CHOOSING A DISPLAY

DATE: 29/10/2011

AUTHOR: WILLIAM MATHESON

There are many things to consider when choosing a display. The largest part of the decision is going to be the type of display used, though this may be dictated by the size required. There are at least three primary technologies that merit present consideration[i]. Alternatively, one can shop for projectors, and we'll briefly touch on those.

A digression: The distinction between computer monitors and televisions has become irrelevant in this age of living room computers, TV tuner cards inside computers, and set-top boxes being used to tune channels. The essential difference between a television and a monitor is that a television has a tuner. Televisions can be used as monitors, but monitors cannot be used as televisions in the proper sense of the word. When you use a set-top box for satellite or cable, you are effectively reducing your television to a monitor since you're bypassing its own tuner in favor of the one in the box.

Cathode Ray Tube (CRT): This type of display relies on the flow of electric current through a vacuum. They are essentially vacuum tubes with electron guns at their base.

CRTs have a naturally wide *viewing angle* (close to 180 degrees – that is, nearly 90 degrees in each direction off a central viewing plane), and they have no *input lag* (there is no delay between the set's receiving information and outputting it) and very fast (less than 1 millisecond) *response times* (the screen itself responds very quickly to changing input). Motion blur, if not an artifact of the source, is non-existent.

CRTs are capable of displaying different *resolutions* (image dimension in terms of individual picture elements, or pixels) without having to resort to scaling. (LCDs and Plasmas, discussed later, have a native resolution and require scaling when used at other resolutions, which decreases image quality.) CRTs, therefore, are ideal for people who want lower resolution images and video displayed over a large area (where simply using large system fonts and magnifying tools isn't enough or appropriate). CRTs are still in demand in gaming for their lowest-possible input lag, fast response time, and multiple "native" resolutions. Classic television enthusiasts should note that NTSC[1]-standard video looks better on CRTs because it doesn't have to be scaled.

CRTs also have high color fidelity and contrast (though these things often have to be manually adjusted), making them popular in professional video, photography, and graphics fields.

[1] - National Television System Committee – a standard for standard-definition analog video, supported by virtually all televisions sold in North America. Newer televisions support digital video standards such as ATSC (the A stands for "Advanced").

But there are reasons why we see fewer and fewer CRTs over time. A significant drawback to CRTs is their bulk: CRTs are the heaviest type of display per inch. A 20-inch (measured on the diagonal, discussed later) unit weighs about 50 pounds. For those seeking the home cinema experience with a CRT, a 40-inch unit can weigh over 300 pounds. CRTs have also been undercut by LCDs in price (but be careful when comparing the diagonals of televisions when the aspect ratio is changing – this will be discussed momentarily).

Liquid Crystal Display (LCD): This type of display exploits the light-modulating properties of liquid crystals – a state of matter that has properties between conventional liquid and solid crystal (in a crystal, the molecules of a substance are arranged in an orderly repeating pattern).

LCDs are compact and light and consume less power than CRTs and plasma displays. They are also highly cost-effective to manufacture (no more vacuum tubes and electron guns) and they have become by far the most common type of display purchased today.

LCDs have certain intrinsic drawbacks which a savvy consumer should be aware of when comparing displays. To begin with, LCDs suffer from limited viewing angles. On the other hand, the lightness of an LCD makes its angle trivial to adjust. More seriously, LCDs have only one native resolution (dictated by the number of crystals – when LCDs are operated at other resolutions, the image is far less "crisp"). They also experience small but significant input lag and pixel response time. It's also possible for individual pixels to become completely stuck or dead, necessitating replacement of the crystal screen (or more likely the unit).

Since LCs do not themselves emit light, light must be supplied from the front or the rear. LCDs today are typically backlit. Depending on the backlighting scheme, the display's ability to differentiate light and dark can be less than that of an equivalent CRT or plasma. Inexpensive computer displays like the ones in our classrooms use a single fluorescent panel. Even when an image is mostly black, the light is still uniformly lit. The only way to get a truly rich black on such a monitor is to turn it off!

A solution is to distribute the lighting duties so that the backlighting behind particular areas of the screen can be enhanced, reduced, or disabled. Enter **LED** (light-emitting diode) **backlit LCD TVs**. Instead of having one fluorescent panel, LED-backlit LCDs have numerous LED lamps that can be turned on or off by area[ii]. It's now possible to have very deep localized blacks.

It's important to note that the television itself is emphatically *not* LED, only the backlighting. There is such a thing in concept as an **LED TV**, which would be a TV based on the fantastic properties of LEDs and bypassing the liquid crystals altogether, but when a retailer offers an "LED TV" they are almost always selling a LED-*backlit* LCD. Feel free to harass salespersons on this point. For a true LED TV, you'll have to look to something akin to Sony's XEL-1 – an 11-inch **organic-LED (OLED)** display that was introduced in 2008 for the low, low price of US$2,499.99[iii].

Plasma: The individual cells of a plasma display contain, instead of liquid crystals, electrically charged ionized gases. Plasma displays don't use backlighting, so they are capable of deeper blacks. They also boast wider viewing angle, less motion blur, and faster response times.

Screen lifespan on today's plasmas can exceed 100,000 hours – much longer than older CRTs. However, plasma displays are expensive to manufacture and are seldom offered for sale in sizes smaller than 37 inches. Conversely, very large plasmas are usually cheaper than equivalently-large LCDs! They are also heavier than LCDs since they require a glass screen to hold the gases.

Plasma technology doesn't work well at high altitudes due to the inside-outside pressure differential. If you live high above sea level, check the television's recommended maximum altitude before you buy.

An alternative to an inherently dynamic screen is using a bright light to project an image onto another surface. **Projection TVs** are commonly found in home-cinema setups[iv]. One can choose between **front-projection** (see the projectors on our classroom ceilings for an example) and self-contained **rear-projection**. Unfortunately, projection has its own set of problems, depending on the technology used. **CRT projectors** have bulky cabinets, are difficult to adjust, and are prone to burn-in. Further to this, CRT rear-projection suffers from a washed-out look compared to its non-projection equivalent. **LCD projectors** give a looking-through-a-screen-door effect to their images (look out for this at inexpensive movie houses). **DLP (digital light processing) projectors** are the kind you see in modern digital movie theatres and in use as state-of-the-art "data" projectors. DLP uses micromirrors on a silicon chip to modulate light (for this reason, DLP is fundamentally a *projection* technology, unless they want to make a silicon chip with a 40-inch diagonal!). The light can be supplied by LED or laser, obviating the need for lamp replacement. **DLP rear-projection TVs** are cheaper than LCD or plasma in terms of screen size for a given price. Unfortunately, they fall short in off-angle viewing: contrast decreases rapidly when viewed from off-center. Finally, Mitsubishi offers a 75-inch **laser TV**[v].

Screen size: Displays are typically sold by their *diagonal*, the measurement from an upper corner to its opposite lower corner (or vice-versa). With CRTs, the diagonal is sometimes a measurement of the picture tube, which isn't necessarily the exposed viewing area.

A shopper must also keep in mind the difference in geometry by aspect ratio. For example, when moving from a **4:3** (traditional modest rectangle) to a **16:9** ("widescreen") set, and having the same content appear at the same height is desired, a longer diagonal must be sought because the wider ratio means more diagonal distance is needed to get the equivalent screen height.

Consequently, when a customer "upgrades" from a 32-inch SDTV[2] to a 32-inch HDTV, the picture content actually gets smaller, since the screen height decreases from 19.2" to 15.7".[vi]

Going through the geometry, the ratio between a 4:3 diagonal and a 16:9 diagonal is exactly ($\sqrt{337}$ / 15) or approximately **1.22**. One must multiply the diagonal of a 4:3 display by this to get the 16:9 diagonal needed to achieve the same vertical space for content. A sample result: People replacing a 32-inch SDTV should be shopping for a 40-inch HDTV.

There isn't space here to consider **connections**, which would make a good report and presentation in and of itself! As for **3-D**, it's offered in both LCD and plasma sets as well as DLP projection sets. There is scant 3-D content available, and all commercially-available technology requires glasses (sometimes $100 a pair – customers will need to ask themselves how often they really have houseguests). I would recommend against 3-D as a primary consideration, unless display-shopping and accessory-buying is being employed as an alternative to chain-lighting $100 bills. Finally, **burn-in** (where static parts of an image can become permanently artifacted in the screen given enough time) is a problem that plagues *every* display type, though the mechanics differ for each type[vii].

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[2] - Standard Definition Television. Usually synonymous with 4:3 NTSC content. HDTV (H for "High") is usually synonymous with 16:9 ATSC content.

References

[i] - “Comparison CRT, LCD, Plasma” - Wikipedia - http://en.wikipedia.org/wiki/Comparison_CRT,_LCD,_Plasma

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[iii] - “Sony XEL-1” - Wikipedia - http://en.wikipedia.org/wiki/Sony_XEL-1

[iv] - “Video projector” - Wikipedia - http://en.wikipedia.org/wiki/Video_projector

[v] - “Laser video display” - Wikipedia - http://en.wikipedia.org/wiki/Laser_video_display

[vi] - “HDTV Plasma and LCD Screen Size Guide” - http://www.screenmath.com/

[vii] - “Screen burn-in” - Wikipedia - http://en.wikipedia.org/wiki/Screen_burn-in