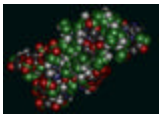
Welcome to 6.837 !

TR 2[30]-4pm, Room 4-163
Fall 2002
http://graphics.lcs.mit.edu/6.837/F02
http://stellar.mit.edu/S/SMA/fa02/SMA.5507
Lecture 1: Thursday, September 5th, 2002
Today's lecturer: Prof. Teller

Welcome to all students:

- MIT students attending lecture today
  - Sign the circulating sign-up sheet today
  - Fill out web survey (on course page) ASAP
- MIT & SMA students viewing lecture via tape-delay (see SMA course page)
  - Email staff this week (for accurate count to EECS HQ)
  - Fill out web survey linked from course page

Plan for today:

- Introduction to course staff
- Why study graphics?
- What 6.837 is (and isn't) about
- Course structure and timeline
- Overview of topics, assignments, project
- Projects from previous offerings of 6.837
- Grading policy
- Prerequisites & substitutions

Introductions

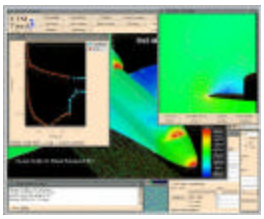
- Lecturers:
  - Prof. Fredo Durand (fredo@graphics.lcs.mit.edu)
  - Prof. Seth Teller (teller@graphics.lcs.mit.edu)
- TA's:
  - Addy Ngan (addy@graphics.lcs.mit.edu)
  - Jingyi Yu (jingyi@graphics.lcs.mit.edu)
- Course Secretary:
  - Bryt Bradley (bryt@graphics.lcs.mit.edu)
- Staff e-mail lists:
  - TA's only: 6.837-tas@graphics.lcs.mit.edu
  - Entire staff: 6.837-staff@graphics.lcs.mit.edu

Team 18's final project from 6.837 (F97)

Why study graphics?

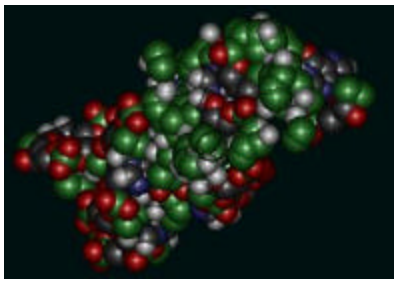
- To make pretty pictures and funny movies … ?
  - Yes, in part. But in addition…
- To improve:
  - Understanding
  - Expression
  - Communication
- Graphics is (or should be) essential to engineers and the practice of engineering!

Computer-Aided Design and Engineering Analysis

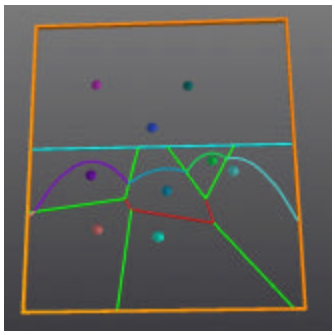


Effective Human-Computer Interaction (HCI)

Scientific Visualization

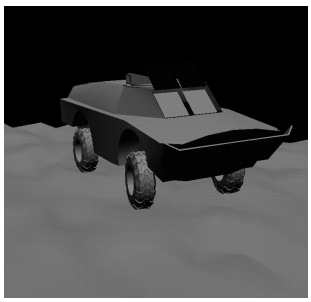


Math & Science Education

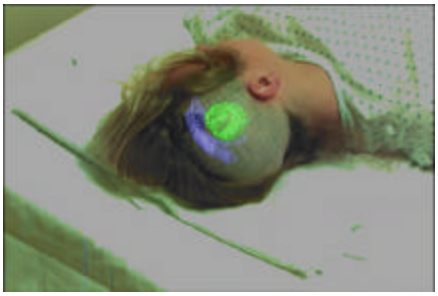


Entertainment & Games

Military Planning & Rehearsal



Computer-Assisted Surgery



Medical Education & Visualization

So … why take 6.837?

- By the end of this term, you'll have the engineering knowledge and skills (in principle) to create or contribute to all of the applications you just saw, and more.

What 6.837 is *not* about:

- Paint packages (Photoshop)
- CAD packages (AutoCAD)
- Rendering packages (Lightscape)
- Modeling packages (3D Studio, Maya)
- Animation packages (Digimation)
- Graphics APIs (OpenGL, DirectX)
- Modeling/Shading Languages (RenderMan)
- Games / Game Development (...)

… But you may use some or all of these this term.

What 6.837 *is* about:

- Geometric modeling
- Rendering
- Animation

} Simulation

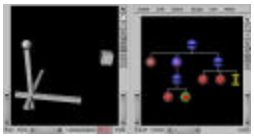
- Advanced topics

Structure of 6.837

- Lectures
  - Optional review sessions for prerequisite material
- Assignments (out Thursdays, due following Friday)
  - Web signup (Weeks 1-2)
    - Surveys your technical background, interests, schedule
  - Geometric Modeling & Appearance (Weeks 2-4)
    - Object modeling, scene composition, appearance, Asst's 1 & 2
  - Rendering (Weeks 4-8)
    - Polygon Rasterization (Wireframe & Solid), Assts 3 & 4
    - Ray Casting & Ray Tracing, Asst's 5 & 6
- Final (team) projects (Weeks 8-14)
  - Brainstorming; proposal; approval
  - Each team meets weekly with "shepherd" TA
  - Writeups, presentations to staff & class at end of term

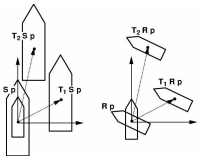
Geometric Modeling

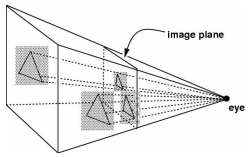
- Specifying an object's shape & appearance
  - Shape primitives
  - Generative modeling
  - Transformations
  - Modeling hierarchies
  - Material attributes
    - Color, texture, lighting, etc.
  - Examples (from Ass'ts 1 & 2, object modeling):
    - person sailboat guitar terminator



Rendering (part I): transformation

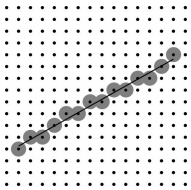
- Geometry of image formation
  - Modeling transformation
  - Viewing transformation
  - Perspective transformation
  - Viewport transformation

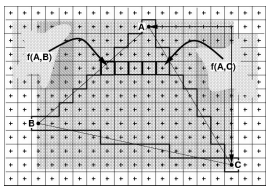




Rendering (part II): sampling

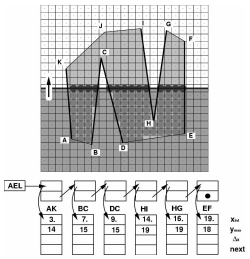
- Discretizing (or *rasterizing*) continuous geometry onto a discrete *pixel grid*
  - Shape representation & pixel resolution
  - Sampling & interpolation method

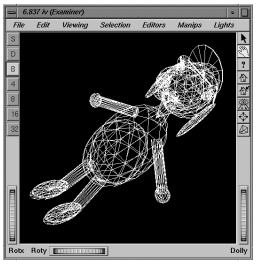




Scan-conversion machinery

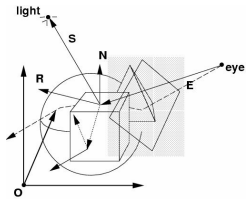
- Assignment 3 (ivscan wireframe):





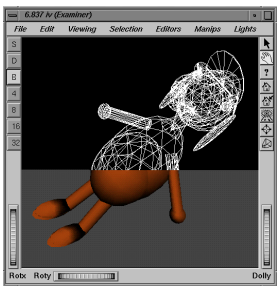
Rendering (part III): shading

- Simulating the interaction of light with surface (and sub-surface) materials in scene
  - Material properties (color, shininess, …)
  - Opacity (occlusion)

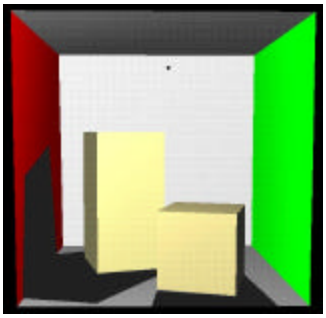


Polygon fill, with depth-buffering

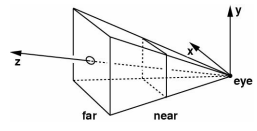
- Assignment 4 (ivscan solid)

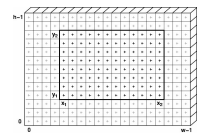


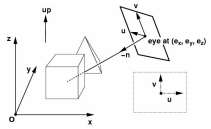
Ray Casting (Assignment 5)

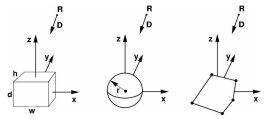


Ray Casting (machinery):

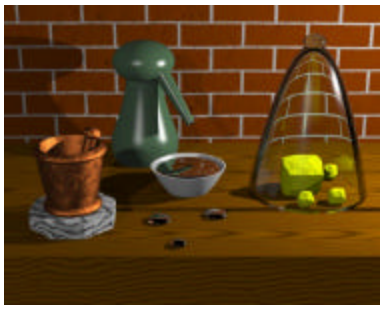




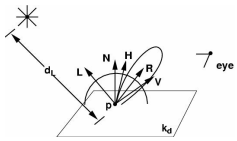


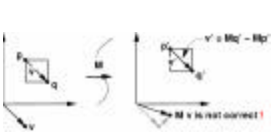


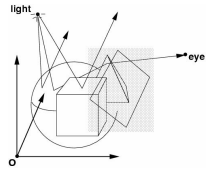
Ray Tracing (Assignment 6)



Ray Tracing (machinery):

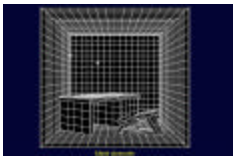


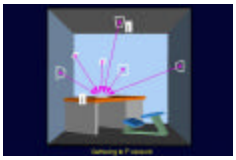


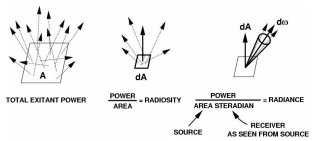


Radiosity

Radiosity (machinery):







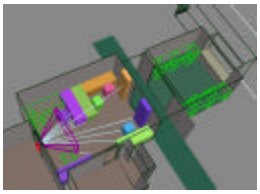
Animation

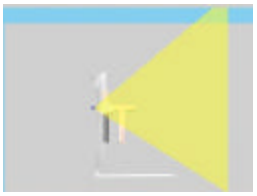
- Key-framing
  - Temporal sampling & interpolation
- Articulation and motion control
- Camera / viewpoint control
- Procedural vs. physically-based methods
- Rendering issues (e.g. motion blur)

Simulation

Advanced topics

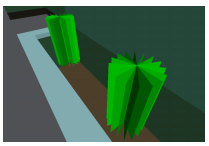
- Visible/hidden surface algorithms

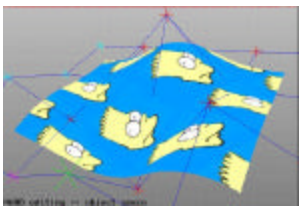


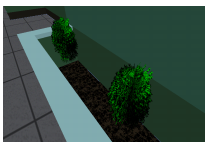


Advanced topics

- Texture mapping

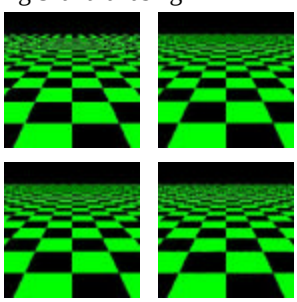






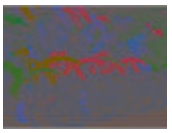
Advanced topics

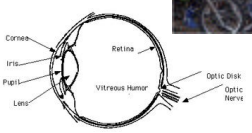
- Sampling & anti-aliasing



Advanced topics

- Color & perception



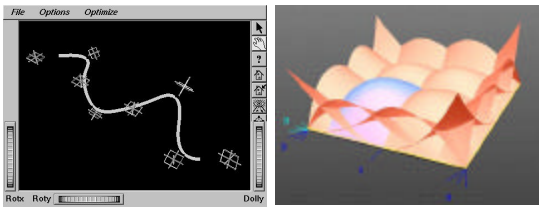


Advanced topics

- Image-based modeling and rendering

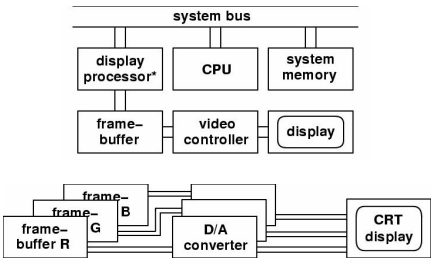
Advanced topics

- Parametric curves & surfaces



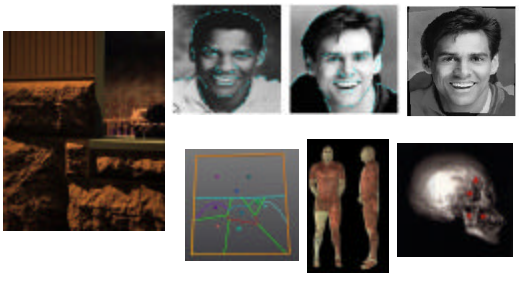
Advanced topics

- Graphics hardware architectures



Advanced topics

- Special topics (from survey of your interests)



Final project topics & examples

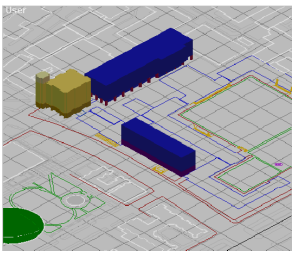
- Teams of 3 or 4 students
- Wide latitude in topic selection:
  - Specialized modeling, rendering effects
  - Animations / short films
  - Physically-based phenomena
  - Connections to text, speech, audio, images, video
  - Modeling tools
  - Geometric Algorithms
  - Scientific Visualization
  - Novel interaction methods
- Previous years' projects linked from homepage

Modeling

- 3D-ifying comic strips

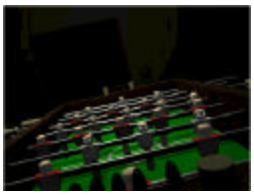
- Dome of the Rock model

- MIT model and animation

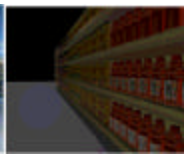


Animations

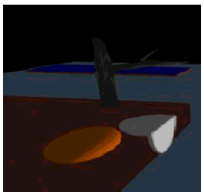
- Foosball players come to life



- Animation set in Star Market

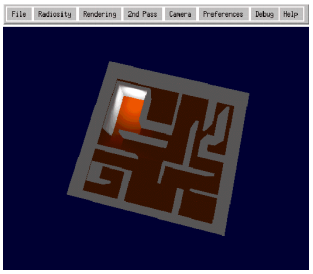


- Animated solid texture (Dali Animation)



Physically-based simulation

- Parallel radiosity solver

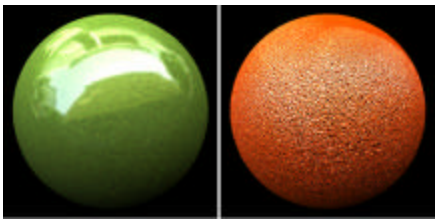


- Physically-based driving simulators

Illustrating a car being stopped by collision checking when hitting a food truck.

- Physically-based flag simulation

- Rendering with real lighting conditions



Connection to other forms of data

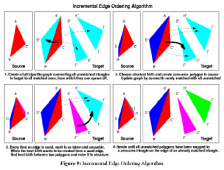
- Text to speech to animation

- MIDI-synchronized hands & piano keys

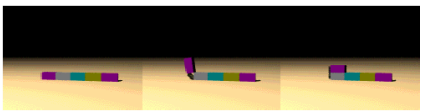
- Insertion of synthetic character into video

Geometric Algorithms

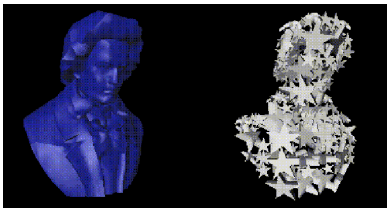
- 3D morphing



- Evolution of motion

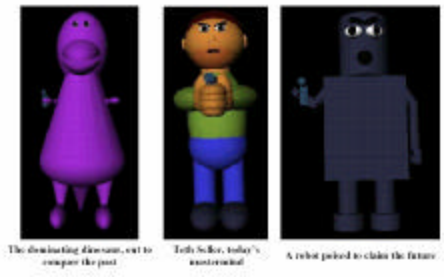


- Conglomerate sculpture

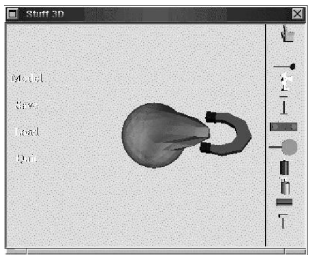


Interaction

- Adventure game



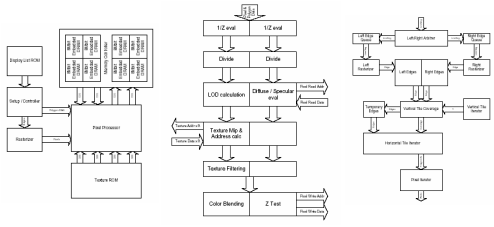
- 3D Modeler for kids



- Networked, multi-user interior design

Architecture studies

- Gate-level hardware 3D accelerator



Other final projects (linked from 6.837 homepage)

- Meteor Animation, Blowing Curtain, Interactive Parallel Radiosity, Acoustic Simulation (Concert Halls), Trick or Treat (Gothic Animation), Luxo Jr. Animation Sequel, Dome of the Rock, 3D Modeler for Kids, Precomputing Ray Tracer, Monk Animation (Douglas Adams), Foosball Players Come to Life (Animation), MIT Model & Animation, Relativistic Ray -Tracing, Human in Free-Fall, The Job (Movie), 3D Drilling for Tumors in MRI Scans Using PHANToM, Dali Animation, Flag modeling & animation, 3D Morphing, Fluid Simulation with Haptics, Evolution of Movement, Tron Gone Wrong

Grading policy

- Programming assignments ~50% of grade
  - To be completed *individually*
  - Late policy:
    - Assignments time-stamped by athena `turnin`
    - No late assignments accepted, period, except with a letter from a Dean.
- Team projects ~50% of grade, involving:
  - Thoughtful initial proposal (3-5 pages)
  - Satisfactory weekly progress
  - Coherent final writeup & presentation
  - Overall technical merit of work
- No quizzes, exams or final

Stated prerequisites:

- 18.06 (Linear Algebra):
  - Vectors (dot, cross products, etc.)
  - Matrices and matrix operators
  - Solving linear systems of equations
  - Bases: spanning, orthonormal, transformations
- 6.046J (Algorithms):
  - Orders of growth
  - Upper & lower bounds
  - Reductions; adversary arguments
  - Sorting, tree traversal, convex hulls, etc.
- Programming experience:
  - Basic knowledge of C, C++, *or* Java assumed

Prerequisite substitutions:

- Analogous coursework
- Relevant experience
- Osmosis
- An enthusiastic attitude
- Tolerance for pain
- Evening review sessions with the TA's

- Bottom line: prereq's are *not* enforced; take the class if you so choose

Questions ?

Assignment 0:

- Fill out survey linked from course web page by **5pm Friday, Sept. 13th** (earlier if possible)

See you Tuesday !