Introduction to Computer Graphics  
SIGGRAPH 2002

Syllabus

Course Organizer

Michael Bailey  
San Diego Supercomputer Center  
University of California San Diego

Course Speakers

Andrew Glassner  
Coyote Wind Studios

Computer graphics is an exciting field of endeavor, but it is often difficult for a newcomer to get started. This course is that opportunity. The topics being presented will address many areas within computer graphics and treat each from the point of view of “why-do-I-care” and “how-to.” Those who take this course will emerge well-prepared to take on further study, including the taking of other SIGGRAPH courses. Attendees will also be ready to take on the vendor show and better appreciate the Electronic Theatre. We hope you enjoy reading and using these notes as much as we enjoyed preparing them.

If you have specific comments about how we can improve the course or the notes, please send them to me at: mjb@sdsc.edu

– Mike Bailey

Take them, use them, bring them to the masses.  
Shake them, lose them, sing them to your classes.  
Tiles of tides, piles of slides.  
Piles of slides that no-one derides.  
Slides of knowledge, slides of power – slides that last a half an hour.  
Take a slide and project it wide.  
Project it far and make it tall, a slide's a slide that's seen by all.  
SIGGRAPH slides go into holders, printed pages go into folders.  
We teach.  We teach in courses.  We teach whatever the market enforces.  
You want pixels?  You want rays?  
We'll lead you through the graphics maze.

– Andrew Glassner
SIGGRAPH ‘02
Introduction to Computer Graphics
About the Speakers

Michael J. Bailey

Mike Bailey is a researcher at the San Diego Supercomputer Center and an adjunct professor in the Computer Science and Mechanical Engineering departments at the University of California at San Diego. Mike received his Ph.D. from Purdue University. He has also worked at Sandia National Laboratories, Purdue University, Megatek, SDSC, and UCSD. Mike’s areas of interest include scientific visualization, computer aided design, and solid freeform fabrication. He has authored numerous papers on the use of computer graphics in engineering and science. Mike founded the interdisciplinary Design Visualization Lab at SDSC/UCSD, which includes the Center for Visualization Prototypes which applies solid freeform fabrication methods to visualization problems. Mike was SIGGRAPH conference co-chair in 1991 and chaired the IEE Visualization conference in 2001. Mike has also served as SIGGRAPH Courses Chair in 1984, 1985, 1987, 1988, and 1994. Mike has two young children, so has no free time to talk about.

Andrew Glassner

Dr. Andrew Glassner is an independent writer and consultant. He has worked at the NYIT Computer Graphics Lab, Case Western Reserve University, the IBM TJ Watson Research Lab, the Delft University of Technology, Bell Communications Research, Xerox PARC, and Microsoft Research. He has published numerous technical papers on topics ranging from digital sound to new rendering techniques. His book *3D Computer Graphics: A Handbook for Artists and Designers* has taught a generation of artists. Glassner created and edited the *Graphics Gems* book series and the book *An Introduction to Ray Tracing*. His most recent text is *Principles of Digital Image Synthesis*, a two-volume treatise on rendering theory and practice published by Morgan-Kaufmann. Andrew served SIGGRAPH ’94 as Chair of the Papers Committee, and creator of the Sketches venue. He has also served as Founding Editor of the *Journal of Graphics Tools*, and Editor-in-Chief of *ACM Transactions on Graphics*. In his free time Andrew plays jazz piano, draws, and writes fiction. He holds a Ph.D. in Computer Science from the University of North Carolina at Chapel Hill.
SIGGRAPH 2002
Introduction to Computer Graphics

Mike Bailey (M)
Andrew Glassner (A)

Course Schedule

8:30 - 9:00 Welcome ................................................................. M
Overview of the Course
Overview of the Graphics Process
Some graphics to look at

9:00 – 10:00 Modeling ................................................................. A

10:00 – 10:15 Morning Break

10:15 – 11:15 Rendering ............................................................ A
11:15 – 12:00 Graphics display hardware ................................. M

12:00 – 1:30 Lunch

1:30 – 2:30 Animation ............................................................... A
2:30 – 3:00 Scientific Visualization ................................. M

3:00 – 3:15 Afternoon Break

3:15 – 3:45 More Scientific Visualization ................................. M
3:45 – 4:00 Graphics on the World Wide Web ......................... M
4:00 – 4:15 How to attend a SIGGRAPH ................................. M
4:15 – 4:30 Finding additional information .............................. M
4:30 – 5:00 Questions and general discussion ........................ A & M
SIGGRAPH 2002
Introduction to Computer Graphics

Course Note Table of Contents

0. Syllabus
   A. Introduction
   B. Overview of the Graphics Process
   C. 3D Object Modeling
   D. Rendering
   E. Graphics Display Hardware
   F. Animation
   G. Computer Graphics in Scientific Visualization
   H. Graphics on the World Wide Web
   I. How to Attend a SIGGRAPH
   J. Finding Additional Information
   K. Bonus Section: Geometry for Computer Graphics
Introduction to Computer Graphics

SIGGRAPH 2002

Mike Bailey
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Mike Bailey

PhD from Purdue University

Has worked at Sandia Labs, Purdue University, Megatek, San Diego Supercomputer Center, and the University of California at San Diego

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Andrew Glassner

PhD from the University of North Carolina - Chapel Hill

Has worked at IBM, Bell Communications, Delft University, NYIT, Xerox PARC, Microsoft Research, and Coyote Wind Studios

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Course Goals

• Provide a background for papers, panels, and other courses
• Help appreciate the Electronic Theater
• Get more from the vendor exhibits
• Give our take on where the future is
• Provide pointers for further study
Topics

• Overview of the “Graphics Process” (Mike)
• Modeling (Andrew)
• Rendering (Andrew)
• Display Hardware (Mike)

More Topics

• Animation (Andrew)
• Scientific Visualization (Mike)
• Graphics on the Web (Mike)
And, Even More Topics!

- How to Attend SIGGRAPH 2001 (Mike)
- Finding Additional Information (Mike)
- Questions and General Discussion (Andrew & Mike)

The Graphics Process

Mike Bailey
San Diego Supercomputer Center
University of California San Diego

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The Graphics Process

3D Geometric Models

Lighting Information

Rendering

Texture Information

3D Animation Definition

Image Storage and Display

Image Storage and Display
The Graphics Process: Geometric Modeling

3D Scanning
Interactive Geometric Modeling
Model Libraries
Displacement Mapping

3D Geometric Models
Rendering

The Graphics Process: 3D Animation

Motion Design
Motion Computation
Motion Capture
Dynamic Deformations

3D Animation Definition
Rendering
The Graphics Process: Texturing

1. Scanned Images
2. Computed Images
3. Painted Images

Texture Information → Rendering

The Graphics Process: Rendering

1. 3D Geometric Models
2. 3D Animation Definition

Rendering

Transformation, Clipping, Perspective → Image Generation

Texture Information → Image Storage and Display
The Graphics Process:
Image Storage and Display

Hardware Framebuffer

Disk File

Film Recorder

Video Recorder

Rendering

The Graphics Process: Summary

3D Geometric Models

Lighting Information

3D Animation Definition

Rendering

Texture Information

Image Storage and Display
And, now to our first topic: Modeling

3D Geometric Models

3D Animation Definition

Lighting Information

Rendering

Texture Information

Image Storage and Display

Rendering

Image Storage and Display

Image Storage and Display
The Graphics Process

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3D Geometric Models
3D Animation Definition

Lighting Information
Rendering
Texture Information

Image Storage and Display
The Graphics Process: Geometric Modeling

3D Scanning
Interactive Geometric Modeling
Model Libraries
Displacement Mapping

3D Geometric Models

Rendering
The Graphics Process: 3D Animation

- Motion Design
- Motion Computation
- Motion Capture
- Dynamic Deformations

3D Animation Definition → Rendering

The Graphics Process: Texturing

- Scanned Images
- Computed Images
- Painted Images

Texture Information → Rendering
The Graphics Process: Summary

- 3D Geometric Models
- 3D Animation Definition
- Rendering
- Lighting Information
- Texture Information
- Image Storage and Display
An Introduction to Modeling

Andrew Glassner
Coyote Wind Studios

Why Create 3D Models?
Image Synthesis
Design
Manufacturing
Simulation
Art

Models for Image Synthesis
Camera
  Viewpoint for image
Light Sources
  Radiate light
  Have size and shape
Objects
  Physical structures

Models for Simulation
Physics
  An airplane wing
Mechanics
  Fit between parts
  Manufacturability

Model Attributes
Structure
  Geometry and Topology
Appearance
  Looks and surfaces

Levels of Detail
Visual detail for images
Structural detail for simulation
Seeing in 3D

The world in basic shapes
Simple but not too simple
**Detail for Image Synthesis**

Real shapes are complex!
More detail = more realism
   Takes longer to model, longer to render, and occupies more disk space
Procedural objects
   More detail when you want it

**Detail for Simulation**

Can affect accuracy of simulation
Different simulations require detail in different places

**Levels of Detail for Simulations**

Does it fit in the box? Does it fit with the cover on?
Primitives and Instances

- Platonic "ideal"
- Shapes are instances of primitives
- Each instance may be different
Choosing a Model

Representation

Cost
Effectiveness
Complexity
Ease of Simulation
Ease of Animation

Model Cost

Designer’s time
Computer Storage
Rendering Time
Simulation Time
Ease of Animation

Model Effectiveness

Geometry
Looks
Accuracy
Appearance
Looks
Accuracy

Model Complexity

Number of primitives
Number of shapes
Complexity of each instance