CSCI 480 Computer Graphics
Lecture 1

Course Overview

Administrative Issues
Modeling
Animation
Rendering
OpenGL Programming
[Angel Ch. 1]

January 14, 2013
Jernej Barbic
University of Southern California

http://www-bcf.usc.edu/~jbarbic/cs480-s13/

Course Information On-Line

http://www-bcf.usc.edu/~jbarbic/cs480-s13/

- – Schedule (slides, readings)
- – Assignments (details, due dates)
- – Software (libraries, hints)
- – Resources (books, tutorials, links)

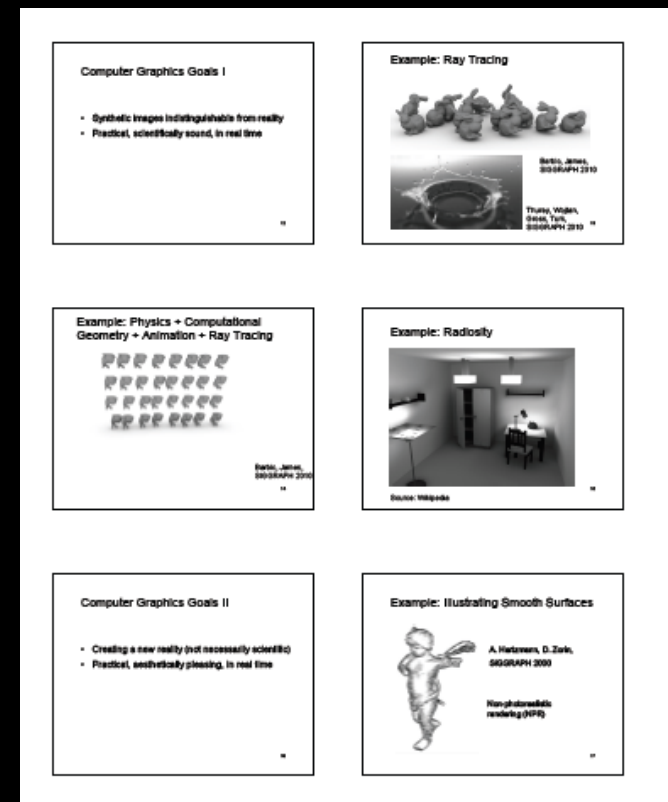## Blackboard:

- – Forum
- – Submit assignments

Course slides

http://www-bcf.usc.edu/~jbarbic/cs480-s13/

- Full-color version

- 6-slides-per-page B&W version
  -- good for printing

- Posted in advance of lectures
  -- bring to class & annotate

- Color viewing in Acrobat Reader:
  Disable "Replace Document Colors" in
  Preferences.Accessibility (if enabled)

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About me

Assistant professor in CS

Post-doc at MIT

PhD, Carnegie Mellon University

jnb@usc.edu

Mon 3:35-5:00, SAL 230

Background:
BSc Mathematics
PhD Computer Science

Research interests:
graphics, animation, real-time physics, control, sound, haptics

Prerequisites

- CSCI 102 Data Structures

- Familiarity with calculus and linear algebra

- C/C++ programming skills

- See me if you are missing any and
  we haven't discussed it

Textbooks

- **Interactive Computer Graphics**
  A top-down approach with OpenGL, Fifth Edition
  Edward Angel, Addison-Wesley

- **OpenGL Programming Guide ("Red Book")**
  Basic version also available on-line (see Resources)

Grading

- 51% Programming Assignments (3x 17%)

- 19% Midterm (one sheet of notes only, in class)

- 30% Final (open book)

Academic integrity

- No collaboration!

- Do not copy any parts of any of the assignments from anyone

- Do not look at other students' code, papers, assignments or exams

- USC Office of Student Judicial Affairs and Community Standards will be notified

Assignment Policies

- Programming assignments

  - Hand in via Blackboard by end of due date
  - Functionality and features
  - Style and documentation
  - Artistic impression

- 3 late days, usable any time during semester
- Academic integrity policy applied rigorously

Computer Graphics

One of the "core" computer science disciplines:

Algorithms and Theory
Artificial Intelligence
Computer Architecture
Computer Graphics and Visualization
Computer Security
Computer Systems
Databases
Networks
Programming Languages
Software Engineering

Course Overview

Theory: Computer graphics disciplines:
- Modeling: how to represent objects
- Animation: how to control and represent motion
- Rendering: how to create images of objects
- Image Processing: how to edit images

Practice: OpenGL graphics library

Not in this course:
- Human-computer interaction
- Graphic design
- DirectX API

Computer Graphics Disciplines

Rendering

Source: Jensen
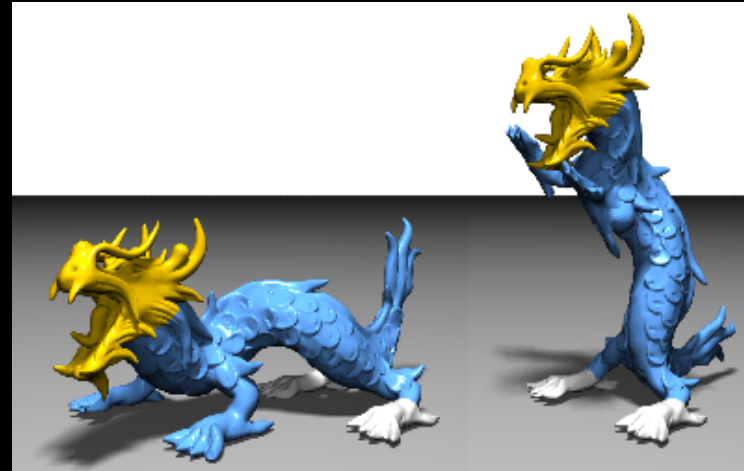
Geometry (Modeling)

Source: Botsch et al.

Animation

Source: Baraff and Witkin

Image Processing

Source: Durand

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Computer Graphics Goals I

- Synthetic images indistinguishable from reality
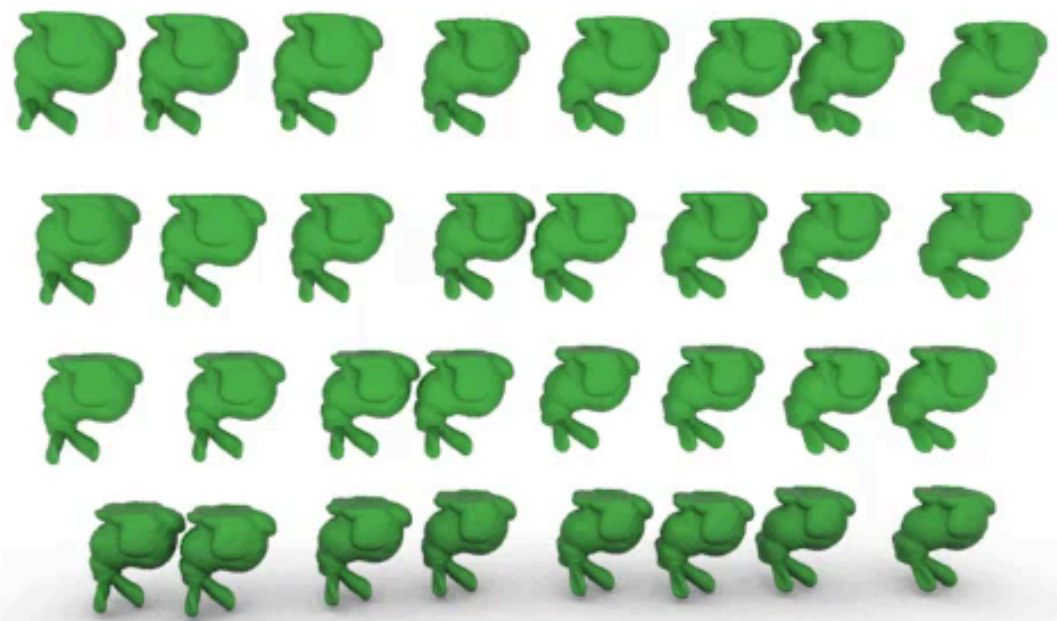
- Practical, scientifically sound, in real time

Example: Ray Tracing
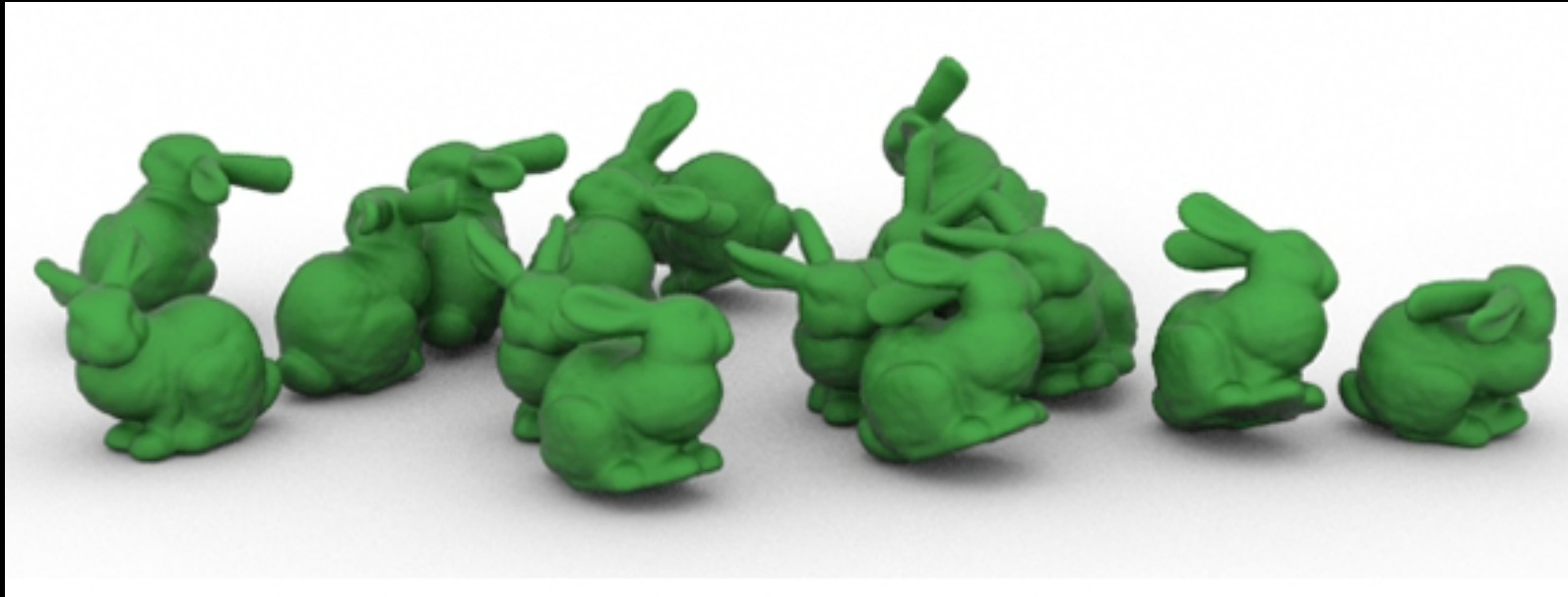
Barbic, James,
SIGGRAPH 2010

Thurey, Wojtan,
Gross, Turk,
SIGGRAPH 2010

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Example: Physics + Computational Geometry + Animation + Ray Tracing

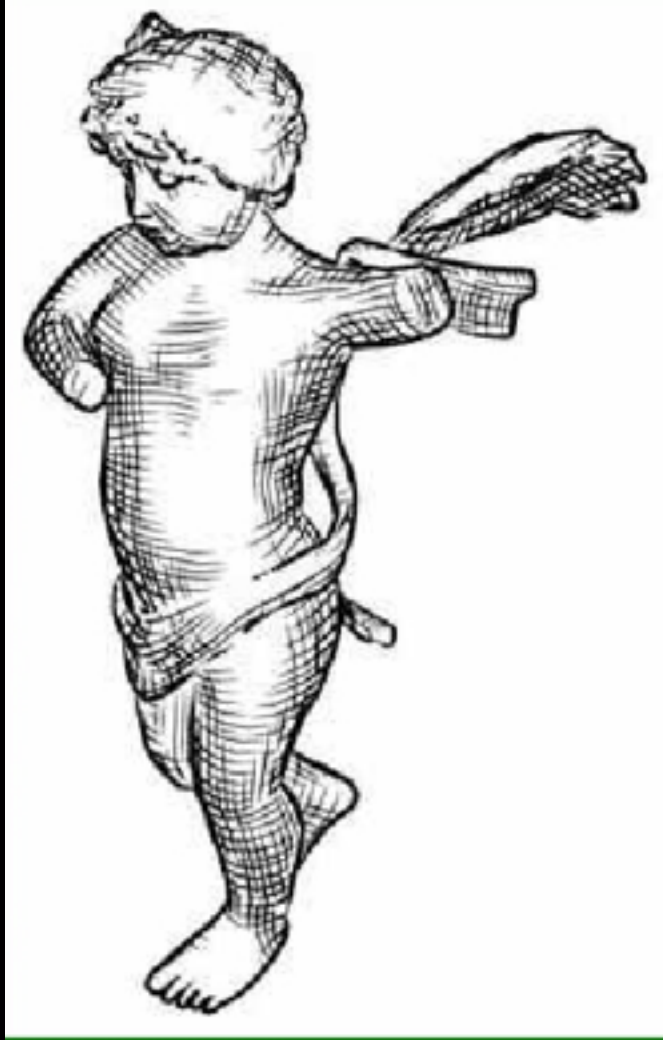Barbic, James, SIGGRAPH 2010

Example: Radiosity

Source: Wikipedia

Computer Graphics Goals II

- Creating a new reality (not necessarily scientific)

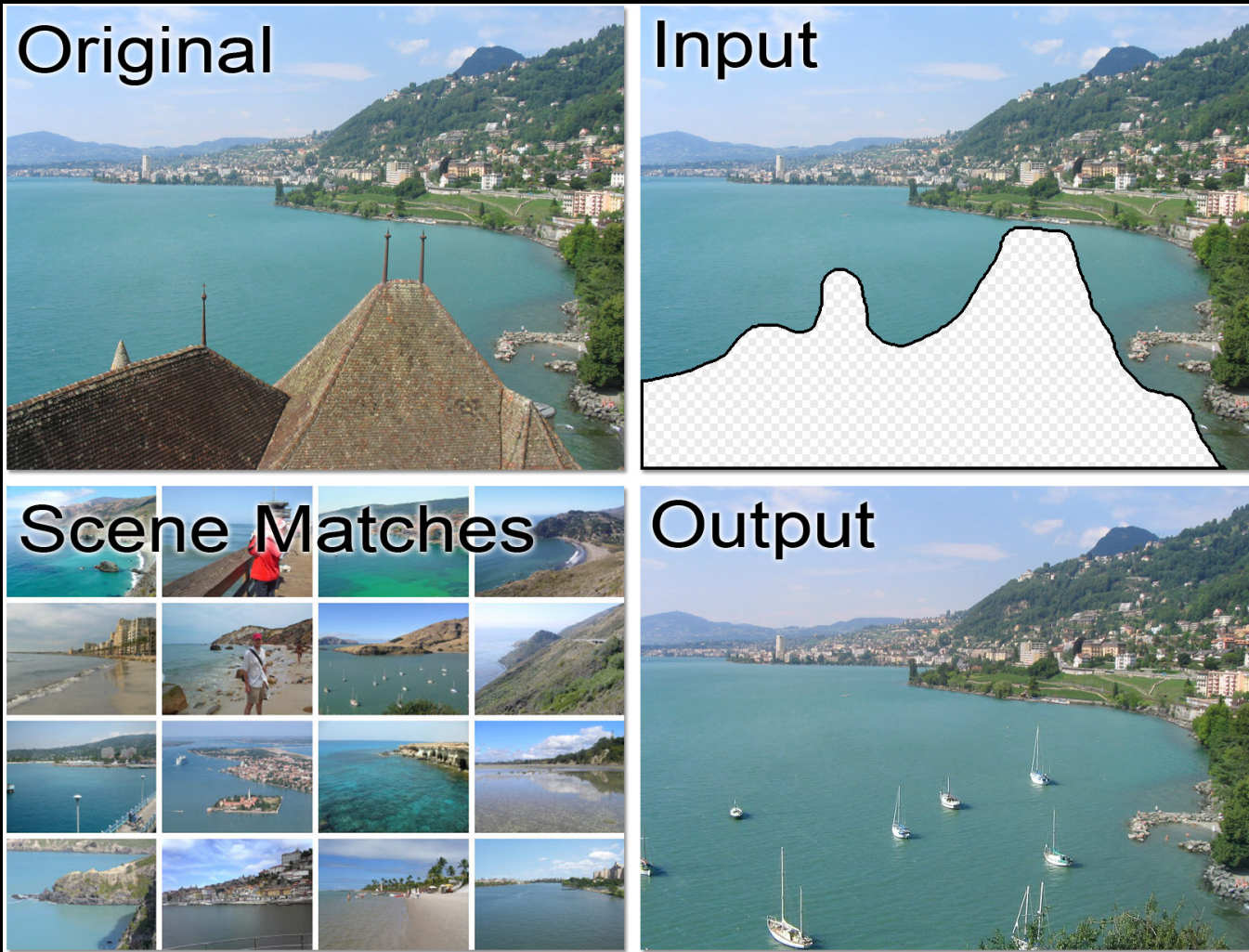- Practical, aesthetically pleasing, in real time

Example: Illustrating Smooth Surfaces

A. Hertzmann, D. Zorin,

SIGGRAPH 2000

Non-photorealistic
rendering (NPR)

Example: Scene Completion

J. Hays, A. Efros,

SIGGRAPH 2007

SIGGRAPH

- Main computer graphics event in the world

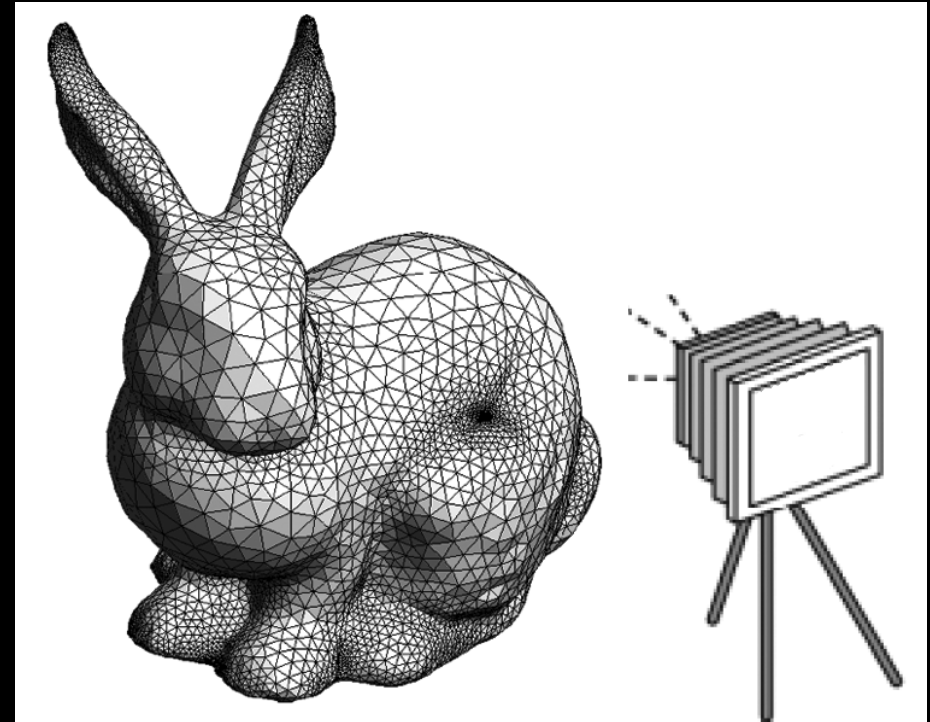- Once per year

- 30,000 attendees

- Academia, industry

1. Course Overview

- Administrative Issues

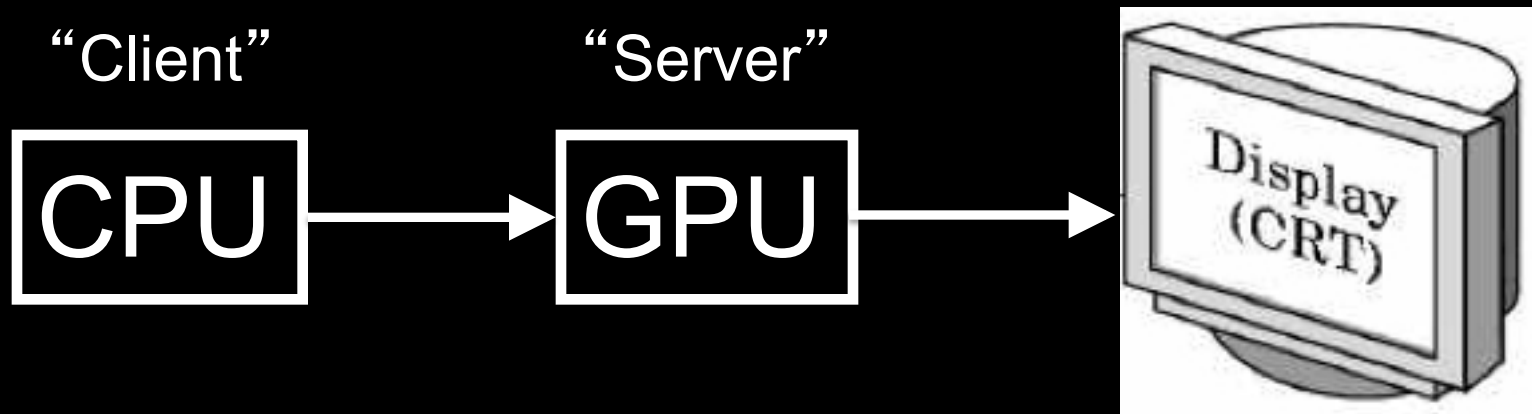- Topics Outline (next)

2. OpenGL Basics

- Primitives and attributes

- Color

- Viewing

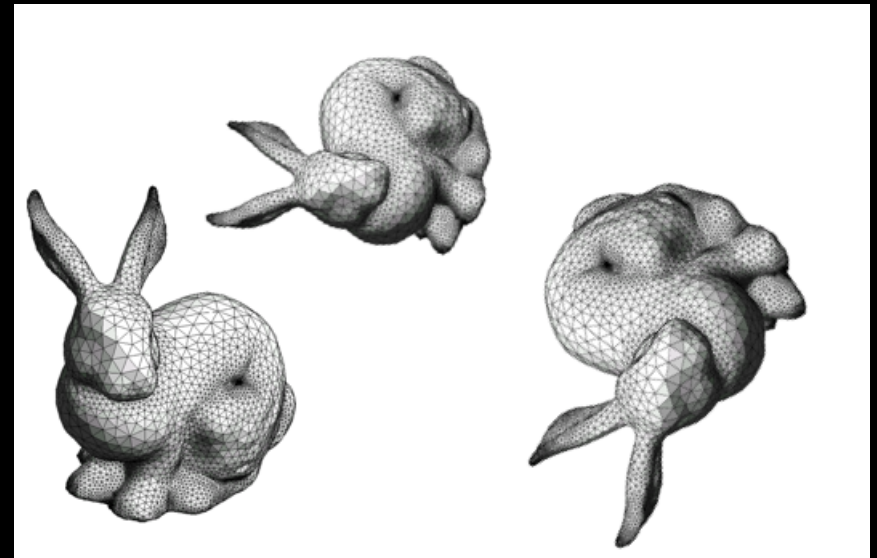- Control functions

- [Angel, Ch. 2]

3. Input and Interaction

- Clients and servers

- Event driven programming

- Text and fonts

- [Angel, Ch. 3]

"Client"   "Server"
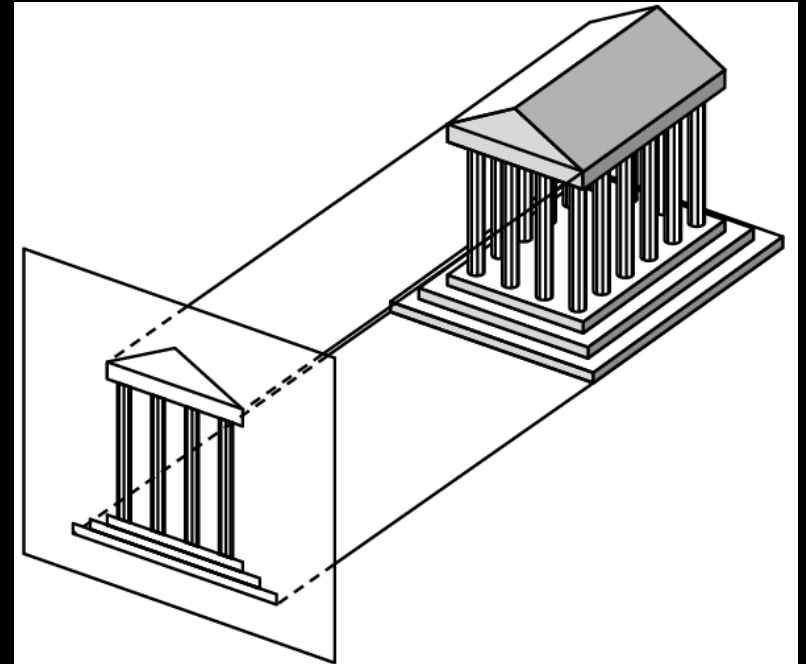
CPU ———→ GPU ———→ Display (CRT)

4. Objects & Transformations

- Linear algebra review

- Coordinate systems and frames

- Rotation, translation, scaling

- Homogeneous coordinates

- OpenGL transformation matrices

- [Angel, Ch. 4]

5. Viewing and Projection

- Orthographic projection

- Perspective projection

- Camera positioning

- Projections in OpenGL

- Hidden surface removal

- [Angel, Ch. 5]

6. Hierarchical Models

- Re-using objects

- Animations

- OpenGL routines

- Parameters and transformations

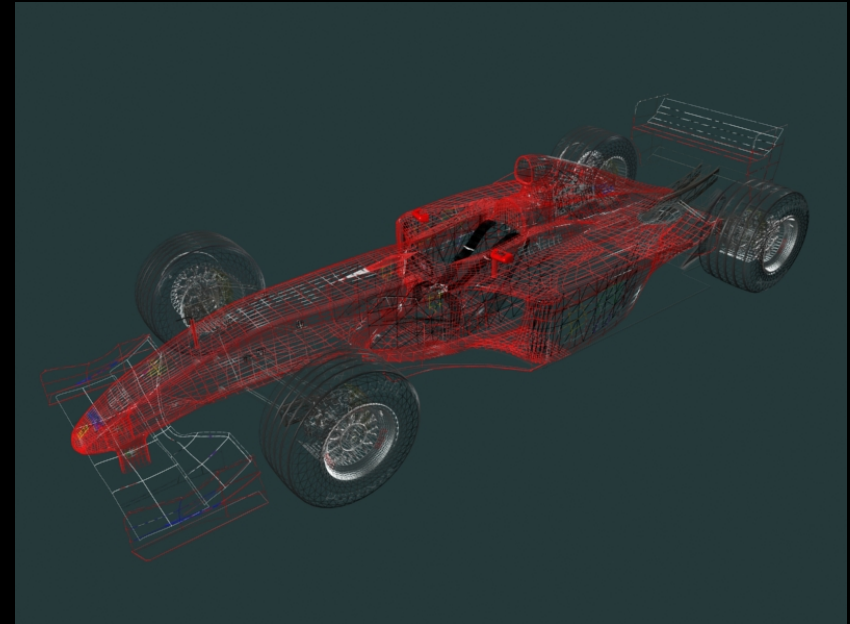- [Angel, Ch. 10]

7. Light and Shading

- Light sources

- Ambient, diffuse, and specular reflection

- Normal vectors

- Material properties in OpenGL

- Radiosity

- [Angel, Ch. 6]

Tobias R. Metoc

8. Curves and Surfaces

- Review of 3D-calculus

- Explicit representations

- Implicit representations

- Parametric curves
  and surfaces

- Hermite curves and surfaces

- Bezier curves and surfaces

- Splines

- Curves and surfaces in OpenGL

- [Angel, Ch. 12]

9. Rendering

- Clipping
- Bounding boxes
- Hidden-surface removal
- Line drawing
- Scan conversion
- Antialiasing
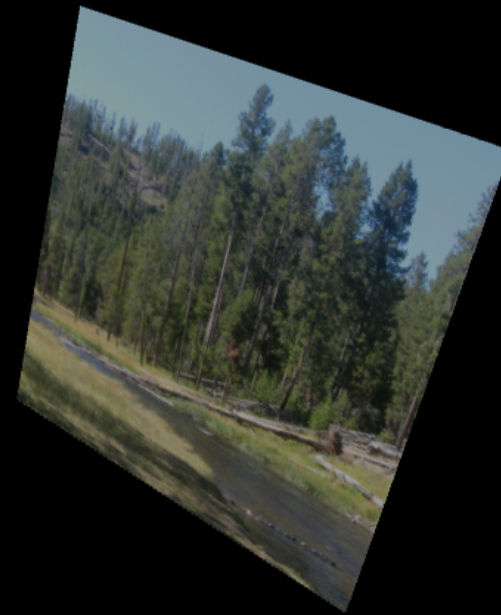- [Angel, Ch. 7,8]
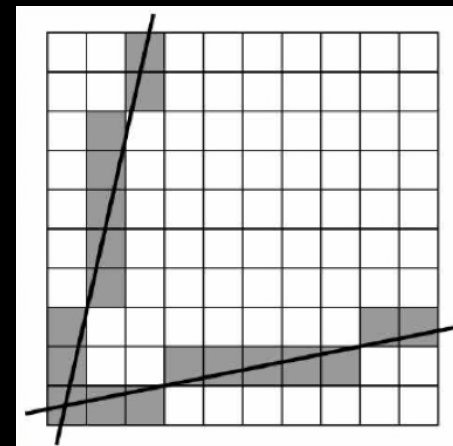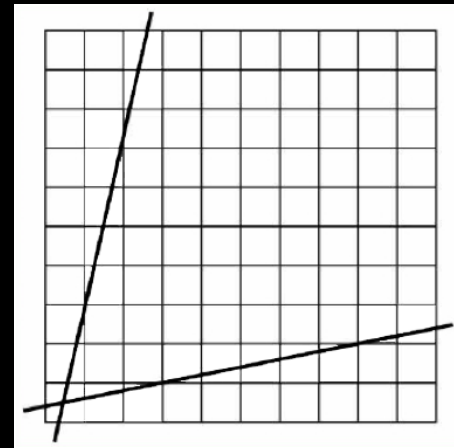
10. Textures and Pixels

- Texture mapping
- OpenGL texture primitives
- Bump maps
- Environment maps

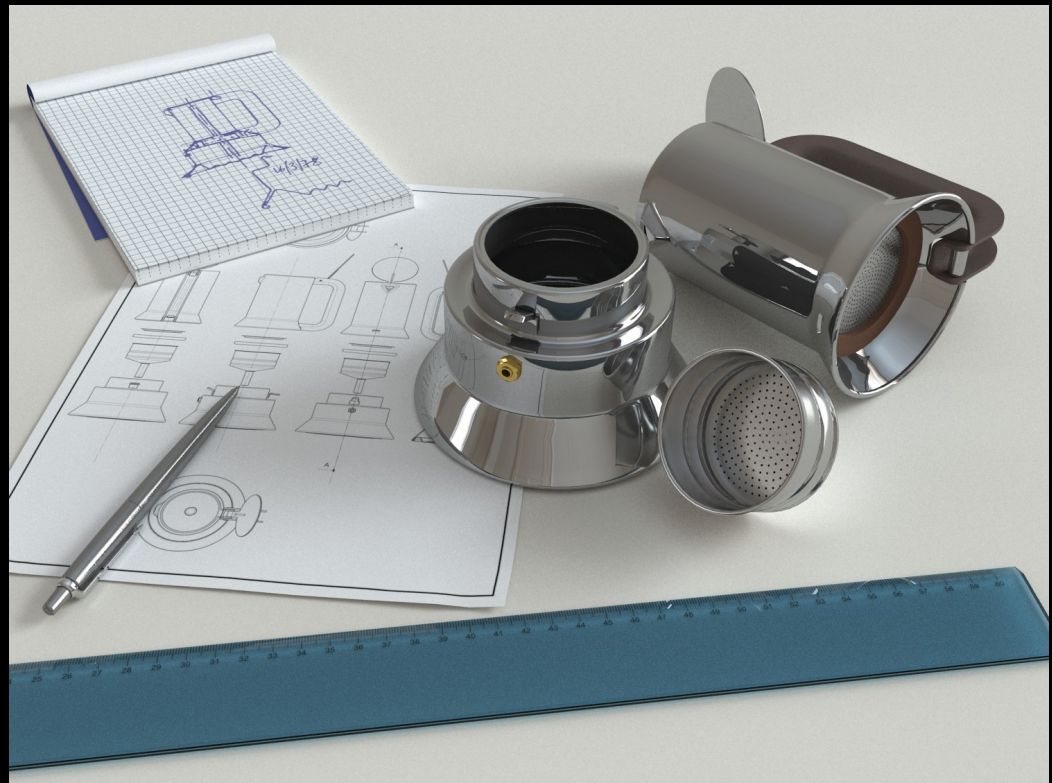- Opacity and blending
- Image filtering
- [Angel, Ch. 8]

texture map

11. Ray Tracing

- Basic ray tracing [Angel, Ch. 13]

- Spatial data structures [Angel, Ch. 10]

- Motion Blur

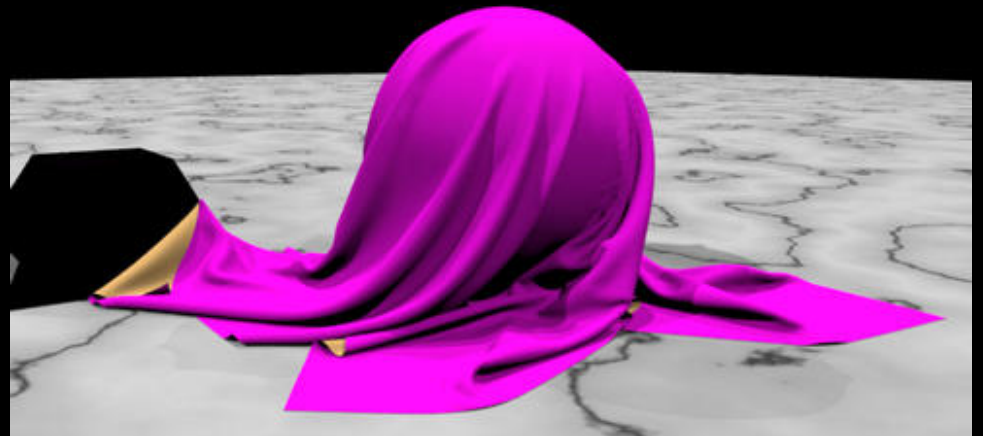- Soft Shadows

12. Radiosity

- Local vs global illumination model

- Interreflection between surfaces

- Radiosity equation

- Solution methods
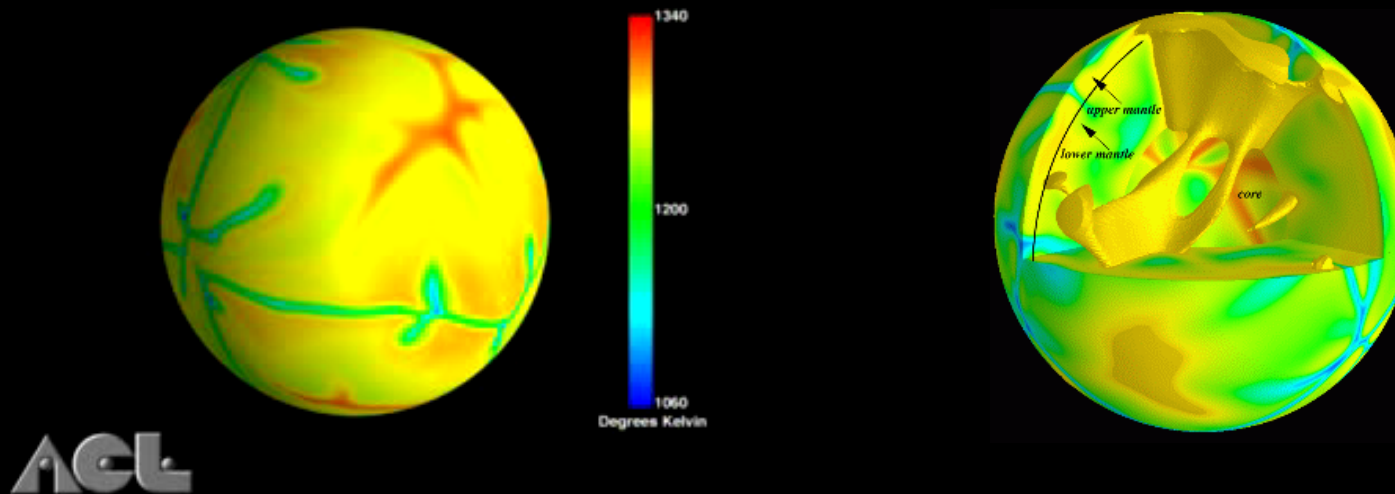
- [Angel Ch. 13.4-5]

Cornell University

13. Physically Based Models

- Particle systems

- Spring forces

- Cloth

- Collisions

- Constraints

- Fractals

- [Angel, Ch. 11]

14. Scientific Visualization

- Height fields and contours

- Isosurfaces

- Volume rendering

- Texture mapping of volumes

Earth Mantle Heat Convection
University of Utah

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Guest Lecture:

TBA

"Wildcard" Lectures:

- Graphics hardware
- More on animation
- Motion capture
- Virtual reality and interaction
- Special effects in movies
- Video game programming
- Non-photo-realistic rendering

Hot Application Areas

- Special effects

- Feature animation

- PC graphics boards

- Video games

- Visualization (science, architecture, space)

Hot Research Topics

- Modeling
  - getting models from the real world
  - multi-resolution
- Animation
  - physically based simulation
  - motion capture
- Rendering:
  - more realistic: image-based modeling
  - less realistic: impressionist, pen & ink

Acknowledgments

- Jessica Hodgins (CMU)

- Frank Pfenning (CMU)

- Paul Heckbert (Nvidia)