Some mixed material

Perceptual illumination components
In this paper we introduce a new perceptual metric for efficient, high quality, global illumination rendering. The metric is based on a rendering-by-components framework in which the direct, and indirect diffuse, glossy, and specular light transport paths are separately computed and then composited to produce an image. (Stokes, Ferwerda, Walter, Greenberg – Cornell University)

Shadows
- Different approaches
  - Projection shadows
  - Soft shadows
  - Shadow volumes
  - Shadow maps
  - One approach: places not seen from light source are in shadow, including faces oriented away from light source.

Why shadows?
- More clues about spatial relationships
- Orientation & gameplay
Definitions

- Light source types
  - Point source
  - Area source
  - Umbra
  - Penumbra

Example: hard vs soft shadows

When scene is viewed, check viewed location in light's shadow buffer
- If point's depth is (epsilon) greater than shadow depth, object is in shadow.

Shadow Map
(Z-buffer from light source)

- When scene is viewed, check viewed location in light's shadow buffer
  - If point's depth is (epsilon) greater than shadow depth, object is in shadow.

Shadow volumes
Most popular method for real time

- Shadow volume concept
- Create volumes of space in shadow from each polygon in light.
- Each triangle creates 3 projecting quads

For each pixel, compare distance to light with the depth stored in the shadow map.
Using the Volume
- To test a point, count the number of polygons between it and the eye.
- If we look through more frontfacing than backfacing polygons, then in shadow.
** Man går igenom rymdens skuggvolymer och håller koll på när man går in och ut.

Fundamental techniques for intersection
Ray calculations using equation of a line
\[ r(t) = o + td \]
Equation for a plane, \( n = \) normal of plane, \( r_0 = \) point on plane:
\[ n \cdot (r - r_0) = 0, \quad n \cdot (r - r_0) = p \]
p gives the distance to the plane and the sign of \( p \) gives the side of the plane.
One application of this: \( n \cdot (r_A - r_0) \cdot n \cdot (r_B - r_0) < 0 \)
means that \( A \) and \( B \) are on different sides of the plane.

The clipping problem
Cohen-Sutherland’s clip algorithm

To clip a line between A and B:
while NOT done {
  CompOutCode(A);
  CompOutCode(B);
  IF A bitwise_OR B == 0 THEN
    {inside; done=TRUE}
  ELSE IF A bitwise_AND B =/= 0 THEN
    {outside; done=TRUE}
  ELSE intersect(A,B,outsideedge);
  }

Parameter clipping

(Cyrus-Beck, Liang-Barsky)
Use \( p(\alpha) = (1- \alpha)p_1 + \alpha * p_2 \)
Clipping is done by first calculating \( \alpha \) for lines that you might clip (less work than to calculate both \( x \) and \( y \))
To clip with the edge \( x=\text{xmin} \) we get: \( \alpha = (\text{xmin} - x_1)/(x_2 - x_1) \)
\( \alpha_1=0; \alpha_2=1; \)
for (all four edges of window) {
  \( \alpha = \text{calculate(edge)} \);
  if entering(edge) \( \alpha_1 = \max(\alpha_1, \alpha) \) else \( \alpha_2 = \min(\alpha_2, \alpha) \);
  if \( \alpha_2 > \alpha_1 \) then drawline(\( \alpha_1, \alpha_2 \));
}

Polygon clipping

Can we use the line clipping algorithm to clip a polygon?

With line clipping the new point could not be included

Sutherland-Hodgeman’s algorithm

Note that in each clipping phase of the polygon you have to keep the order of the vertices
What happens if the clipping give more than one polygon?

Bounding volume creation

- Axis Aligned Bounding Box (AABB)
- Oriented Bounding Box (OBB)
- Discrete Oriented Polytope (DOP)
- Using k planes is called a k-DOP
- Bounding Sphere

Bounding Volume Hierarchies

- BVH is efficient in checking collisions hierarchically.
- It takes time to build the hierarchies with bounding volumes at each level.
frame-to-frame coherency

- objects are close to where they were in the previous frame
- many methods are e.g. iterative which means that the previous frame can be used as start approximation

Compare radiosity and ray tracing, example from Cornell

http://www.graphics.cornell.edu/online/tutorial/radiosity/

Ray tracing
Radiosity

Non-photorealistic rendering

Brainball

Raskar et al., Non-photorealistic Camera:..., SIGGRAPH 2004
**Virtual retinal display**
Projicerar laserstråle direkt på näthinnan (retina)

**Fogscreen**
Projicerar en bild på tunn dimma i luften

**Färgsystem, Natural Vision**
En färgskärm som bygger på 6 stycken grundfärger i stället 3.

**Fördjupningsuppgifter**
Grundteknik
- partikelsystem
- non photo realistic rendering
- belysningsmodeller
- texturtekniker
- image based rendering
- skuggor
- spännande interaktionsmekanik (haptik, Wii, …)

**Tillämpningar**
- modellering, animering
- spel
- bebyggelse
- natur, inkl. fraktaltekniker