What is Computer Graphics?

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Objectives

• In this lecture, we explore what computer graphics is about and survey some application areas

• We start with a historical introduction
Computer Graphics

• *Computer graphics* deals with all aspects of creating images with a computer
  - Hardware
  - Software
  - Applications
Example

- Where did this image come from?
- What hardware/software did we need to produce it?
Preliminary Answer

- **Application**: The object is an artist’s rendition of the sun for an animation to be shown in a domed environment (planetarium)
- **Software**: Maya for modeling and rendering but Maya is built on top of OpenGL
- **Hardware**: PC with graphics card for modeling and rendering
Basic Graphics System

Input devices

Processor

Frame buffer

Memory

Output device

Image formed in FB
Can be used either as a line-drawing device (calligraphic) or to display contents of frame buffer (raster mode)

- Computer graphics goes back to the earliest days of computing
  - Strip charts
  - Pen plotters
  - Simple displays using A/D converters to go from computer to calligraphic CRT

- Cost of refresh for CRT too high
  - Computers slow, expensive, unreliable

• **Wireframe** graphics
  - Draw only lines
• Sketchpad
• Display Processors
• Storage tube

wireframe representation of sun object
Sketchpad

• Ivan Sutherland’s PhD thesis at MIT
  - Recognized the potential of man-machine interaction
  - Loop
    • Display something
    • User moves light pen
    • Computer generates new display
  - Sutherland also created many of the now common algorithms for computer graphics
Display Processor

- Rather than have the host computer try to refresh display use a special purpose computer called a display processor (DPU)

- Graphics stored in display list (display file) on display processor
- Host compiles display list and sends to DPU
Direct View Storage Tube

- Created by Tektronix
  - Did not require constant refresh
  - Standard interface to computers
    - Allowed for standard software
    - Plot3D in Fortran
  - Relatively inexpensive
    - Opened door to use of computer graphics for CAD community

• Raster Graphics
• Beginning of graphics standards
  - IFIPS
    • GKS: European effort
      – Becomes ISO 2D standard
    • Core: North American effort
      – 3D but fails to become ISO standard

• Workstations and PCs
Raster Graphics

• Image produced as an array (the *raster*) of picture elements (*pixels*) in the *frame buffer*
Raster Graphics

• Allows us to go from lines and wire frame images to filled polygons
Although we no longer make the distinction between workstations and PCs, historically they evolved from different roots

- Early workstations characterized by
  - Networked connection: client-server model
  - High-level of interactivity

- Early PCs included frame buffer as part of user memory
  - Easy to change contents and create images

Realism comes to computer graphics

smooth shading
environment mapping
bump mapping

- Special purpose hardware
  - Silicon Graphics geometry engine
    - VLSI implementation of graphics pipeline
- Industry-based standards
  - PHIGS
  - RenderMan
- Networked graphics: X Window System
- Human-Computer Interface (HCI)

- OpenGL API
- Completely computer-generated feature-length movies (Toy Story) are successful
- New hardware capabilities
  - Texture mapping
  - Blending
  - Accumulation, stencil buffers
Computer Graphics: 2000-

- Photorealism
- Graphics cards for PCs dominate market
  - Nvidia, ATI, 3DLabs
- Game boxes and game players determine direction of market
- Computer graphics routine in movie industry: Maya, Lightwave
- Programmable pipelines