
Who's Afraid of "Advanced" Rendering?

Larry Gritz
Graphics R&D
Pixar Animation Studios
lg@pixar.com

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
