Development of Computer Graphics

1951
- Whirlwind, Jay Forrester (MIT)
- CRT displays

mid 1950s
- SAGE air defense system
- command & control CRT, light pens

late 1950s
- Computer Art, James Whitney Sr.
- Visual Feedback loops

1962
- Sketchpad, Ivan Sutherland
- data structures, light pen for drawing and choices

Early display devices (mid-60s):
- Vector, stroke, line drawing, calligraphic displays
- Architecture of Vector Display

Architecture of a vector display - random scan
- vector generator converts digital coordinates to beam deflections

1964
- CAD and CAM
- General Motors DAC, Italk Digitek for Lens Design
- 1964-1970s
  - Photorealism at University of Utah
  - Sutherland, Evans, Catmull, Blinn

1968
- Evans & Sutherland
  - commercial company - flight simulators
  - 3D vector pipeline, matrix multiplier, clipping

1969
- First SIGGRAPH

1970
- Pierre Bezier - Bezier curves

1971:
- Gouraud Shading
Development of Computer Graphics

- 1974-1977
  - Catmull - Z-buffer
  - Bui-Toung Phong creates Phong Shading (Utah)
  - Martin Newell's teapot (Utah)
  - Computer graphics at NYIT - computer animation
  - Raster Graphics (Xerox PARC, Shoup)

Architecture of a raster display

- Raster Scan
  - need to store whole image
  - 1024 x 1024 x n : n bits per pixel
  - mono 1 bit, color 8 (256 color), 24 (16 million)
  - 32 to 96 bits used (double buffering, z-buffering)
  - 1280x1024x24 needs only 3.75 MB video RAM

Random Scan versus Raster Scan

- Raster Scan advantages:
  - low cost, superior fill ability, refresh rate independent of complexity, 70Hz sufficient to avoid flicker
  - Raster disadvantages:
  - discrete nature of pixel representation, need for scan conversion in software or RIP chips
  - real-time dynamics more demanding
  - approximation of lines by sequence of pixels
  - aliasing - jaggies or staircasing
  - manifestation of sampling error in signal processing
  - need for anti-aliasing
Development of Computer Graphics

1976
- Image and texture mapping (Blinn)

1977
- 3D Core Graphics System,
  - first “standard” for device independent graphics package
  - allowed portable graphics programming
  - ACM SIGGRAPH committee including Foley, Van Dam, Feiner
  - baseline specification - many implementations

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1982
- Hardware support for transforms (matrix-vector multiplies), clipping (variant of Sutherland-Hodgman algorithm)
  - IRIS - Integrated Raster Imaging System, SGI
  - High-end workstation
  - Hardware acceleration of graphics pipeline

1982
- TRON, Star Trek - Genesis Effect

1982
- Ray Tracing, Turner Whitted

1983
- VRAM, Video random access memory, Texas Instruments
  - can read out all pixels in one memory cycle

1983
- Fractals

1985
- Radiosity, Don Greenberg (Cornell)
  - GKS, Graphical Kernel System
  - First ANSI standard
  - Elaborated cleaned up version of CORE but only 2D

1986
- Renderman

1988
- PHIGS, PHIGS+
  - Programmer’s Hierarchical Interactive Graphics System
  - More complex than CORE
PHIGS v GKS

- GKS allowed grouping of primitives into “segments”
- no nesting of segments
- PHIGS allowed nested hierarchical grouping of 3D primitives into “structures”
  - all primitives subject to geometric transformations
  - editable database of structures
  - auto-update of screen when database altered
- PHIGS+
  - extension for pseudo-realistic rendering on raster devices
- PHIGS, PHIGS+ large packages
  - run best with hardware support of transformations, clipping and rendering

Development of Computer Graphics

- 1993
  - OpenGL - Open Graphics Library
  - derived from SGI’s GL library
- 1993
  - Open Inventor, OO layer on OpenGL
- 1995
  - QuickDraw 3D, Apple
- 1995
  - Direct3D, Microsoft, game playing API

Development of Computer Graphics

- Input Devices
  - early light pens to modern mice
  - data tablet
  - touch sensitive screens
  - 3D input devices (spaceballs etc.)
  - button and dial boxes