

Image Synthesis: Overview and Goals

cs348b

Matt Pharr

Goals and Applications

- Goals
 - Realistic image synthesis
- Problems
 - Modeling reality: light, materials, shapes
 - Simulating physics
 - Managing complexity
- Applications
 - Movies
 - Interactive entertainment
 - Lighting design

State of the art



Versus photos of reality



Ansel Adams



www.urban75.org

Modeling & Simulating Appearance

- Light sources
- Geometric shapes
- Materials
 - Surfaces
 - Participating media
- Cameras and film
- Perception & the human visual system

Early challenges in graphics

- Projection to the screen
- Visibility: hidden surface removal
- Basic shading
 - Gouraud
 - Phong
 - Texture mapping
 - Bump mapping
- ~What graphics hardware does today

Physically-Based Image Synthesis

- Surface reflection
 - The BRDF
- Participating media
 - Absorption, attenuation, the phase function
- Light transport algorithms
 - Ray tracing
 - The rendering equation / equation of transfer

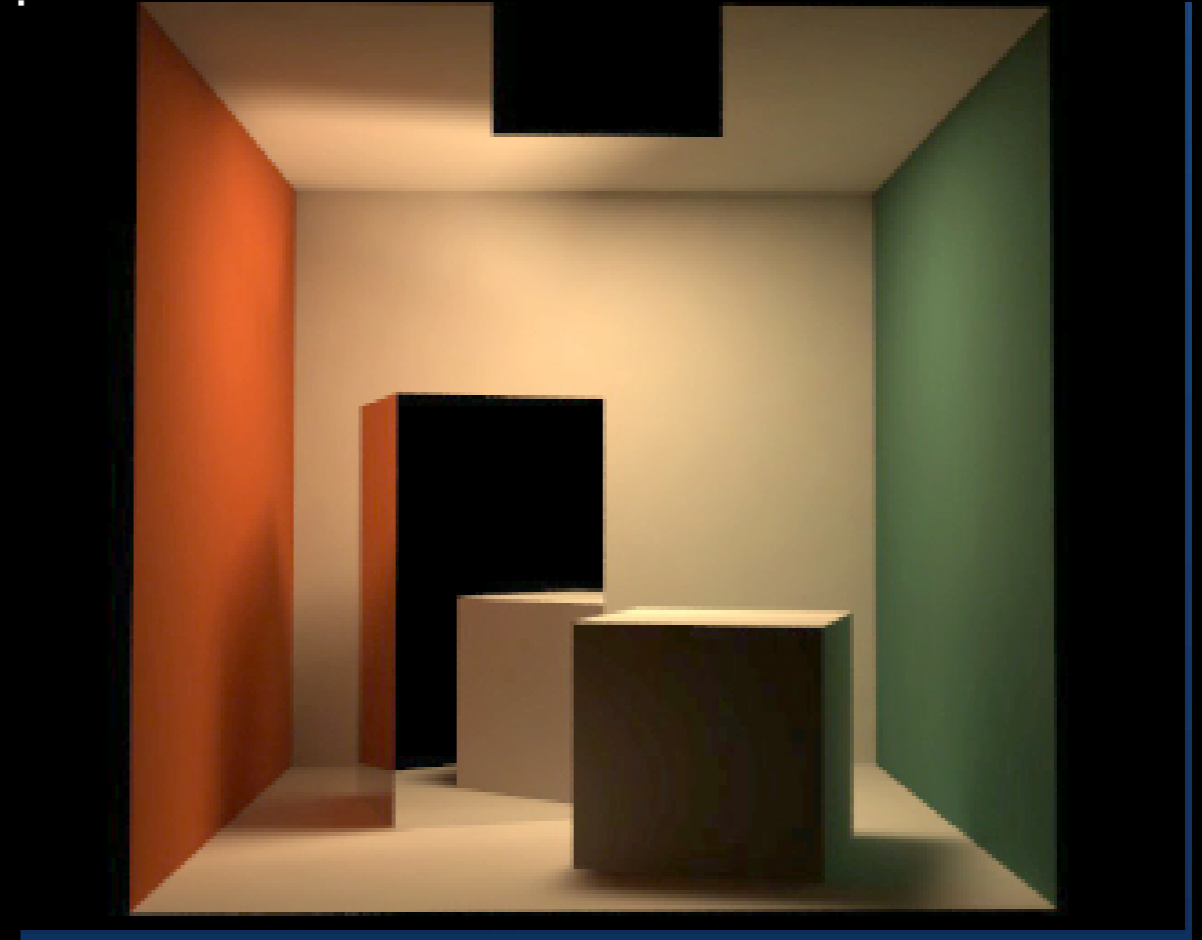
Lighting Simulation

- The Rendering Equation
 - Given a scene consisting of geometric primitives with material properties and a set of light sources, compute the illumination at each point on each surface
- Challenges
 - Primitives complex: lights, materials, shapes
 - Exponential number of paths, dense coupling
- How to solve it?
 - Radiosity: Finite element
 - Ray tracing: Monte Carlo

Radiosity: Cornell Experiment



Measured

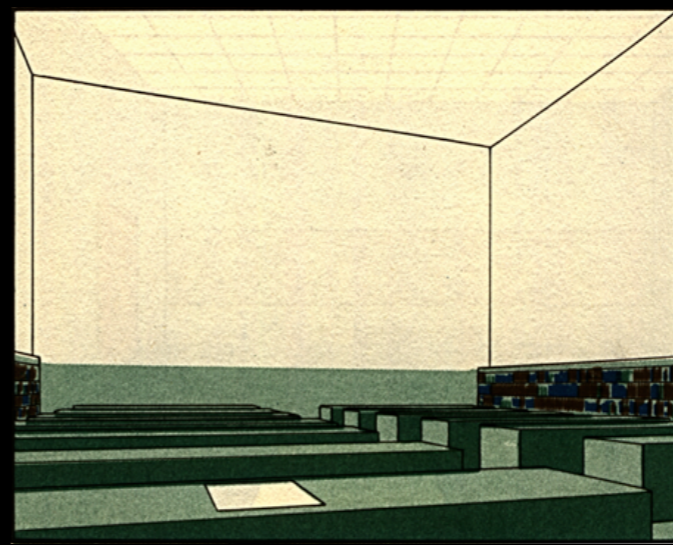
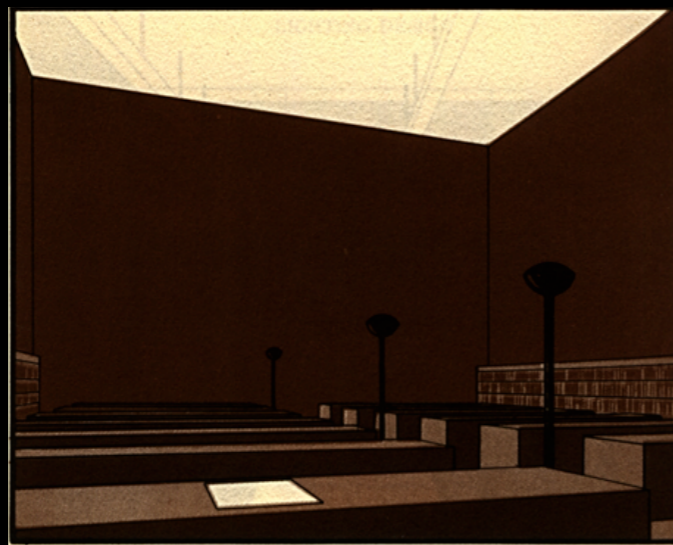
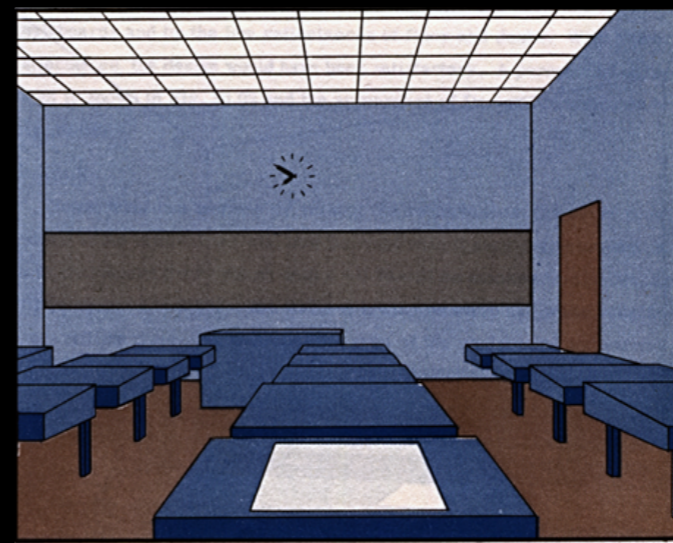
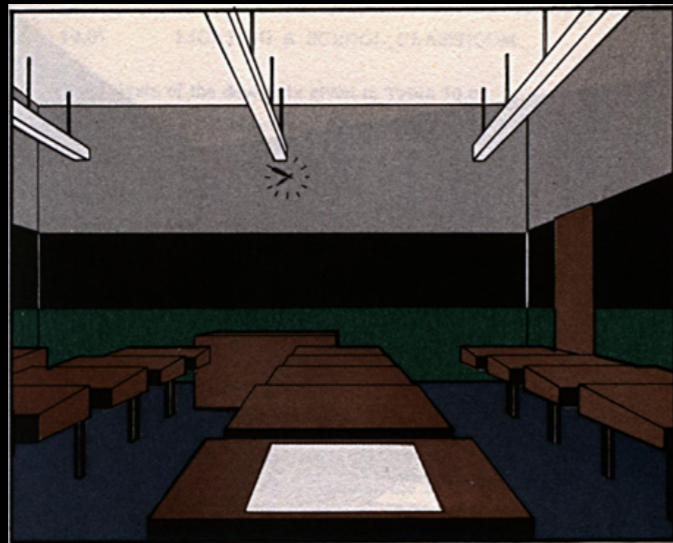


Simulated

Early Radiosity



Early, Early Radiosity



Parry Moon and Domina Spencer (MIT), Lighting Design, 1948

Early Diffuse+Glossy



Tribute to Vermeer
Program of Computer Graphics, Cornell

Steel Mill



Camera Simulation

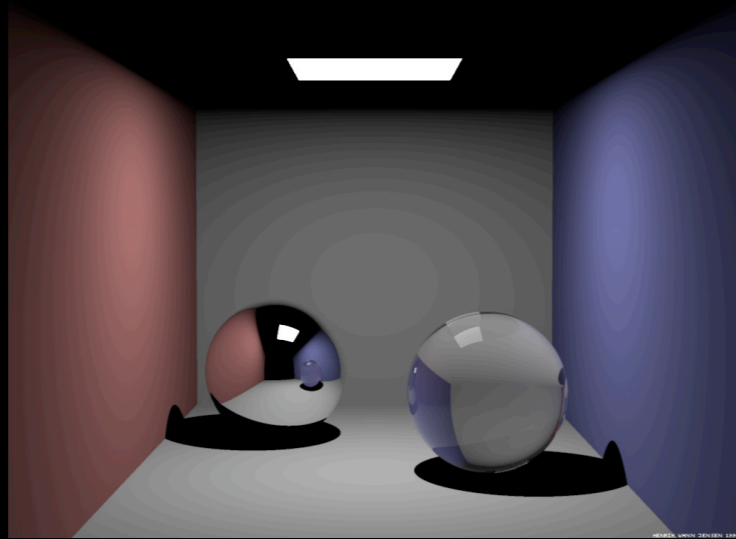


Difficult Light Paths

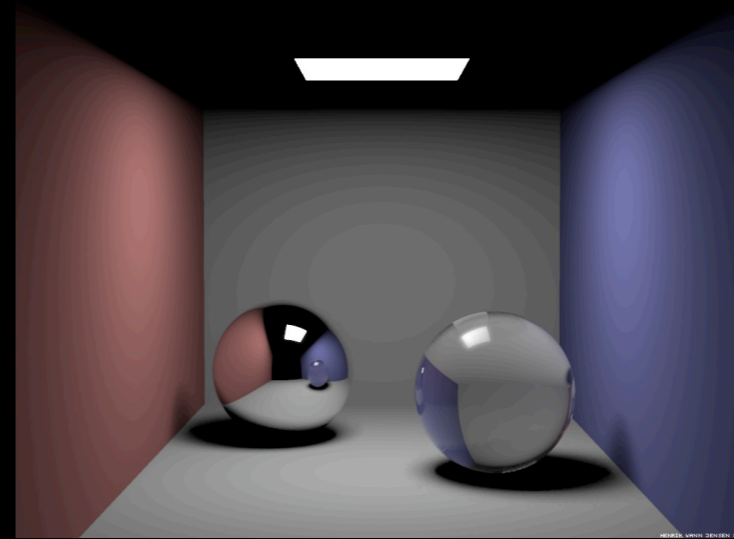


Eric Veach

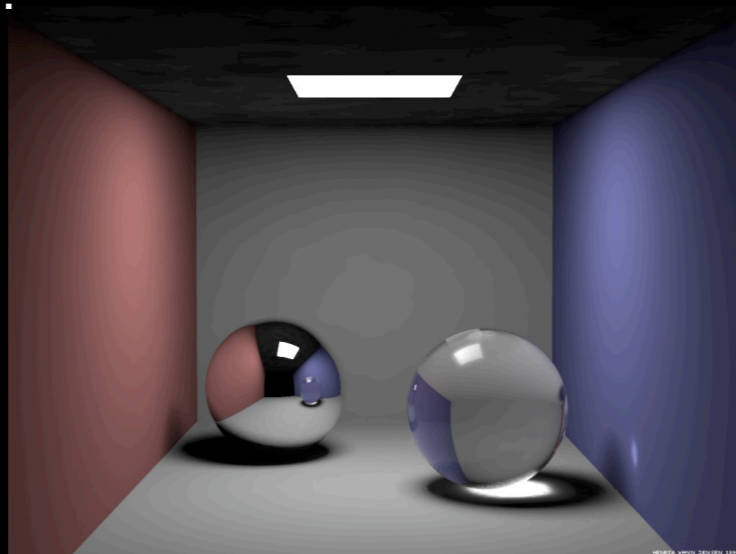
Lighting Effects



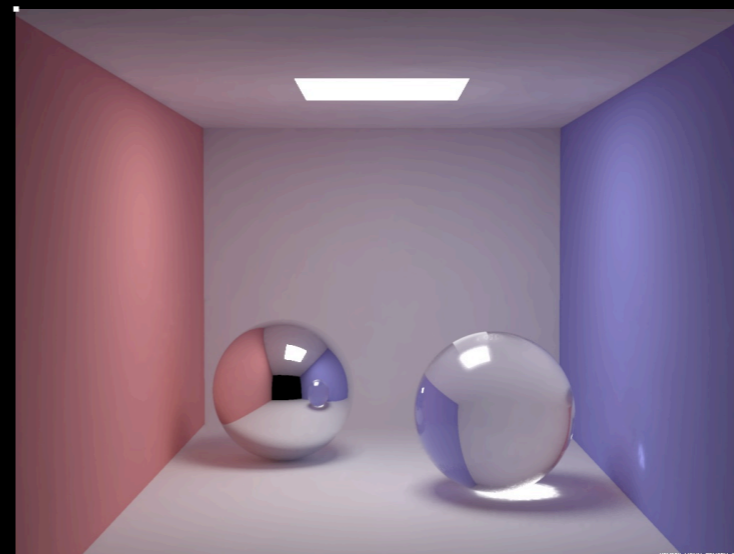
Hard Shadows



Soft Shadows



Caustics



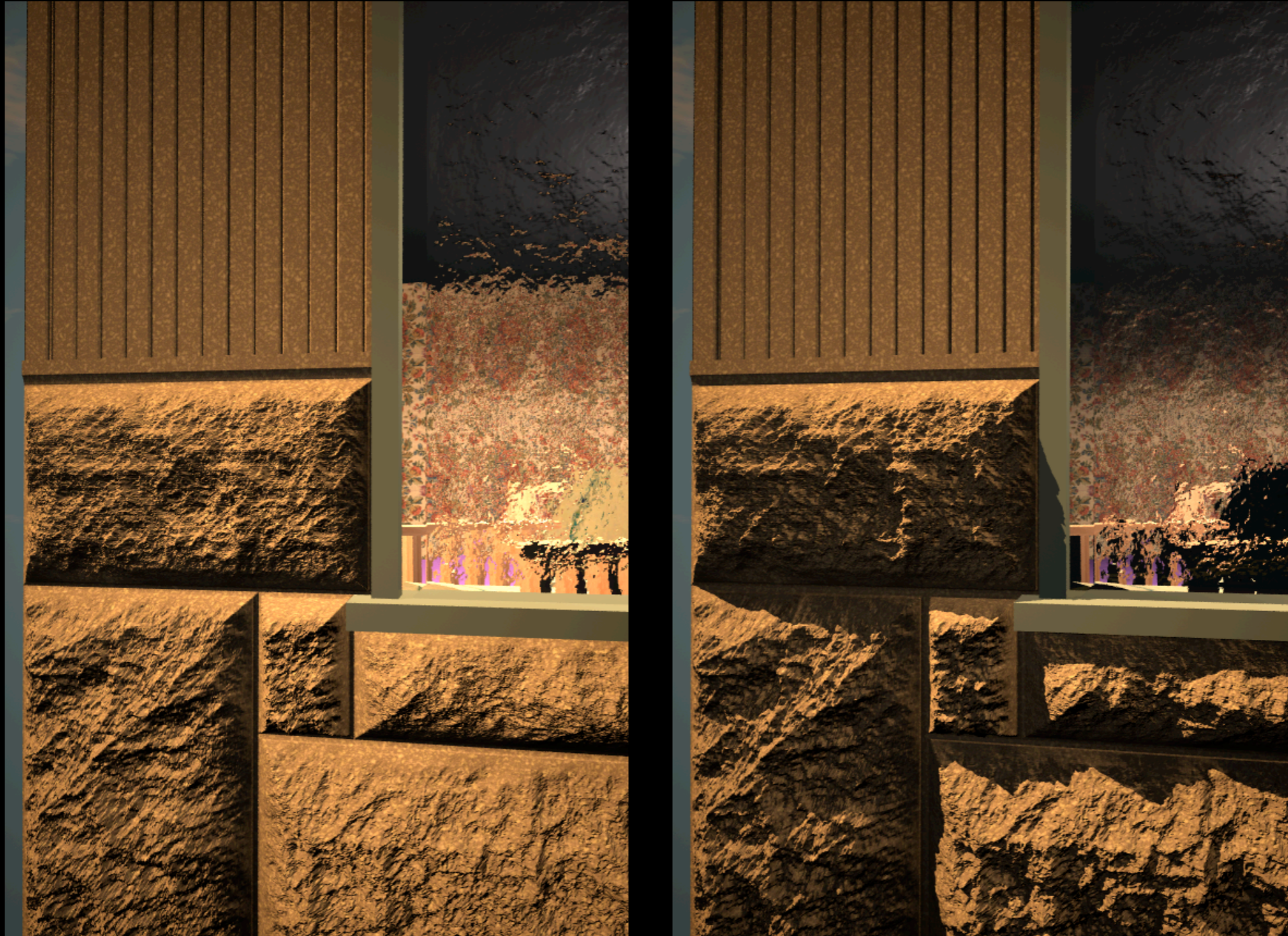
Indirect Illumination

Complex Indirect Illumination



Modeling: Stephen Duck; Rendering: Henrik Wann Jensen

Shadows on Rough Surfaces



Translucency



Surface Reflection



Subsurface Reflection

Water Flows on the Venus



Virtual Actors: Faces



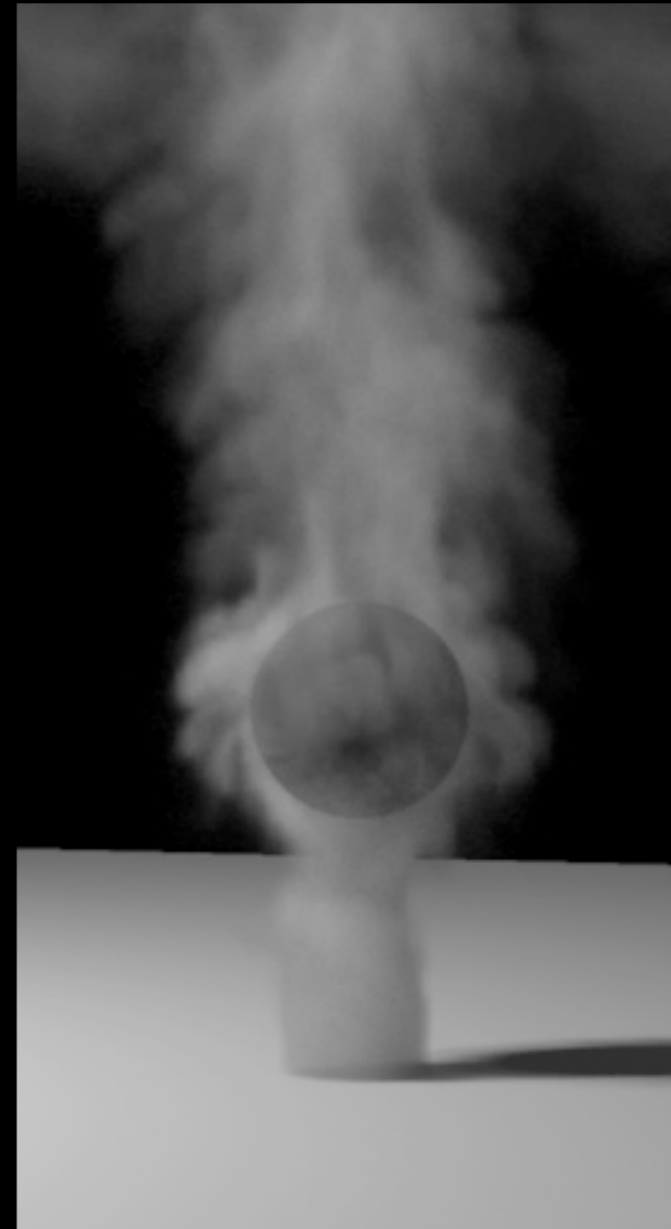
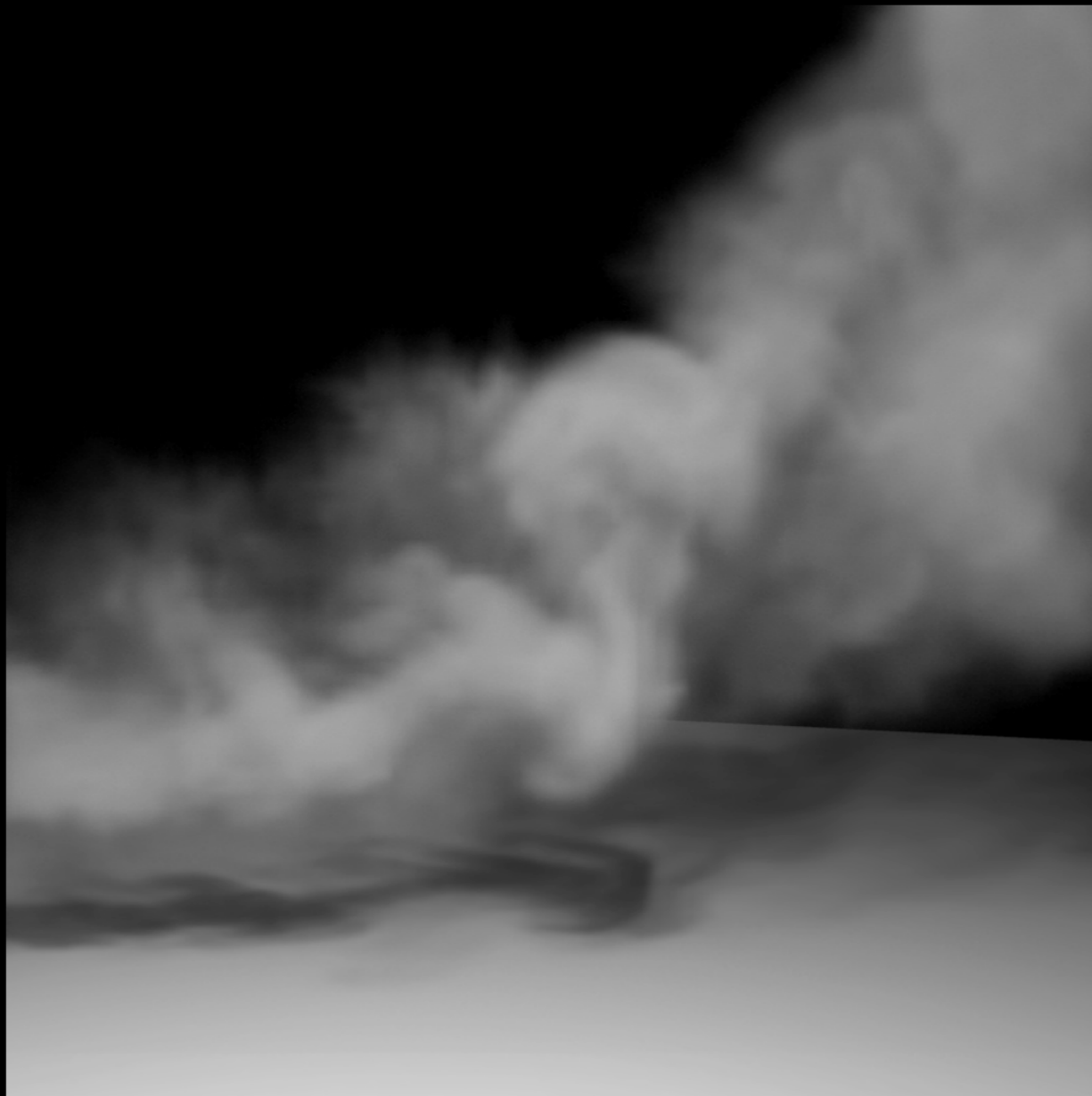
Square USA
The digital heroine of the Final Fantasy film.

Final Fantasy
SquareUSA



Jensen, Marschner, Levoy, Hanrahan

Coupling Modeling & Rendering



Fedkiw, Stam, Jensen 2001

Plant Ecosystems



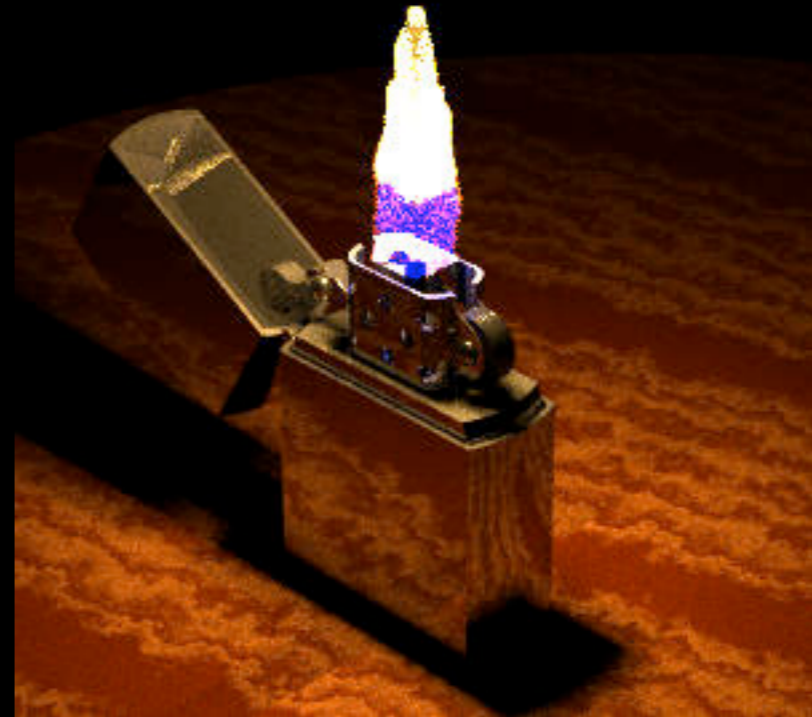
Past Final Projects

Orchid



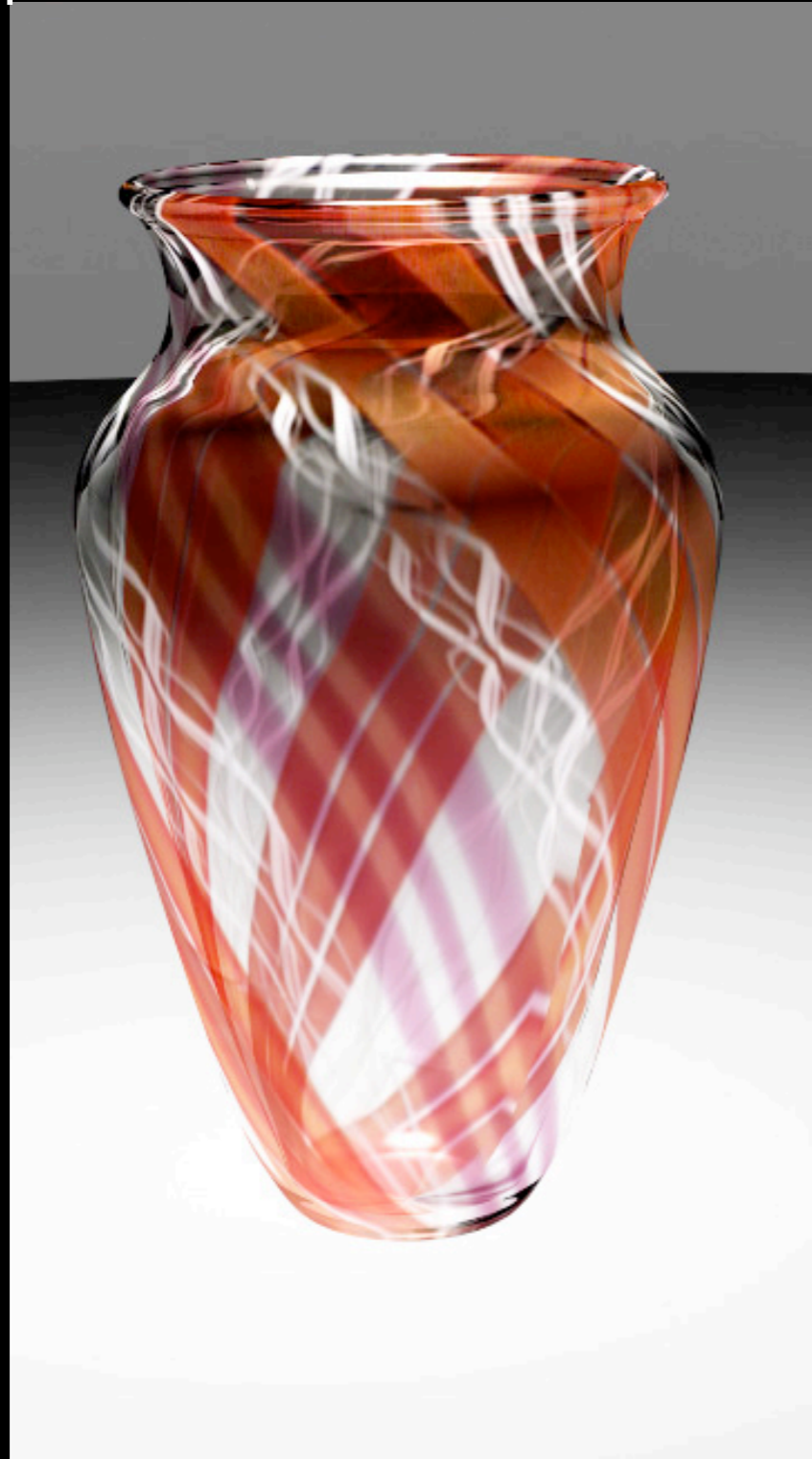
Menelaos Levas

Zippo Lighter



Greg Hutchins and Yu Ping Hu

Glass Vase



by Georg Petschnigg and
Inam Ur-Rahman Malik

Glass Vase



by Georg Petschnigg and Inam Ur-Rahman Malik

Digital Sculpture



by Robert Bridson

Igloo



by Farhan Zaidi and Irfan Zaidi

Grand Central



by Pradyumna Siddhartha and Erick Armbrust

Packard



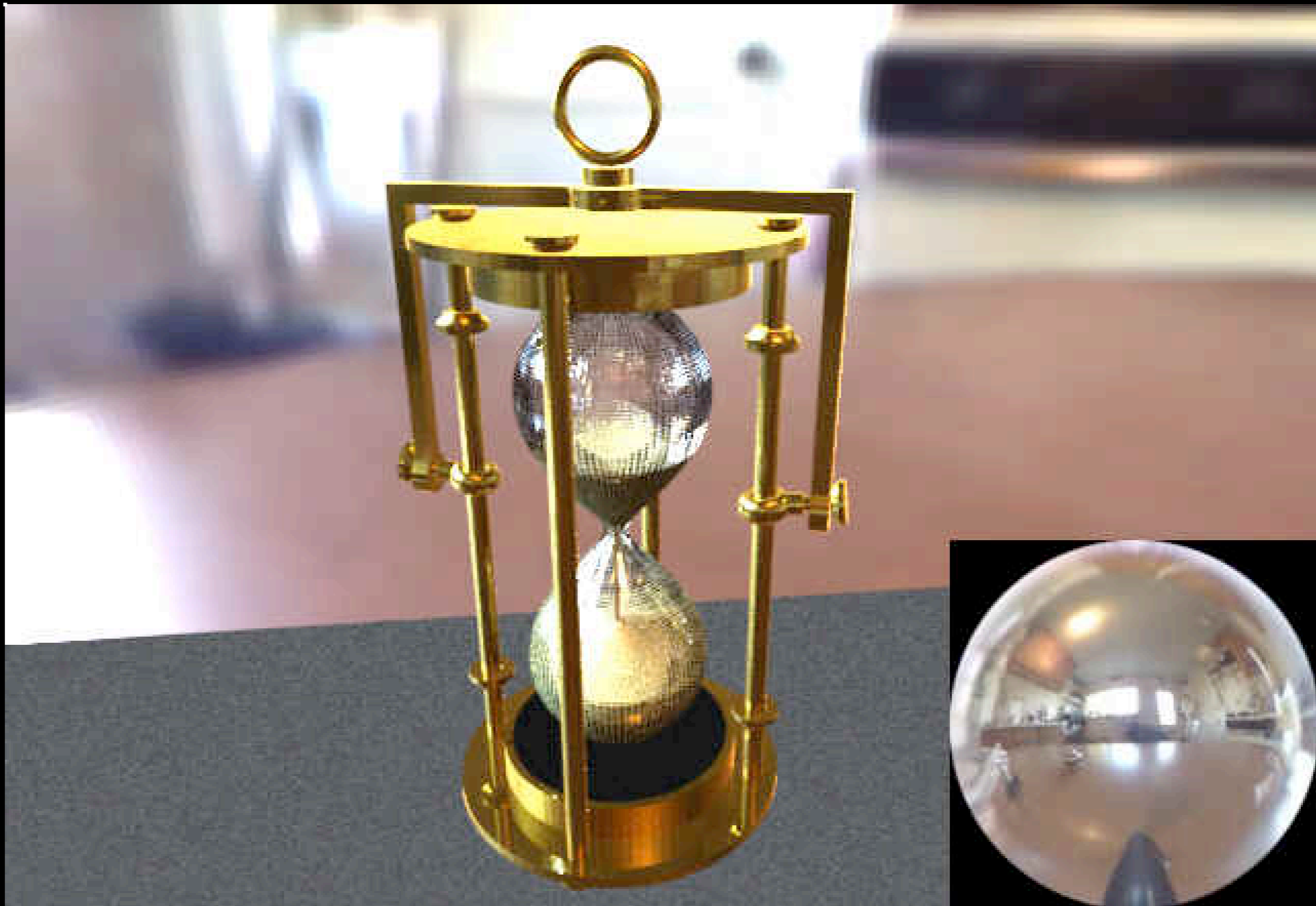
by Mike Houston and
Jonathan Ragan-Kelley

Martinis



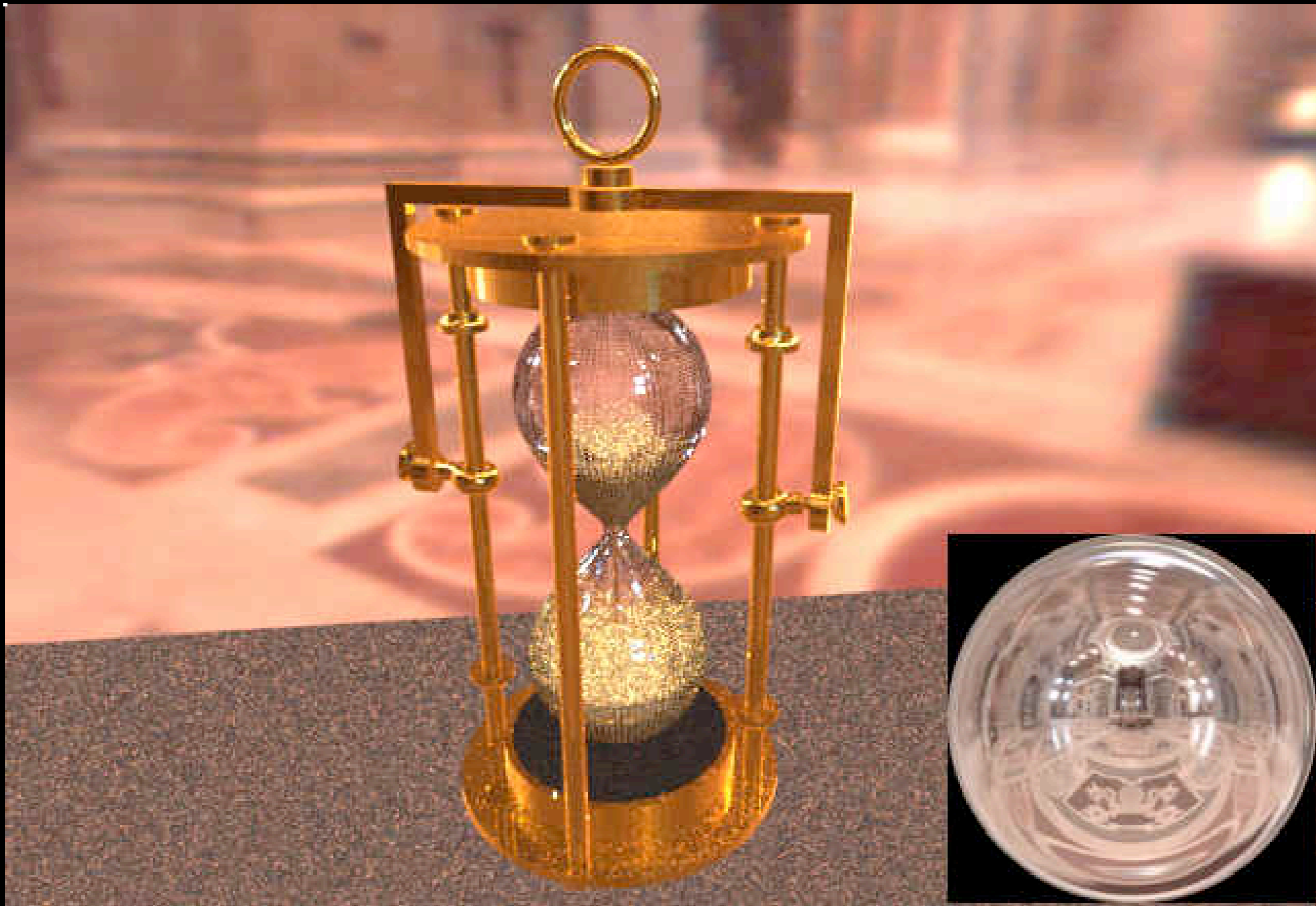
by Khai Weyn Ong

Hourglass



by Brad Johanson and Jeremy Johnson

Hourglass



Iridescence

by Steve Bennett and Arthur Amezcua

Class Details

- <http://cs348b.stanford.edu>
- T,Th, 9:30-10:45, here
 - Readings for each class meeting
- Lecturer: Matt Pharr
- TA: Ian Buck

Class Details

- Prereqs: cs248b, cs348a
 - Calculus, probability, signal processing
- 3 problem sets + final project
 - No exams
- Texts
 - Matt Pharr and Greg Humphreys, *Physically Based Image Synthesis: Design and Implementation of a Rendering System*
 - Andrew Glassner, *An Introduction to Ray Tracing*

To Do

- Send mail to ianbuck@graphics
 - Name and home page
 - e-mail address
 - Est. probability of taking this class
 - Do you want a bound copy of *Physically Based Image Synthesis*? (Approx \$25)
- Readings for Thursday