What is Computer Graphics?

- Creation, Manipulation, and Storage of geometric objects (modeling) and their images (rendering)
- Display those images on screens or hardcopy devices
- Image processing
- Others: GUI, Haptics, Displays (VR)...

What drives computer graphics?

- Movie Industry
  - Leaders in quality and artistry
  - Not slaves to conceptual purity
  - Big budgets and tight schedules
  - Reminder that there is more to CG than technology
  - Hey, How'd they do that?
  - Defines our expectations

- Game Industry
  - The newest driving force in CG
  - Why? Volume and Profit
  - This is why we have commodity GPUs
  - Focus on interactivity
  - Cost effective solutions
  - Avoiding computing and other tricks
  - Games drive the baseline

- Medical Imaging and Scientific Visualization
  - Tools for teaching and diagnosis
  - No cheating or tricks allowed
  - New data representations and modalities
  - Drive issues of precision and correctness
  - Focus on presentation and interpretation of data
  - Construction of models from acquired data

- Computer Aided Design
  - Mechanical, Electronic, Architecture,...
  - Drives the high end of the hardware market
  - Integration of computing and display resources
  - Reduced design cycles == faster systems, sooner
What drives computer graphics?
- Graphic User Interfaces (GUI)
  - www.webpagethatsuck.com

What is Computer Graphics?
- Rendering
  - Photorealistic
  - Non-Photorealistic
  - Image-based techniques
  - Texture Synthesis
- Modeling
- Interaction: Perception and Virtual Environments
- Hardware Rendering
- Animation
- Simulation and Dynamics

Rendering
- Many think/thought graphics synonymous with rendering
- Well researched
  - Working on second and third order effects
  - Fundamentals largely in place

Rendering
- Major areas:
  - Ealiest: PhotoRealism
  - Recent: Non-Photorealistic Graphics (NPR)
  - Recent: Image-based Rendering (IBR)

Rendering
- Ray Tracing has become practical
  - Extremely high quality images
  - Photorealism, animation, special effects
  - Accurate rendering, not just pretty

Rendering Realism
Morning
Evening
a preetham,
Rendering Realism

Cornel Measurement Lab

Rendering Realism

Shirley, et. al., cornell

Is this real?

m fajaro, usc

Terrain Modeling: Snow and Trees Added

s premoze, et.al., utah

Growth Models

o deusson

Rendering/Modeling Hair

http://www.rhythm.com/~ivan/hairRender.html
/Users/gooch/Desktop/tabby.qt.moov
Is Photorealism Everything?

Non-Photorealistic Rendering

Tone Shading
NonPhotorealistic Rendering

Image Based Rendering
- Model light field
- Do not have to model geometry
- Good for complex 3D scenes
- Can leave holes where no data is available

3D Scene Capture
Fuchs et al., UNC
UNC and UVA

3D Scene Recreation
Faugeras et al.

360° Scan
p willemsen, et. al., utah

Modeling
- Many model reps
  - Bezier, B-spline, box splines, simplex splines, polyhedral splines, quadrics, super-quadrics, implicit, parametric, subdivision, fractal, level sets, etc (not to mention polygonal)
Modeling
- Physically based
  - Newton
  - Behavior as well as geometry
- Materials
  - Metal, cloth, organic forms, fluids, etc.
- Procedural (growth) models

Modeling... is hard
- Complexity
- Shape
- Specifying
- Realistic constraints
- Detail vs concept
- Tedious, slow

Modeling is hard
- Mathematical challenge
- Computational challenge
- Interaction challenge
- Display challenge (want 3D)
- Domain knowledge, constraints

Growth Models

Model Capture
marc levoy, et. al., stanford

Models

© Johnson and JS Beaman, Utah
Interaction
- Way behind rest of graphic's spectacular advances
- Still doing WIMP:
  - Windows, icons, menus, pull-downs/pointing
  - Once viewed as “soft” research
    - Turns out to be one of hardest problems

Interaction still needs...
- Better input devices
- Better output devices
- Better interaction paradigms
- Better understanding of HCI
  - Bring in psychologists

Hardware: Amazing Changes
- Fundamental architecture shift
  - Dual computing engines:
    - CPU and GPU
    - More in GPU than CPU

Hardware: Amazing Changes
- Fast, cheap GPUs
  - ~$300
- Cheap memory
- Displays at low cost
  - How many monitors do you have/use?

Hardware: Amazing Changes
- Wired -> Unwired
- World of Access

Hardware... some not so good
- Devices
- 3D displays
- Etc
Hardware
- How old is Nvidia
- How big is Nvidia
- QED

In This Class
- We will read lots of papers
- Most important is reading papers
  - State what you found to be the most interesting
  - What you were confused about or would like to understand better
  - Presentations

Np Required Books

Each class
- Introduction Lecture by me
- At least 2 paper reviews led by student
- Occasional Animation viewing
- Project discussion and help session
- At least one 15 minute break in the middle

Grades
- 15 % = Class participation
- 35 % = Presentations
- 50 % = Project