HOW DO Cathode Ray Televisions and Oscilloscopes work

cathode ray tubes

- Cathode Ray: a stream of electrons in a vacuum tube
- neon tubes work along a similar basis, but with different gases inside the tube
- in order to display dynamic images on a cathode ray tube, some kind of phosphoresent substance must be applied. phosphors are substances that glow when struck by electrons. diff from florescence which is glowing when struck by photons (??)

oscilloscopes

- in order to adjust where the electons strike front of a tube, magnets/electromagnets are used
- in an oscilloscope, tthere are two standard ways of displaying a signal: the standard way involves the beam scanning from right to left at a selectable rate with the input signal displacing the beam up or down depending on the amplitude of its voltage. the secondary way involves sending two signals in and the beam pointing straight ahead in the center with one signal assigned to an x displacement and the other to a y displacment. Industrial usage of this was for deterimining phase & ratio relationships between signals. you can also use transducers (vibrations to voltage) to analyze relationships between mechanical components in engines
- oscilloscopes can work at many different rates, fastest analog ones being 1 gigahertz

how does a CRT work

- in a Television, the beam scans constantly from the top left hand side of the screen down to the bottom right hand side in a fixed number of lines in what is called raster scan.
- history of electronic image transmission

    - this predates television but not by a lot. with the infrastructure in place for telegraph and newspapers it was inevitable. early fax machines were able to transmit the motion of a pen writing electically

RASTER VS VECTOR

- anyone who has worked with computer graphics knows raster vs vector. raster is often referred to instead as a bitmap. the origins of these image types comes from these two methods of displaying images on cathode rate tubes. an oscilloscope in x-y mode can draw a vector image, a crt draws a raster image.
- a vector in the scope is more 'analog' in one way of thinking, b/c it doesn't involve any sort of encoding/decoding of information. voltage comes in and is used to control electromagnetic deflection. a raster on a crt, even if black and white, requires both encoding and decoding in order to scan correctly for horizontal and vertical placement of each pixel.
- vectors are actually parameterized 1 dimensional shapes in 2 dimensional space. they are represented as continuous one dimensional lines drawn in two dimensional space. vectors are very compact ways of storing and displaying information, but with many serious limitations
- rasters are fully 2 dimensional images
- in a vector, if a certain 'pixel' is not used for the image, then no information is stored. in raster, information still needs to be stored even if 'nothing' is being displayed
- vectors in a scope aren't really capable of doing full color (going back to encoding/decoding). crts have more complex electronic architecture before the signal is displayed that can decode the chrominance information and create a full color image

SO HOW TO TURN A CRT into an OSCILLOSCOPe

- THIS IS DANGEROUS AND YOU CAN DIE AND KILL OTHERS AROUND YOU
- this is also much much easier to do with older ass crts. start with like a tiny black and white unit from the 70s if possible. there are probably more steps involved for color units from the 90s and 2000s.
- to use a crt as a horizontal scanning scope (voltage over time) you have to desolder the vertical deflection coil (refer to service manual or just trial and error, theres only two). where you detached the vertical coil, solder a wire that you can pull out through the case and if you prefer, add some kind of input jack here.
- to use crt as in an x-y mode you just do the same for the horizontal deflection and now use both inputs to create lissajous patterns
- issues: your horizontal and vertical rates are limited by the hardware. horizontal scan rate is about 15khz, so actually below the highest audio frequencies. i forget vertical scan, but in ntsc you have 525 lines so is fixed at a rate of how m

SO WHAT IS XYZ MODE?

- some oscillscopes have a z input on the back. this input is typically 'fixed' in that you don't have any ability to control rate or amplitude of how it gets displayed. its functionality is just amplification of the brightness (not displacement) of one or both of the input signals. its usage was to send in trigger signals to highlight certain time steps so you can syncronize things running at very fast speeds.
- z mode was used in scanimate systems (more on that later) to create illusions of depth. brightness is interpreted as something being closer so a z input could be used to to create the illusion of certain lines being 'in front of' other lines. keep in mind that much of the depth illusion involved in oscillographics is done by using multiple oscillators as inputs to X and Y to begin with, so when doing complex 3-d shapes you have to have at least two 'z oscillators', one involved in amplitude modulation of your x and y oscillators, and another involved in the direct brightness modulation

general terms definitions

- encoding and decoding:

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