



# VU Rendering SS 2012

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Unit 10: Here Be Dragons





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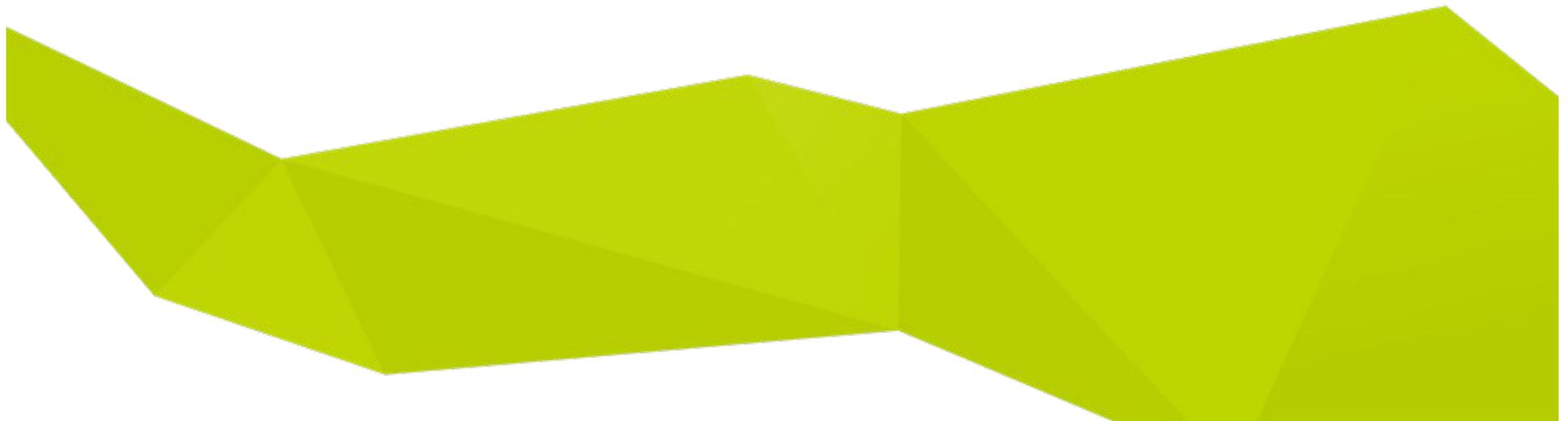
## Future of CG?





# Overview

1. Past problems
2. Jim Blinn's Unsolved Problems
3. 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, practical 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)



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## 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



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## 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>





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## 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



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## 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



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## 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



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## 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



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## 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



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## Legacy Compatibility (6/10)

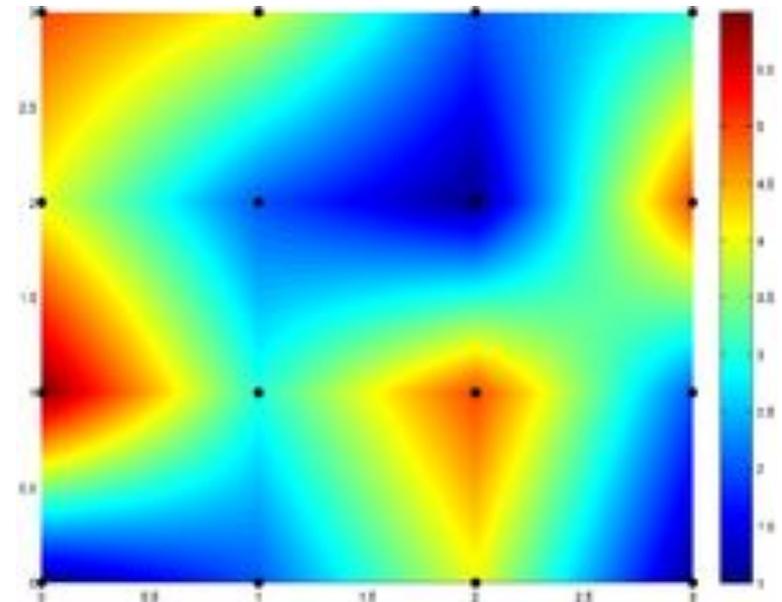
- Technological improvements change trade-off
- Legacy applications and data, e.g. 3D APIs, file formats, ...
- How to not abandon the old while allowing the new



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## Arithmetic Sloppiness (7/10)

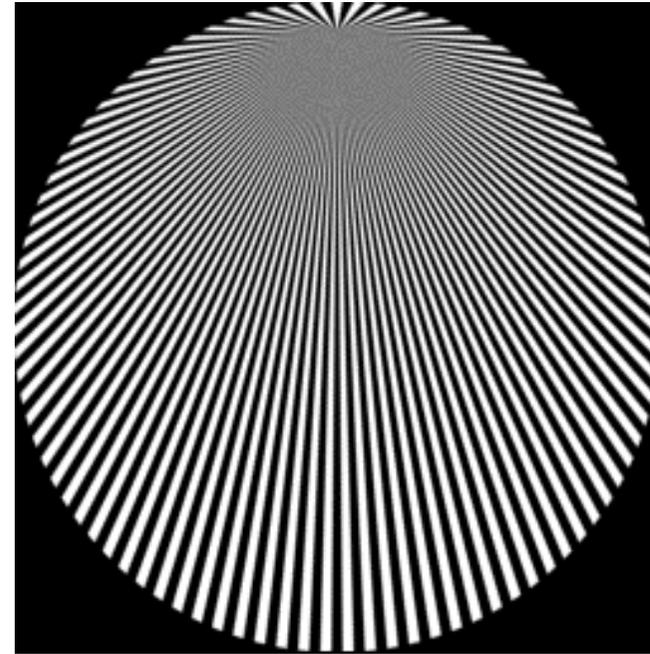
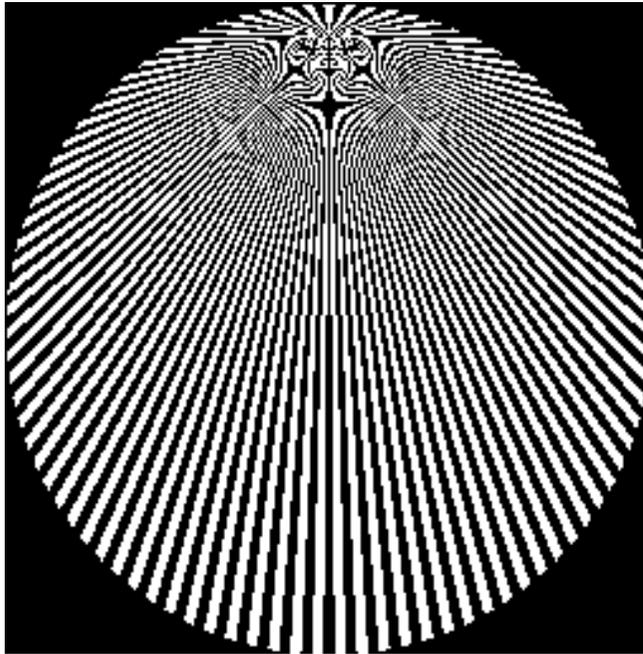
- Programmers are tempted to do a sloppy job of pixel arithmetic to appease the great god of speed
  - E.g. texture filtering: bilinear interpolation between four nearest texels → adds diamond-shaped artifacts to the image
  - Phong BRDF model
- How accurate do we need to be?
- Certain approximations not necessary anymore





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## Antialiasing (8/10)



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



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## 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





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# 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





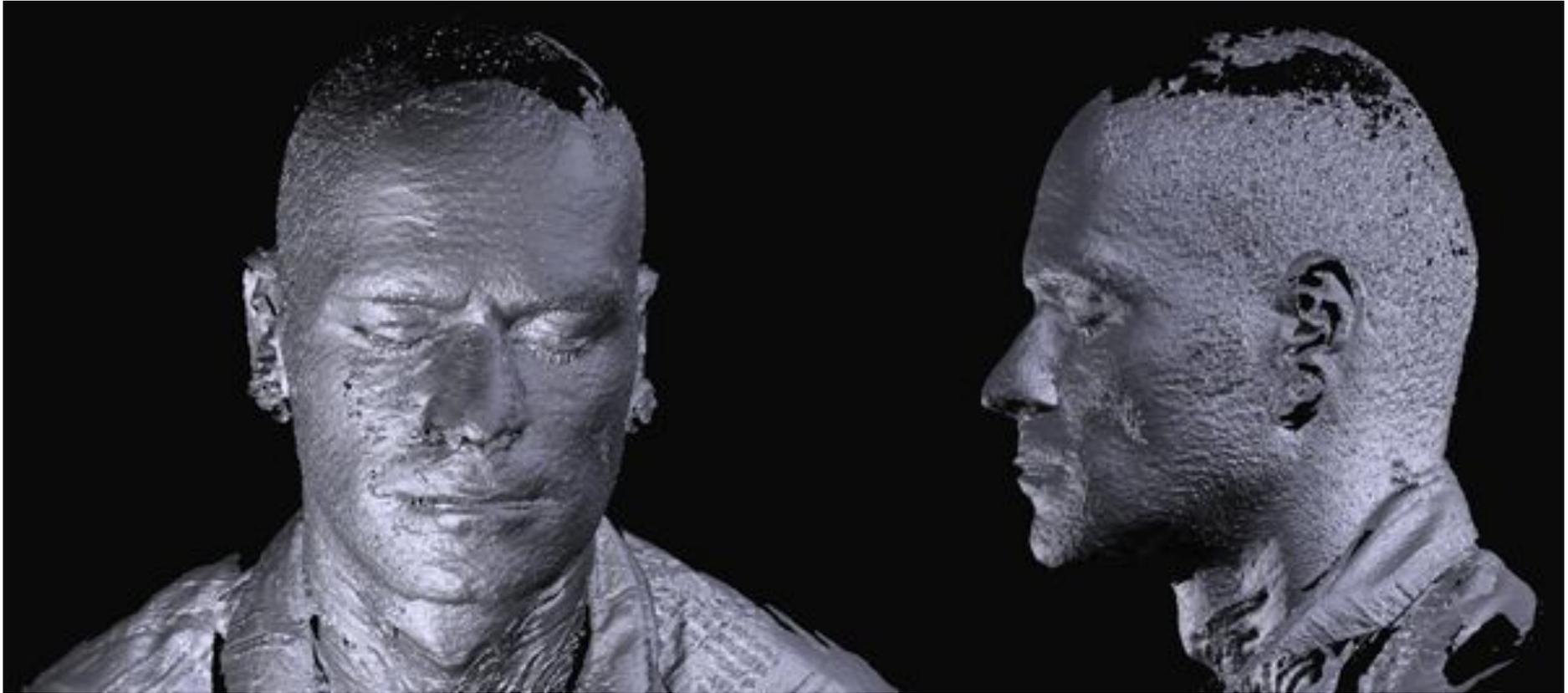
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## Unsolved Issues in PR 2

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

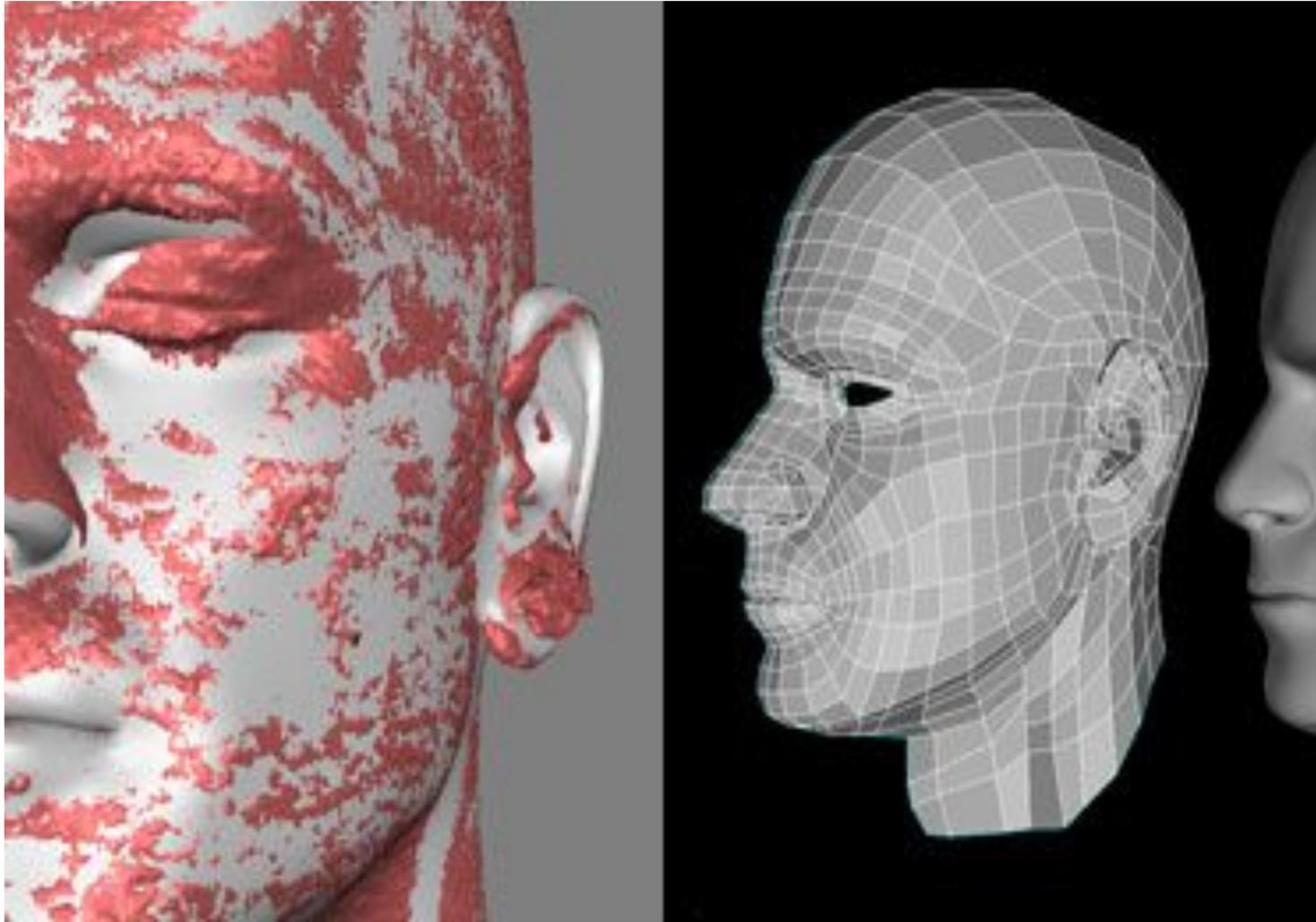


## 3D Scn





## 3D Scan Reconstruction





## Fluorescent Immersion Range Scanning





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## Unsolved Issues in PR 3

- Smart rendering - 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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## Global Illumination Scene





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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 Einarsson Charles-Felix Chabert Andrew Jones Wan-Chun Ma<sup>1</sup>  
Bruce Lamond Tim Hawkins Mark Bolas<sup>2</sup> Sebastian Sylwan Paul Debevec

USC Centers for Creative Technologies  
National Taiwan University<sup>1</sup>  
USC School of Cinema-Television<sup>2</sup>

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



## Perception Example





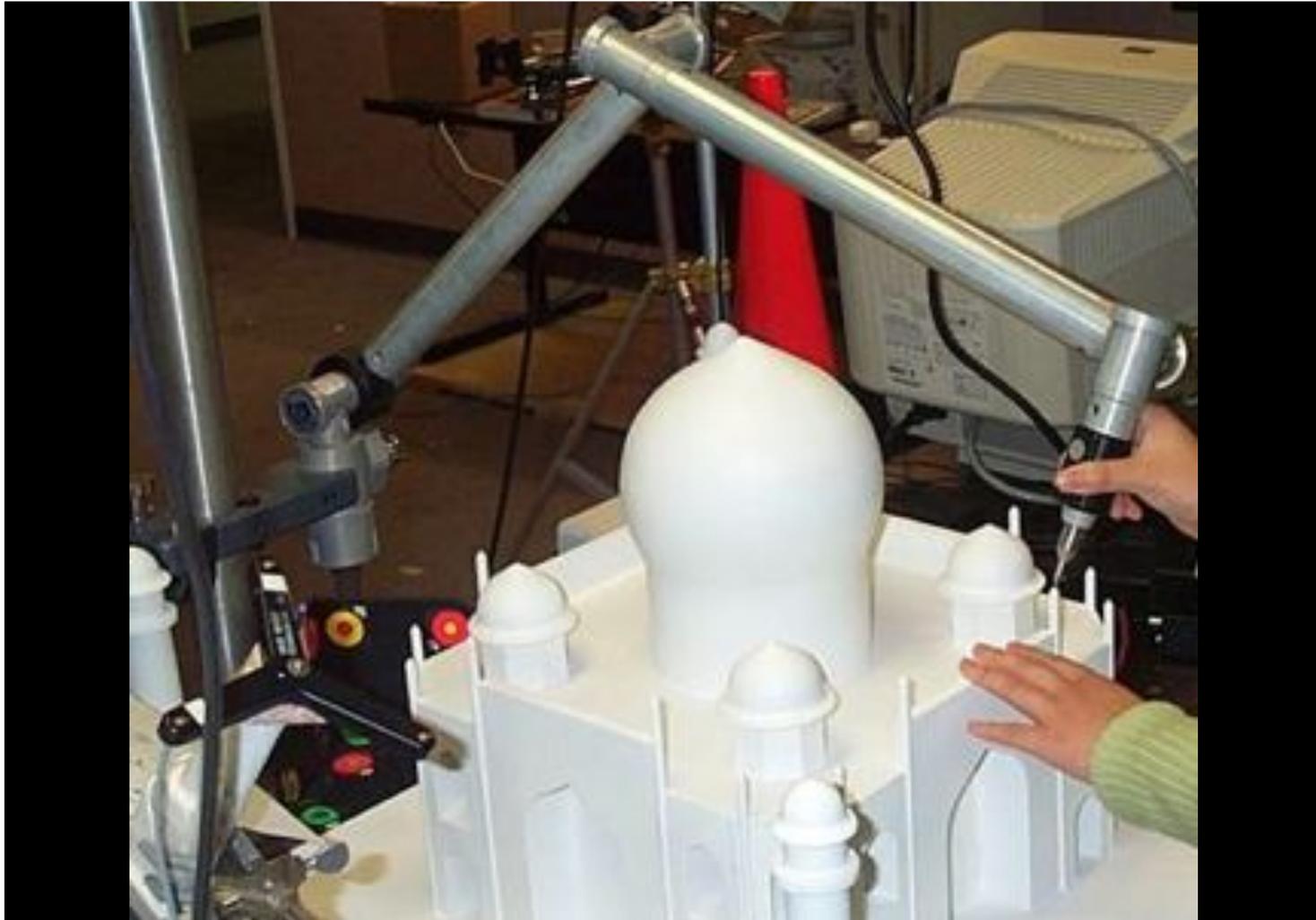
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## Unsolved Issues in PR 7

- 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

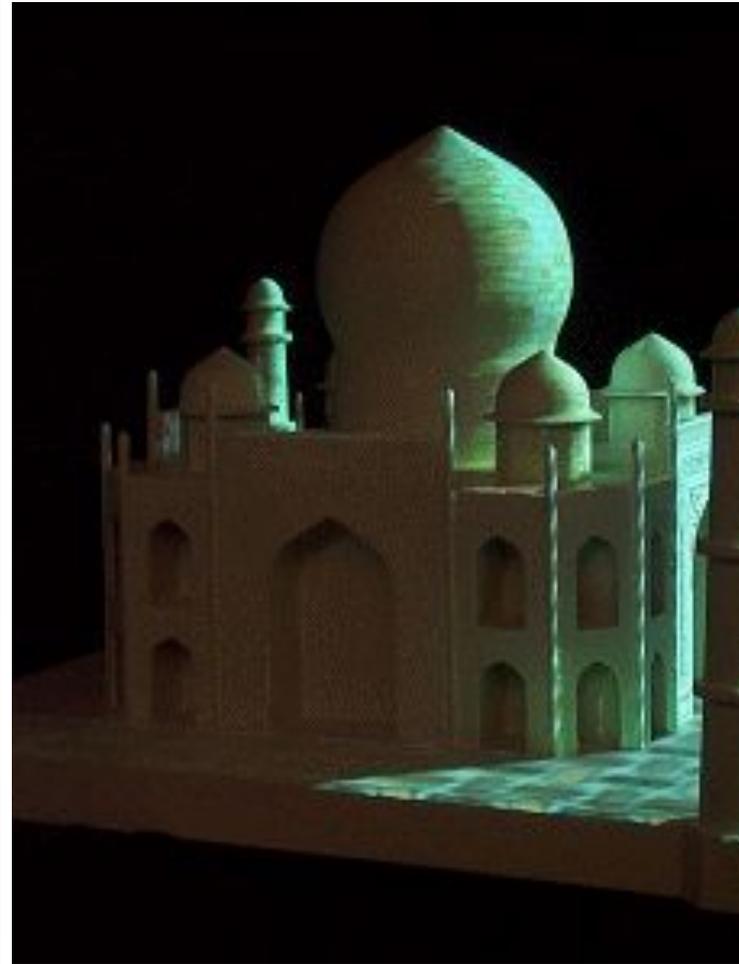


## Shader Lamps (2000)





## Shader Lamps (2000)





## Office of the Future (2000)





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## The Ultimate Photorealistic Renderer

- 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



# A Magical World

