Who’s Afraid of "Advanced" Rendering?

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Part 1: Why not "advanced" rendering?
We Make Movies

• Images portray and accent story points
• Output will be seen very large by millions of viewers
• Deadlines cannot be broken
Live Action Movies...

- Do not simply shoot action
- Use many "unmotivated" lights
- Are "bigger than life," not true to life
- Would alter physics if they could!
Requirements of Production Rendering

- Handle large amounts of HQ geometry
- Arbitrary programmable shading/lighting
- Render in limited time & memory
- No artifacts (aliasing, tessellation, noise, cracks, pinpricks, numerical instability, etc.)
- Extreme flexibility & robustness
The World We Render In

- **120,000 final rendered frames**
  - not counting trials, multiple takes, mistakes, multiple elements
- **Input geometry per frame ~1Gb**
- **Average cost: 4 hours, 256-512 Mb**
  - range from 1-80 hours, no panic until 10 hours
Rendering Algorithm

- The REYES Algorithm
  - High-level primitives (bicubics, trimmed NURBS, subdivision surfaces)
  - Adaptively discretize, shade at grid vertices
  - Bust grids into micropolygons for hidden surface removal
  - Carefully sample & filter

- Aggressive culling (frustum, occlusion)
- Decoupled visibility & shading
- No ray tracing
"Advanced Rendering" Problems

- **Time/memory requirements**
- **Automation/Control trade-off**
  - Skilled lighters do as well in much less time
  - Remember the live action problem
- **Quality Issues**
  - ray tracing tends to be more artifact-prone
- **Cheating Physics**
Part 2: Why *not* "advanced rendering?"
Ray Tracing in Pixar’s Films

• Yes, we have done it
• Arcane setup with two renderers:
  – PRMan (REYES)
  – BMRT (ray tracing, radiosity, RenderMan-compliant)
• Basic idea: BMRT answers “ray queries” from PRMan
• Used for 15 shots on "A Bug’s Life”
• [video]
Lessons Learned

• We can do "advanced rendering"
• Glad we only do it occasionally
  – very expensive
  – good thing we had a tractable test case
• Appetites have been whetted!
• Time to revisit automation/control tradeoffs
  – We’d like to reduce crew size
• Actively trying to solve the problems with ray tracing and global illumination
The End