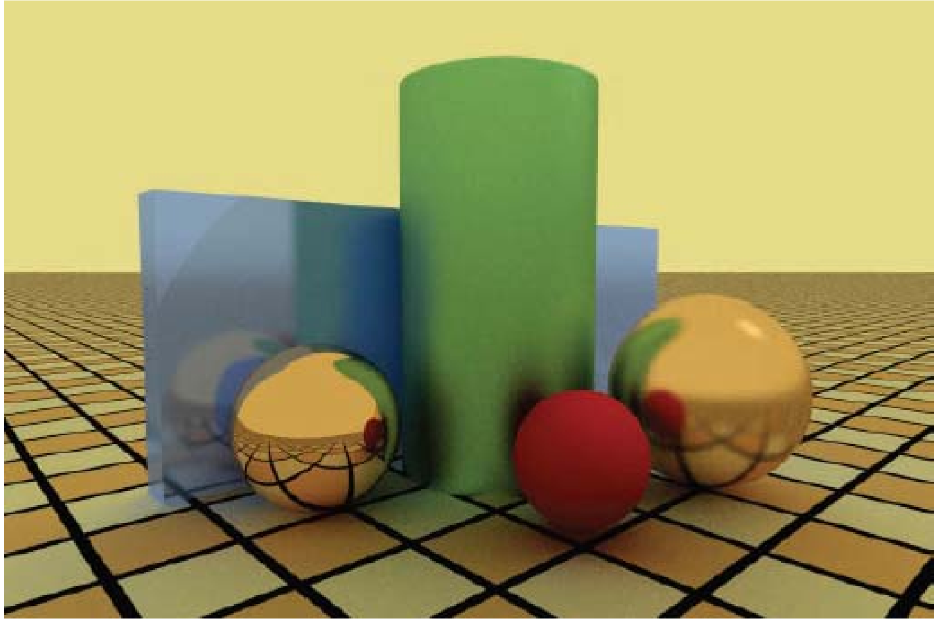
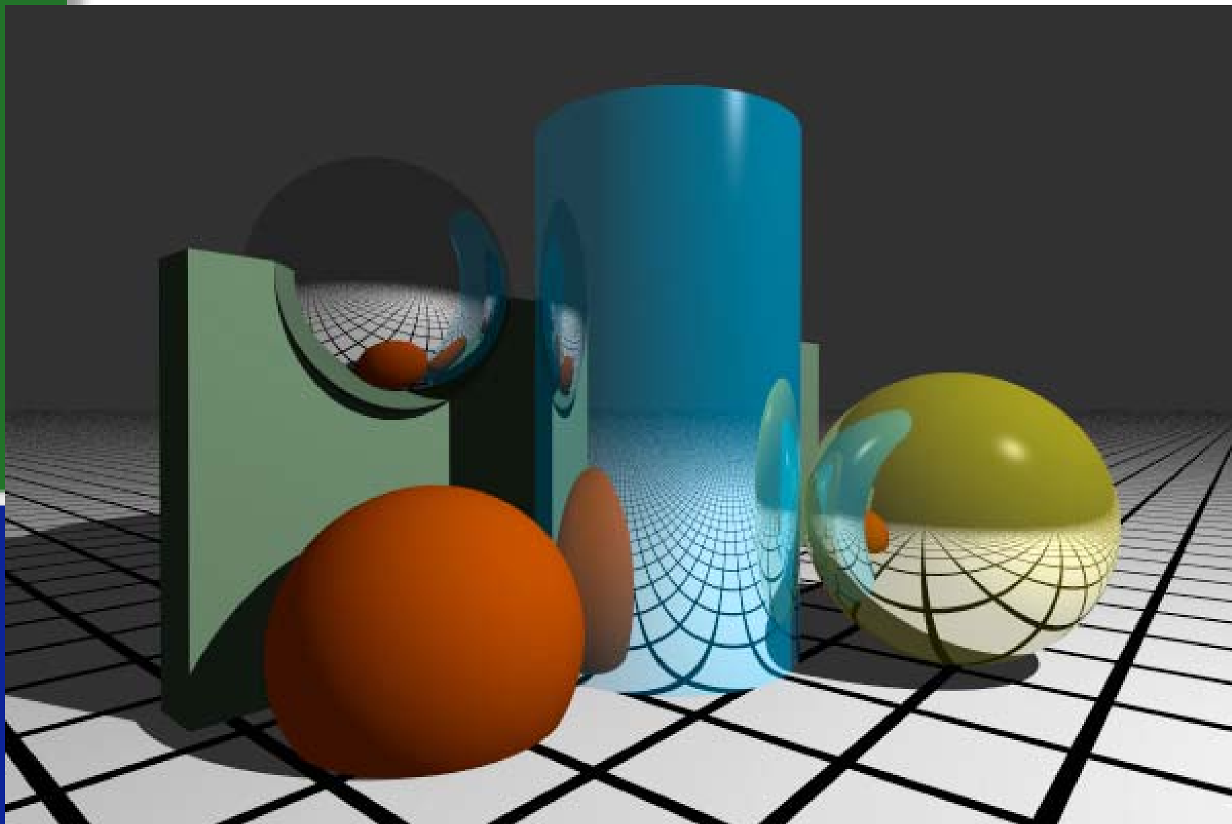
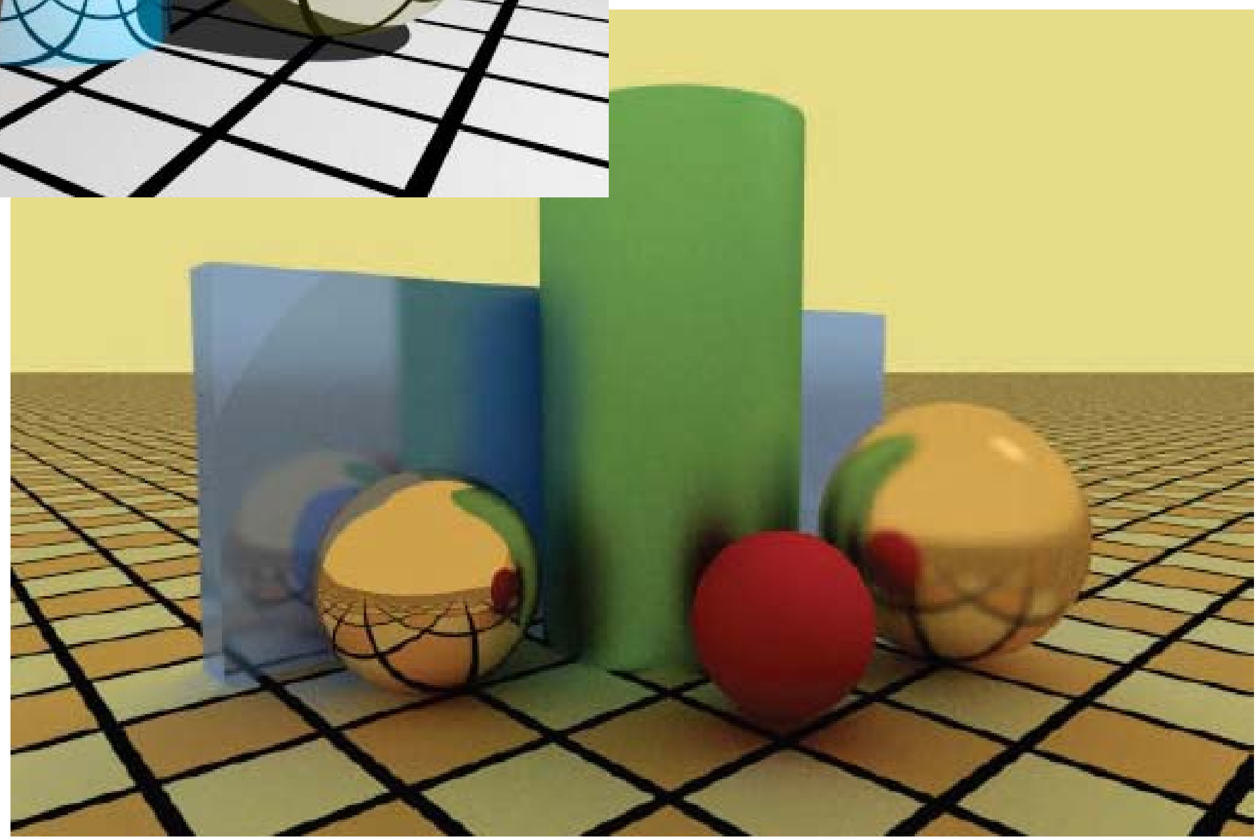
CS 563 Advanced Topics in Computer Graphics
Glossy Reflection



by Nik Deapen

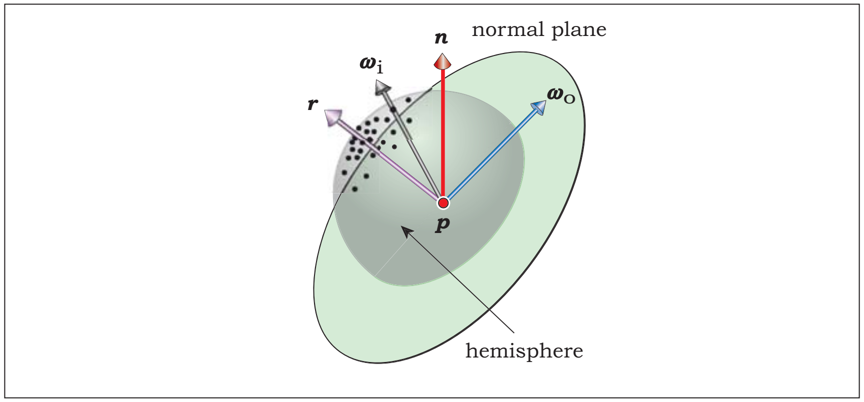
Difference?

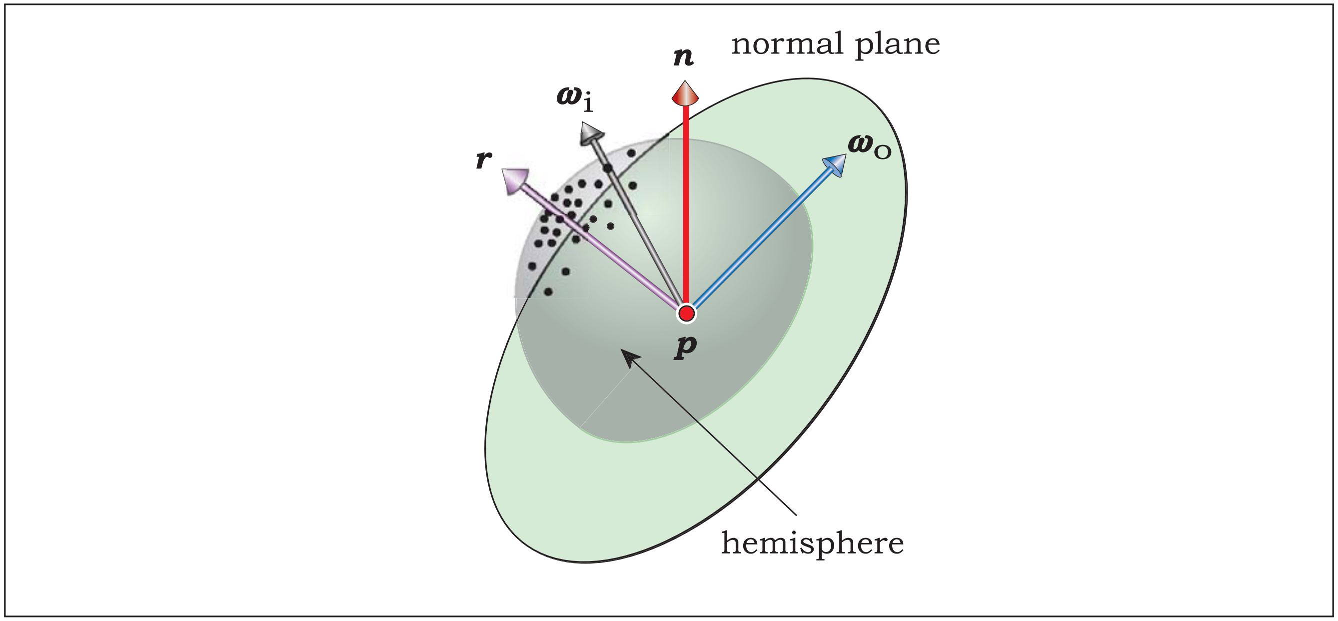




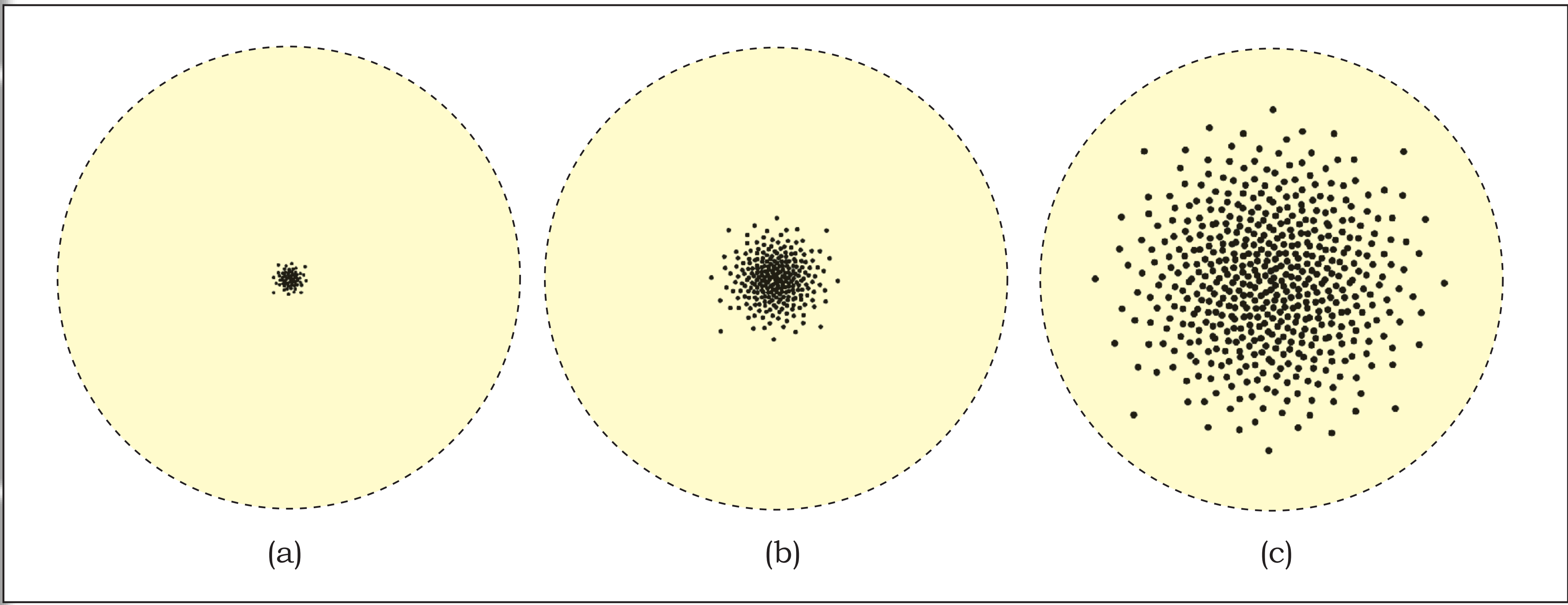
Difference from Mirror Reflection

- Instead of having the same direction for the reflection, jitter it with a cosine power distribution
- BRDF
  - $\cos(\theta)^e$
  - The constant e controls the glossyness of the image
  - e = infinity gives perfect mirror reflection
  - e = 1 gives diffuse sphere
  - e in 100 to 1000 gives good results




normal plane
n
ωi
r
ωo
p
hemisphere

- Cosine Distributions



Affects of e

- e = (1, 10, 100, 1000, 10000, 100000)

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C:\Users\Nik Deapen\Desktop\Chapter25\Ray Traced Images 25\Figure25.08(d).jpg	C:\Users\Nik Deapen\Desktop\Chapter25\Ray Traced Images 25\Figure25.08(e).jpg	C:\Users\Nik Deapen\Desktop\Chapter25\Ray Traced Images 25\Figure25.08(f).jpg

Runtime

- **Variables**
  - MAX_DEPTH
  - NUM_SAMPLES
- **Worste Case (per primary ray)**
  - NUM_SAMPLES * MAX_DEPTH
- **What should these numbers be?**
  - MAX_DEPTH
    - depends on the scene
    - 5 seems like a good number
      - unless more is obviously needed
  - NUM_SAMPLES
    - Kevin Suffern likes 1
      - This falls in nicely with his architecture
      - Then he has to sample with more primary rays (around 100)
    - I can get same results much faster with 9 secondary and 9 primary
      - Why?
        - Most rays don't actually hit a glossy object so it only expands if it needs to
      - Problems
        - Mine is exponential (although it doesn't happen often in most scenes)

Implementation

- Steps
  - Calculate r (Previous Chapter)
    - (the reflected ray in perfect mirror reflection)
  - Calculate (r x w) and -w
    - this will give u an orthonormal basis for the hemisphere
  - Sample The Hemisphere
    - compute the new ray (p->s)
      - if this ray is below the orthonormal plane, reflect it above the plane
  - Trace the rays again
    - Compute the color of each ray that was traced from the object
    - Combine this color with the color of the object

Orthonomal Basis

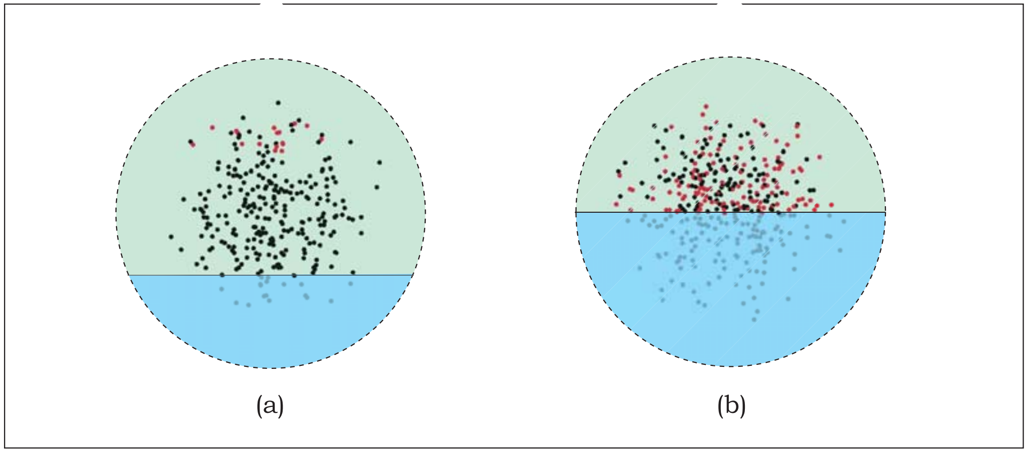
- -w = -w
- r = -w + 2 (n*w) n
  - Chapter 24***
- u = (r x w)
- w and u are the basis with r pointing strait up the hemisphere

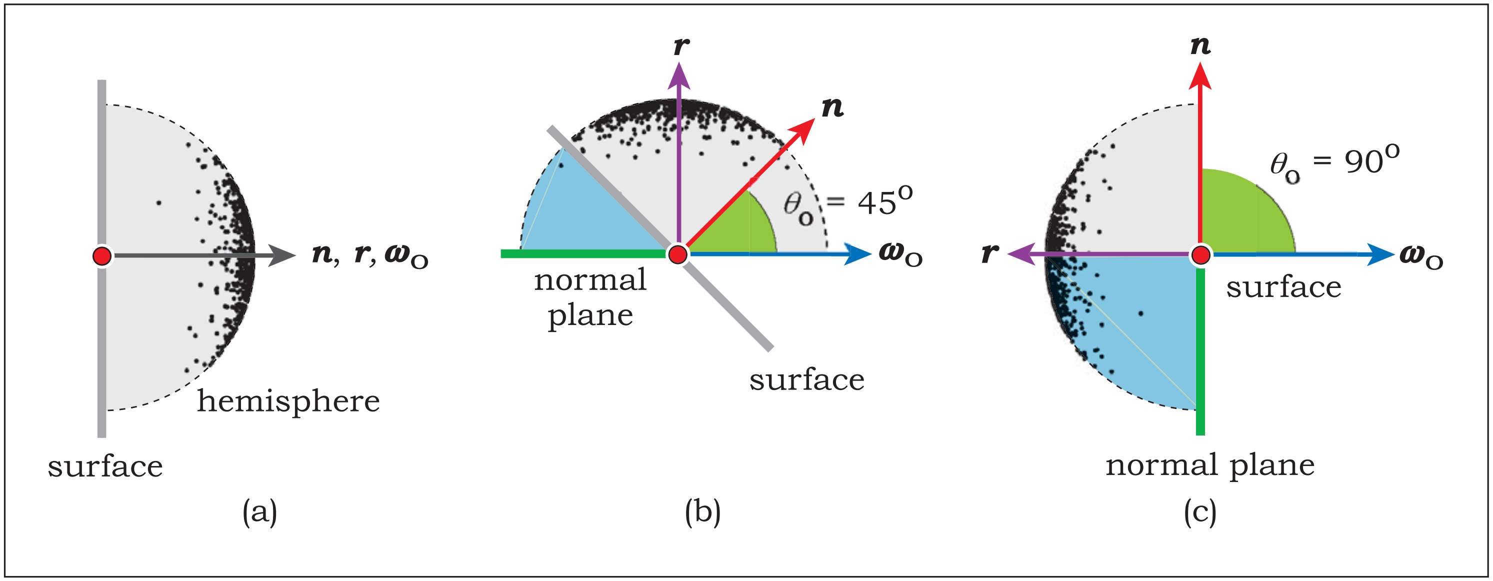
Sample the Hemisphere

- See Chapter 7
  - Explains in detail how to sample a hemisphere with a cosine power distribution
- Compute (p->s)
  - (easliy done)
  - p = the hit point
  - s = the sample point

Reflect the Ray

- If (p->q) is below the plane given by (p,n)
  - REFLECT
- How?
  - Test if (n*w) < 0
  - New Ray
    - $-s_x u - s_y v + s_z w$
- Problems With Reflection
  - Distribution is destroyed
  - Doesn't really matter?





What happens if we don’t?

- The sphere on the left is rendered incorrectly
  - The dark edges around the circumference come from the occlusin of the points that are bounced inside the sphere
- This reflection can be ommited for real time
  - See further reading

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Retrace The Ray

- Trace the ray (p->q)
  - Make sure you don’t hit the object you are tracing from
- Keep track of the bounce count
  - When the ray exceeds the maximum bounce color it black
    - Other options??
- Combining Colors
  - First Combine all the colors obtained from retracing
  - Now combine it with the color of the material

Phsyically Based Glossy Reflectance

- Based on Parameters
  - Specular
  - Contrast
  - Distinctness of Image
  - Haze
  - Sheen
  - Absense of Texture
- Not all of these are physical quantities

Results


NEW ORLEANS
SIGGRAPH
NEW ORLEANS
SIGGRAPH
Gloss perception
2 PREVIOUS WORK

References

- Ray Tracing From the Ground Up
  - Kevin Stuffern
- Toward a Psychophysically Based Light Reflection Model for Image Synthesis
  - Pellacini (200)
- Is Accurate Occlusion of Glossy Reflections Necessary?
  - Kozlowski (2007)