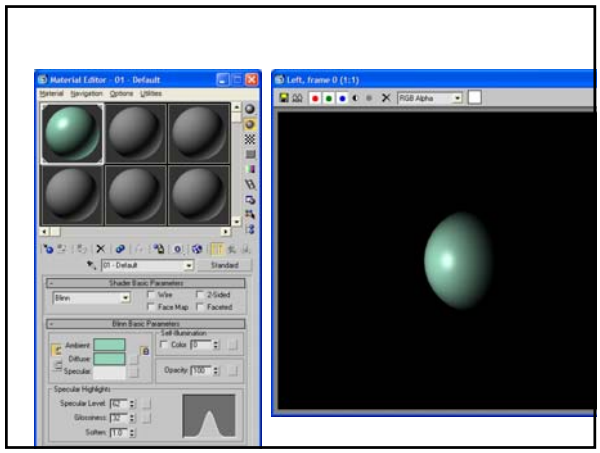
Figure 2.26 A rendered version of the solid formed by considering the reflected intensity (in all directions) for light incident from a particular direction. The arrow tail is L and the arrowhead shows the mirror direction. (a) and (b) The Phong model for high and low angles of incidence. (c) and (d) The Blinn model for high and low angles of incidence.

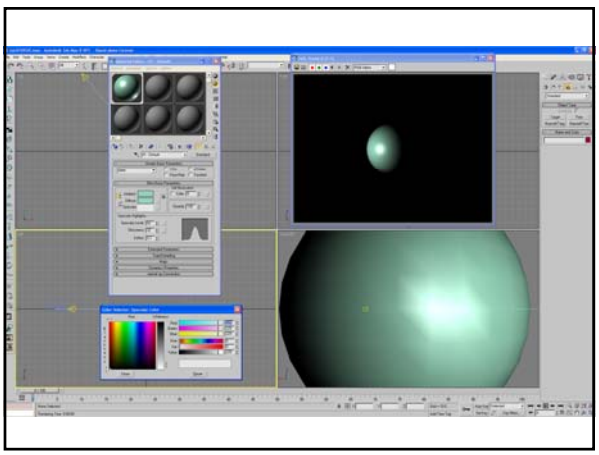


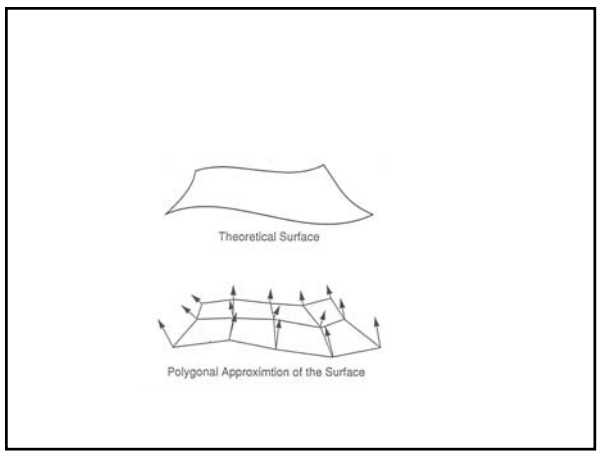


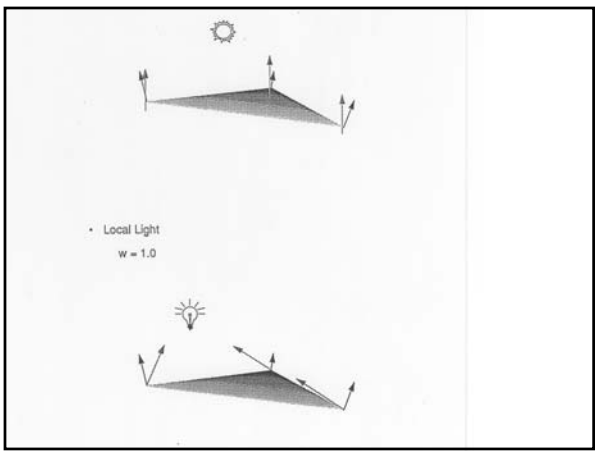


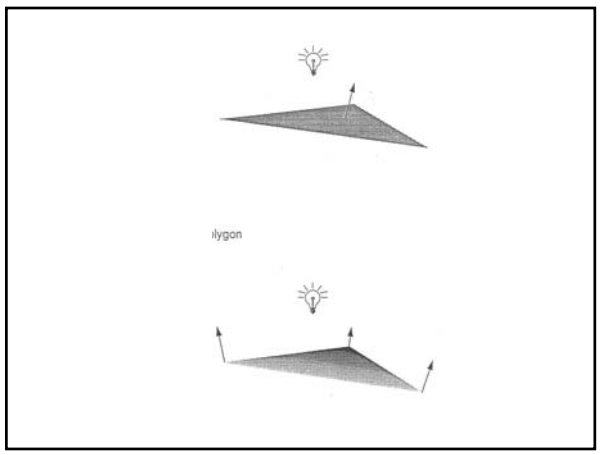

Material Editor - 01 - Default
Left, frame 0 (1:1)

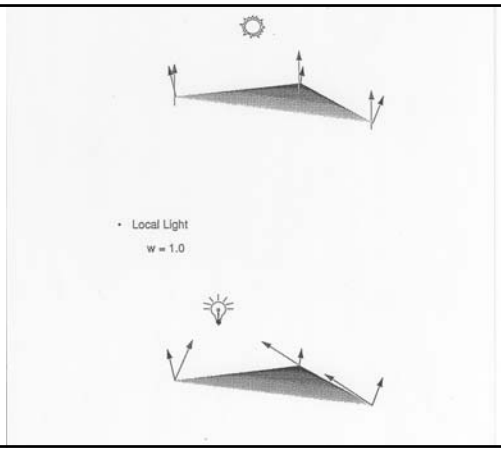

Material Editor - 01 - Default
Left, frame 0 (1:1)




Theoretical Surface
Polygonal Approximtion of the Surface


• Local Light
w = 1.0


ilygon



Notation other CG-books Bouknight – W&W

$$I = b + R \cdot r \cdot \cos\theta = I_a k_a + k_d (N \cdot L)$$

$$I_{\lambda,r} = I_{\lambda,a} k_a(\lambda) + k_d(\lambda)(N \cdot L)$$

Phong - W&W

$$I = I_a k_a + I_i [k_d \cos\theta + W(\theta)(\mathbf{R} \cdot \mathbf{V})^n]$$

$$\cos\theta = \mathbf{N} \cdot \mathbf{L} \; ; \; W(\theta) = k_s \; ; \mathbf{H} = \frac{\mathbf{L} + \mathbf{V}}{2}$$

$$I = I_a k_a + I_i [k_d (\mathbf{N} \cdot \mathbf{L}) + k_s (\mathbf{N} \cdot \mathbf{H})^n]$$

$$I_{\lambda,r}(\lambda, \phi) = I_{\lambda,a} k_a(\lambda) + I_{\lambda,l} [k_d(\lambda)(\mathbf{N} \cdot \mathbf{L}) + k_s (\mathbf{N} \cdot \mathbf{H})^n]$$

GL tutorial/manual (some)

$$E = E_e + E_a + E_s + E_b$$

$$= M_E + S_A M_A + \sum (\mathbf{S} \cdot \mathbf{L})^m \; \frac{L_A M_A + L_C M_D (\mathbf{N} \cdot \mathbf{L}) + L_C M_S (\mathbf{N} \cdot \mathbf{H})^s}{k_0 + k_1 d + k_2 d^2}$$