




VO Rendering SS 2010


Unit 10: Here Be Dragons




Sources:

Future of CG?




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Overview

- Past problems
- Jim Blinn's Unsolved Problems
- Future of Physically Based Rendering


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10 Unsolved Problems

- Long tradition of posing unsolved problems
- First suggested by Ivan Sutherland in 1965
- Became the focus of future developments in 70's and 80's


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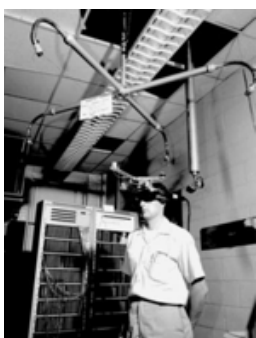

When Is a Problem "Solved"?

- "Solved" in the theoretical sense vs. in the practical sense
 - ◆ E.g. rendering equation: problem is theoretically solved, but unsolved in the practical sense
- We want cheap and fast solutions


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CG (VR) in the 1960's






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Sutherland 1966 


- Cheap machines with basic capability
- Basic interaction techniques
- Coupling simulations to their display
- Describing motion
- Continuous tone displays (halftoning)
- Making structure of drawings explicit
- Hidden line removal
- Program instrumentation and visualization
- Automatic placement of elements in network diagrams
- Working with abstractions (scientific visualization)



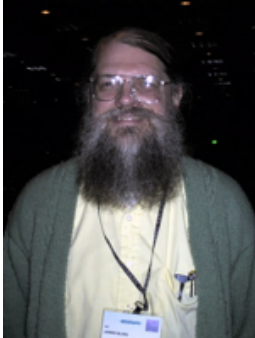
Heckbert 1987 


- Converting implicit models to parametric
- High-quality texture filtering
- Antialiasing
- Shadows without ray tracing
- Practical ray tracing
- Practical radiosity
- Frame-to-frame coherence
- Automating model culling
- Smooth model transitions
- Affordable real-time rendering hardware




Jim Blinn's 10 Unsolved Problems 


- CG pioneer
- Siggraph Keynote Address 1998
- More sociological or marketing issues than technical problems
- <http://www.research.microsoft.com/research/graphics/blinn>







Novelty (1/10) 


- Simply find something that hasn't been done yet
- Easy problems have been solved
- Sometimes difficult to figure out something that somebody hasn't already invented




Education (2/10) 


- **Learning:** Keeping up with what has been done
 - ◆ Related to problem 1
 - ◆ Don't reinvent the wheel
- **Teaching:** Dissemination of new discoveries




System Integration (3/10) 


- How to use all the tricks in one production
 - ◆ e.g. "The Incredibles" in which facial animation, cloth simulation, hair simulation and so on are well integrated.







Simplicity (4/10) 


- “Make things simple” - but life is not so simple
 - ◆ Cloth, hair, skin, trees, water, physically based motion, deformations, texture synthesis, weathering, solid textures, multi-resolution models, image-based rendering...
- Is simplicity even possible ?
- Nonetheless, one should still strive for simplicity
- Make it as simple as possible




Better Pixel Arithmetic Theory (5/10) 


- RGBA pixel concept incomplete
- Three problems
 - ◆ Pre-multiplication of the color channels by the alpha channel (local/global distinction)
 - ◆ Correlated edges of a foreground and background object
 - ◆ Combining compositing operations with light reflection models
- Unified field theory of pixel arithmetic



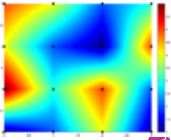
Legacy Compatibility (6/10) 


- Technological improvements change trade-off
- Legacy applications and data, e.g. 3D APIs, file formats, ...
- How to not abandon the old while allowing the new




Arithmetic Sloppiness (7/10) 

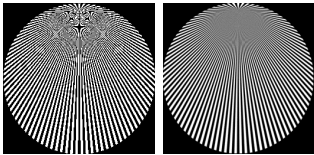
- Programmers are tempted to do a sloppy job of pixel arithmetic to appease the great god of speed
 - ◆ E.g. texture filtering: bilinear interpolation between four nearest texels → adds diamond-shaped artifacts to the image
 - ◆ Phong BRDF model
- How accurate do we need to be?







Antialiasing (8/10) 


- Textures in perspective will *always* be either too fuzzy or too jaggy
- “Nobody will ever figure out how to do antialiasing”







A Modeling, Rendering, Animation Challenge (9/10) 

- 1D shape - piles of rope or string and even conceivably to protein folding
- Modeling is figuring out the shape of it
- Rendering is how to make a picture of it
- Animation is figuring out how it moves with time





Cloth Rendering



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Finding a Use for Real-Time 3D (10/10)

- Find large-scale uses for it
 - ◆ Entertainment (movies, games)
 - ◆ Engineering (CAD / CAM)
 - ◆ Visualisation
- Interaction and communication (GUIs, printed media, art, Ecommerce, Web3D and Virtual Communities)

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Words from Blinn

Get Hopping

“ I realize that people will mostly pursue the easiest of these: spaghetti. The other problems will likely require group participation but are, probably, rather more important. Whichever challenges you - hop to it! And let me know what you find. ”

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Unsolved Issues in PR 1

- Acquisition and modeling BRDFs
- Reliable, accurate and cheap
- Render and measurement time too long
- Measure more samples where more accuracy is needed

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BRDF Measurement

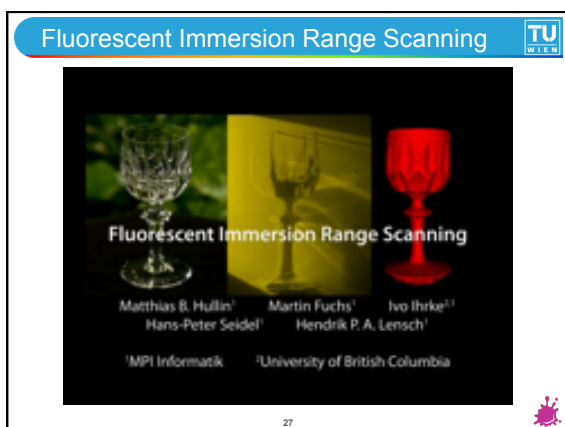
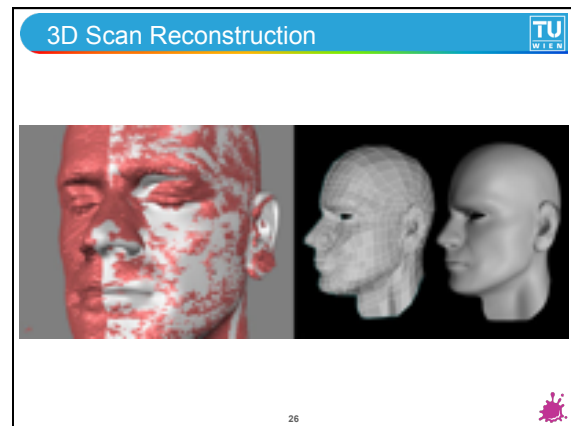




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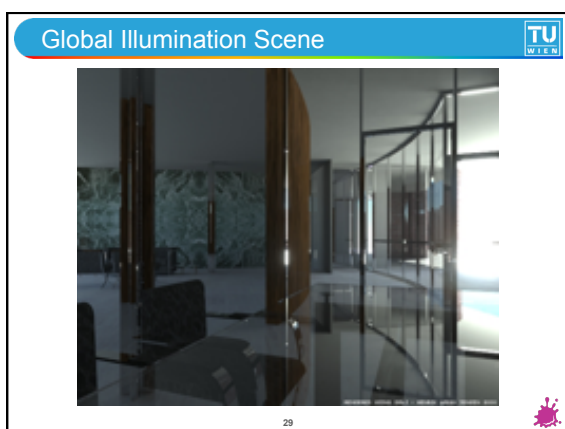
Unsolved Issues in PR 2



- Acquisition of geometry and surface appearance
- Problematic for non-diffuse and transparent surfaces or when illuminant is unknown


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- Unsolved Issues in PR 3 
- Self-adaptive light transport
 - Some algorithms perform better in specific situations than others
 - Adaptive overall global illumination algorithm picks right mode depending on surface, illumination, ...
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- Unsolved Issues in PR 4 
- Scalable and robust rendering
 - Complex scenes without user intervention
 - Especially important in interactive and dynamic applications, e.g. games
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Unsolved Issues in PR 5 

- Geometry-independent rendering
- Currently many ray-objects intersection calculations
- What if geometry is not known explicitly (e.g. light fields, photographs)?



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Video 

**Relighting Human Locomotion
with Flowed Reflectance Fields**


Per-Einarsson¹, Charles-Felix Chabert², Andrew Jones³, Wan-Chun Ma¹,
Bruce Lamont⁴, Tim Hawkins⁵, Mark Sotoudeh², Sebastian Syrewitz⁶, Paul Debevec⁷

¹ USC Center for Creative Technologies
² National Taiwan University
³ USC School of Cinema-Television


Eurographics Symposium on Rendering, June 2006




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Unsolved Issues in PR 6 


- Radiometric accuracy main driven force
- Usually not necessary
- Psychoperceptual rendering → perceptual correct images
- Viewer might still judge the image to be realistic




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Perception Example 







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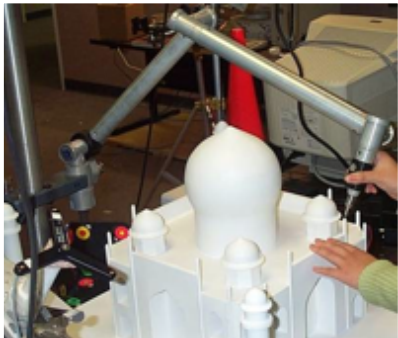
Unsolved Issues in PR 7 


- Integration with real elements
- Put real objects in virtual scene and virtual object in real scene, e.g. with projectors
- Blend between real and virtual elements



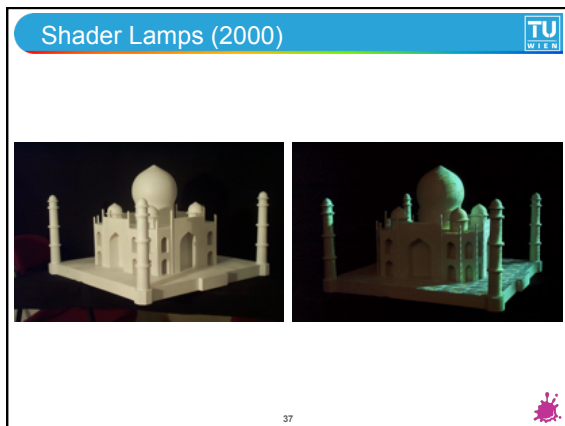
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Shader Lamps (2000) 





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The Ultimate Photorealistic Renderer TU
WIEN

- Interactivity
 - ◆ Render scenes at interactive speed
- Any material, any geometry
 - ◆ Materials from pure specular to pure diffuse on any type of geometry
- Many different input models
 - ◆ Virtual or based on acquisition
- Realism slider
 - ◆ Different styles of realism

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