## Solving the rendering problem

### 1. Abstract the behavior to produce a model

- **consider the application**
  - **polygons work well for manmade objects**
- **choose a scale**
  - **typical microfacet size >> wavelength of visible light**
- **example**
  - **Kajiya's rendering eqn = geometric optics with local behavior handled by phase function**
- **Use real physics whenever possible**
  - **scattering theory came late to volume rendering**

### 2. Approximate the model

- **error metric**
  - **Q. what are we sensitive to? A. discontinuities**
- **consider the application**
  - **shadows -> discontinuities**
- **example**
  - **radiosity = finite element approximation with discontinuity meshing & interpolation during display**
- **Use established methods whenever possible**
  - **finite element method came late to computer graphics**

### 3. Evaluate the approximation

- error metric
  - Q. what is important? A. screen size
- take advantage of coherence
  - adjacent points have similar visibility
- take advantage of scaling properties
  - distant objects contribute little to the solution
- example
  - hierarchical radiosity = N-body algorithm with patch subdivision and an importance oracle
- use established algorithms whenever possible
  - Monte-Carlo algorithms came late to ray tracing

## Be on the lookout for creative solutions

### 1. Unusual abstractions

- tarnish = accessibility (Miller '93)

### 2. Unusual approximations

- volumetric fur (Kajiya '89)

### 3. Unusual evaluation algorithms

- Shear-warp volume rendering (Lacroute '94)

## Systems issues

### Managing complexity

- **“writing a model” and “compiling” it**
- **managing storage and bandwidth**

### Level-of-detail

- **deciding how much to use**
- **geomorphing, detail textures**
- **changing levels of abstraction**

### Hardware acceleration

- **lags 10 years behind algorithms**
- **the great wheel of reincarnation**

## Things we can’t render yet

### Modeling

- **people, trees, geology**

### Animation

- **people, fire, breaking waves**

### Rendering

- **people, weathering, atmospheric effects**

## Other open problems in rendering

**non-photorealistic rendering**

**visualization**

**inverse rendering problems**