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:

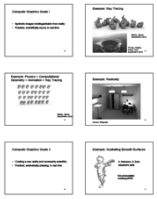
- Forum
- Submit assignments



## 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)





## About me

Assistant professor in CS

Post-doc at MIT

PhD, Carnegie Mellon University

jnb@usc.edu

Mon 3:35-5:00, SAL 230



## About the teacher

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)

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## Grading

- 51% Programming Assignments (3x 17%)
- 19% Midterm (one sheet of notes only, in class)
- 30% Final (open book)

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## 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

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## 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

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## 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

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## 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

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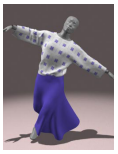
## Computer Graphics Disciplines

Source: Jensen

Rendering

Source: Botsch et al.

Geometry (Modeling)



Source: Baraff and Witkin

Animation

Source: Durand

Image Processing

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## Computer Graphics Goals I

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

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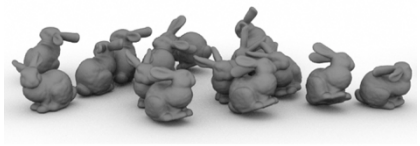
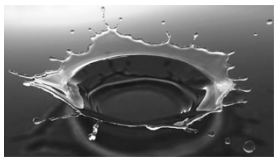
## Example: Ray Tracing





Barbic, James, SIGGRAPH 2010

Thurey, Wojtan, Gross, Turk, SIGGRAPH 2010

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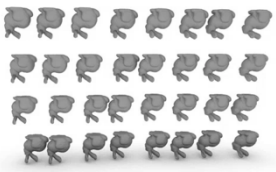
## Example: Physics + Computational Geometry + Animation + Ray Tracing



Barbic, James, SIGGRAPH 2010

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## Example: Radiosity

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Source: Wikipedia

## Computer Graphics Goals II

- Creating a new reality (not necessarily scientific)
- Practical, aesthetically pleasing, in real time

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## Example: Illustrating Smooth Surfaces

A. Hertzmann, D. Zorin, SIGGRAPH 2000

Non-photorealistic rendering (NPR)

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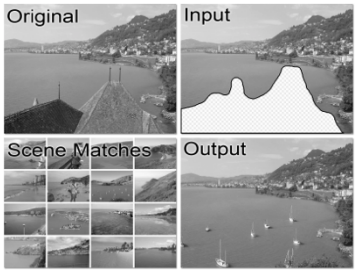
## Example: Scene Completion




J. Hays, A. Efros, SIGGRAPH 2007

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## SIGGRAPH

ACMSIGGRAPH

- Main computer graphics event in the world
- Once per year
- 30,000 attendees
- Academia, industry

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## 1. Course Overview

- Administrative Issues
- Topics Outline (next)

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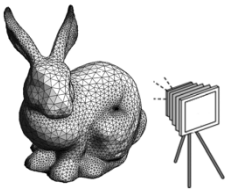
## 2. OpenGL Basics

- Primitives and attributes
- Color
- Viewing
- Control functions
- [Angel, Ch. 2]



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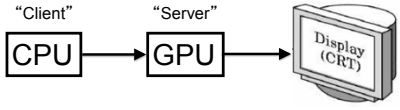
## 3. Input and Interaction

- Clients and servers
- Event driven programming
- Text and fonts
- [Angel, Ch. 3]

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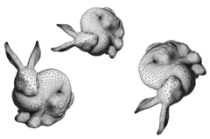
## 4. Objects & Transformations

- Linear algebra review
- Coordinate systems and frames
- Rotation, translation, scaling
- Homogeneous coordinates
- OpenGL transformation matrices
- [Angel, Ch. 4]



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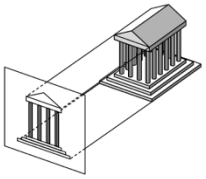
## 5. Viewing and Projection

- Orthographic projection
- Perspective projection
- Camera positioning
- Projections in OpenGL
- Hidden surface removal
- [Angel, Ch. 5]



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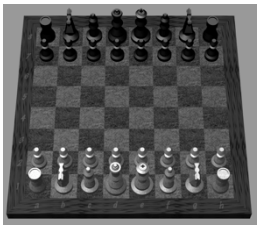
## 6. Hierarchical Models

- Re-using objects
- Animations
- OpenGL routines
- Parameters and transformations
- [Angel, Ch. 10]



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## 7. Light and Shading

- Light sources
- Ambient, diffuse, and specular reflection
- Normal vectors
- Material properties in OpenGL
- Radiosity
- [Angel, Ch. 6]

Tobias R. Metoc

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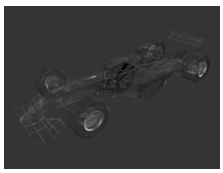
## 8. Curves and Surfaces

- 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]



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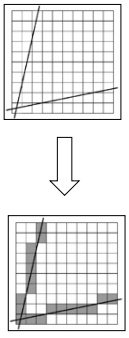
## 9. Rendering

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



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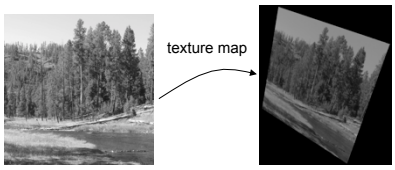
## 10. Textures and Pixels

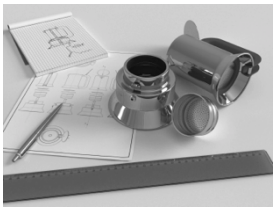
- Texture mapping
- OpenGL texture primitives
- Bump maps
- Environment maps
- Opacity and blending
- Image filtering
- [Angel, Ch. 8]






## 11. Ray Tracing

- Basic ray tracing [Angel, Ch. 13]
- Spatial data structures [Angel, Ch. 10]
- Motion Blur
- Soft Shadows



www.yafaray.org

## 12. Radiosity

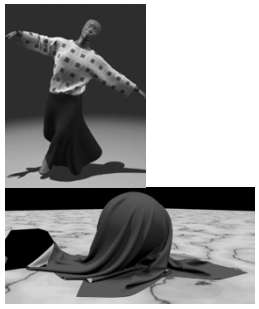
- Local vs global illumination model
- Interreflection between surfaces
- Radiosity equation
- Solution methods
- [Angel Ch. 13.4-5]

Cornell University



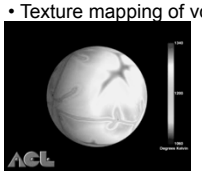
## 13. Physically Based Models

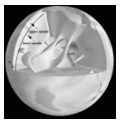
- Particle systems
- Spring forces
- Cloth
- Collisions
- Constraints
- Fractals
- [Angel, Ch. 11]



## 14. Scientific Visualization

- Height fields and contours
- Isosurfaces
- Volume rendering
- Texture mapping of volumes





Earth Mantle Heat Convection
University of Utah



## 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)

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## 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

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## Acknowledgments


- Jessica Hodgins (CMU)
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