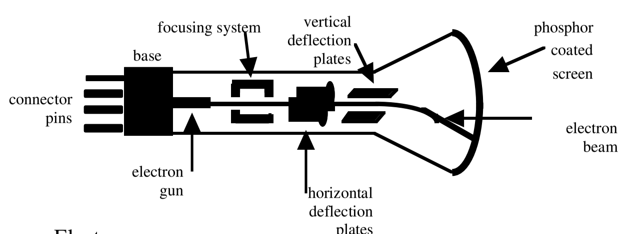
Lecture Notes #1 - Graphics Hardware & Lines

- Reading:
  - Skim chapters 1&2.
  - Read sections 3.1-3.5, 4.8
- Overview
  - Vector and raster display devices
  - Bresenham's algorithm for drawing lines
  - Antialiasing

History

- Sketchpad -- 1963, Ivan Sutherland
  - constraint-based
  - object-oriented
  - interaction techniques for choosing, pointing, drawing
  - data structures for replicating components
  - beginning of modern interactive graphics

Cathode ray tubes (CRTs)

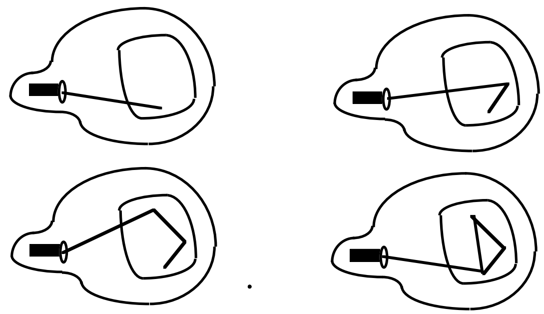


- Electron gun
- Electron focusing lens
- Horizontal and vetical deflection amplifiers
- Electron beam
- Anode (phosphor coating)

CRTs, cont.

- Brightness comes from
  - fluorescence (fraction of microsec)
  - phosphorescence (10 -- 60 microsecs)
- Different phosphors have different
  - colors
  - persistence
- Image needs to be **refreshed** to avoid **flicker**
  - typically, need at least 60Hz
  - exact number depends on: image intensity, ambient lighting, wavelength, size of screen, observer,...

Calligraphic displays



- **Calligraphic display**
- **Vector display**
- **Stroke display**
- **Random scan display**

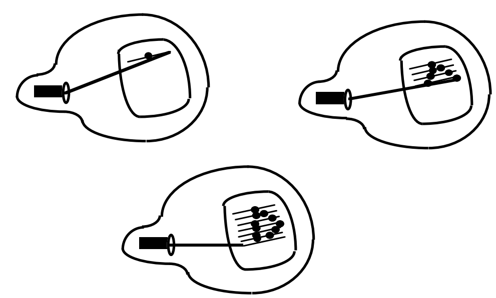
Calligraphic displays, cont.

- Used for example by:
  - Sutherland's Sketchpad
  - Asteroids video game
  - Tempest video game

Raster displays

- History:
  - Developed by Dick Shoup -- early 70's, Xerox PARC
  - Based on TV technology
  - Has had huge impact on computer graphics

Raster displays, cont.



- Electron beam traced in **raster scan order**
- Each left-to-right trace called a **scan line**
- Intensity of beam modulated according to **framebuffer** contents
- Each element of framebuffer associated with a **pixel** on the screen

Black & White Images

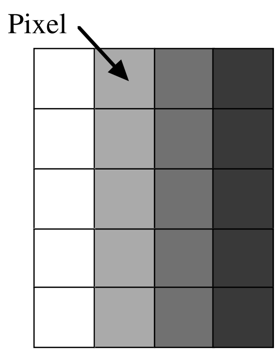


Image (on screen)

255	150	75	0
255	150	75	0
255	150	75	0
255	150	75	0
255	150	75	0

Frame Buffer

Resolution

- **Resolution** is measured in terms of
  - number of scan lines
  - number of pixels per scan line
  - number of bits per pixel
- Examples:
  - TV has around 478 scan lines
  - High res monitors are 1024 x 1280
  - Framebuffers may have 1, 4, 8, 24 or even 96 bits/pixel

Note: Framebuffers require lots of memory -- e.g.,

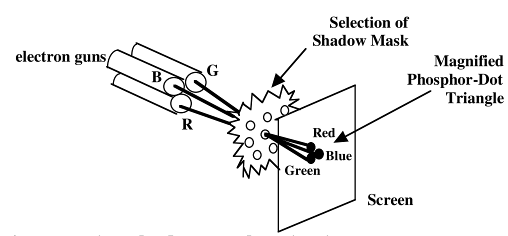
1024 x 1280 x 24 is about 3 megabytes!

Calligraphic vs. Raster Displays

Calligraphic

Raster

Color CRT



Most color monitors employ **shadow mask** technology

- Uses triads of red, green and blue phosphors at each pixel
- Uses three electron guns, one for each color
- Uses **shadow mask**

Such CRTs are also known as **RGB monitors**