L24: Output Technology

- HW2 due Sunday
For the full effect of this user interface, browse to http://dl.dropbox.com/u/25059665/CustomerForm.html.

Let’s discuss:

- form alignment
- the Great State of Texas
- big Submit buttons

For further analysis, see http://ux.stackexchange.com/questions/11229/is-this-rotating-cube-interface-user-friendly
Today’s Topics

- CRTs
- LCDs
- Electronic paper
- Projectors
A great video showing the guts of an LCD monitor: http://www.youtube.com/watch?v=jiejNAUweQ8#!
Properties of Displays

- Diagonal size
- Pixel dimensions & aspect ratio
- Pixel density
- Refresh rate
- Color depth (# colors or grays)
- Color gamut
- Gamma
how CRTs can make pixels larger or smaller by changing frequency of scan (analog resampling), but LCD pixels are fixed

display’s natural resolution always looks sharpest

square vs. nonsquare pixels
Note that DPI and PPI are sometimes used confusingly – sometimes the quoted “dpi” for an LCD panel is actually three times its true ppi, because they’re counting the three subpixels.


Lines per inch refers to number of halftone grid lines per inch. Digital halftoning uses a subgrid of pixels instead of different sizes of dots. So for 100 shades of gray, you’d need 10x10 pixel grid squares, so a 600 ppi printer would only be able to get 60 lpi halftoning.

So a bad rule of thumb is to multiply the lpi by 10 to find the equivalent ppi. Magazine printing using digital halftoning can be up to 2500 ppi!
Subpixel rendering takes this a step further. Every pixel on an LCD screen consists of three discrete pixels side-by-side: red, green, and blue. So we can get a horizontal pixel density which is three times the nominal pixel density of the screen, simply by choosing the colors of the pixels along the edge so that the appropriate subpixels are light or dark. It only works on LCD screens, not CRTs, because CRT pixels are often arranged in triangles, and because CRTs are analog, so the blue in a single “pixel” usually consists of a bunch of blue phosphor dots interspersed with green and red phosphor dots. You also have to be careful to smooth out the edge to avoid color fringing effects on perfectly vertical edges. And it works best for high-contrast edges, like this edge between black and white. Subpixel rendering is ideal for text rendering, since text is usually small, high-contrast, and benefits the most from a boost in horizontal resolution. Windows XP includes ClearType, an implementation of subpixel rendering for Windows fonts. (For more about subpixel rendering, see Steve Gibson, “Sub-Pixel Font Rendering Technology”, http://grc.com/cleartype.htm)
white particles are titanium dioxide (about a micron in size)

Electronic Paper

- Electrophoretic display
  - charged white particles in a dark-colored oil
  - made by E Ink
  - used by Amazon Kindle & Sony Reader

- Only consumes power to change display
- Low refresh rate (1-2 Hz), low contrast
- Kindle is 167 ppi, 16 levels grayscale
Multiple Monitors and Very Wide Displays

- Multiple monitors are increasingly common
- Microsoft DSharp prototype
  - made with 3 LCD projectors = 3072 x 768 pixels
  - curved, 48" wide, 12" high, 4:1 aspect
- Problems with multiple monitors
  - losing mouse pointer
  - clutching
  - bezels & seams
  - locus of attention
For a clever idea of how to use a DLP projector for automatic projector calibration, see:

http://www.youtube.com/watch?v=XgrGjJUBF_I

and

http://www.youtube.com/watch?v=liMcMmaewig
Wearable Displays

- One or two displays mounted in helmet or glasses
- Opaque vs. see-through
- Stereoscopic (3D) vs. monoscopic image
- Augmented reality vs. purely virtual
Summary

- Displays
  - CRT, LCD, e-paper, projector, wearable
  - Dimensions, density, refresh rate, color depth