Ergonomics Considerations of LCD versus CRT Displays

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Conventional computer systems have used cathode ray tube (CRT) technology for the computer display. However, in the past decade technological advances in thin film transistor (TFT) liquid crystal displays (LCDs) have made this an increasingly popular technology. From an ergonomics perspective, which is best for the computer user? There is confusion about the advantages and disadvantages of each display technology. Modern LCDs can offer several advantages over CRTs in terms of visual work performance, space and energy savings. This article will compare and contrast LCD and CRT display technologies.

Do LCDs improve visual work performance?

Yes. Recent research studies have compared whether visual work performance is superior for LCDs compared to CRTs for typical visual work. The significant benefits of LCDs have been shown to be that:

- Visual search times for text targets embedded in a screen of text are 22% faster for LCDs than CRTs, and also faster for low contrast, small characters. [1,2]
- Eye fixation times are 9% shorter and 15% fewer eye fixations are needed to read the same information from an LCD versus a CRT.[1,2]
- Visual search error frequency is 22% less when reading from an LCD than a CRT.[3]
- LCDs have been shown to allow for greater postural variety during computer work.[4]

Do LCDs eliminate geometric image distortions and flicker?

Yes. LCDs are free from flicker because they do not rely on a scanning electron beam. CRTs are more prone to flicker. LCDs are free from geometric image distortions at the screen edges because they are a flat matrix display where every pixel is active; CRTs are subject to peripheral distortion of the image as the electron beam becomes progressively more tangential to the monitor screen phosphors at the edges, hence CRT screens typically have a black deadspace around them. These improvements in the quality of the visual image with LCDs are thought to be responsible for the improvements in visual performance.

Do LCDs reduce specular glare problems?

Yes. LCDs have uniform screen brightness and the screen is covered with a flexible surface that is substantially less prone to specular glare compared to a glass covered CRT screen.

Do LCDs reduce Computer Vision Syndrome?

Yes. LCDs are flicker free, which should reduce the risks of headaches, and the reductions in occulomotor effort (number of fixations) and the reductions in specular glare problems with LCDs should reduce complaints of eyestrain. However, additional research is required to confirm these predict benefits.

Do LCDs save space?

Yes. An LCD display is much thinner and lighter than a CRT display of the equivalent viewing area. An LCD occupies substantially less space than a CRT (an LCD is usually <20% of the footprint of a CRT for the equivalent viewing area. The front of the LCD screen needs to be at a similar distance to the eye, so the space saving occurs behind the screen. An LCD can save the most space when it is mounted on an articulating arm, so that the user can easily move this out of the way to access the worksurface for other activities. An LCD can also save space because it can be placed on a narrower worksurface at the same screen to eye distance. The lighter weight and thinner profile of an LCD makes it easier to reposition. Functional workstation areas are reduced by 10-20%.[5]

Do LCDs save energy?

Yes. LCDs use considerably less energy than CRTs, both when running and also when in standby mode. Overall, LCDs can reduce display energy use by some 60%.[5] For example, a 15" LCD uses around 25 watts when operational and around 3 watts when in standby mode, compared with an equivalent viewing area 17" CRT that uses 80 watts when operational and 5 watts in standby mode.[6] LCD screens recover from standby faster than CRTs and consume less power when they do they this. LCDs do not emit the same heat load as does a CRT, and this saves energy on air conditioning in a building. The uniform brightness of an LCD screen means that the screen can better tolerate variations in light levels, and reductions in lighting also saves energy. A recent Japanese study estimates that if Japan continues on it's path towards replacing old CRTs with new LCDs so that some 76% of displays will be LCDs by the end of 2003, this will save 3 billion kWh of power consumption (the equivalent of the total power consumption of 1,000,000 households or the power production of about 3 nuclear power plants).[7]

Do LCDs increase screen viewing areas?

Yes. With an LCD the whole screen area is active and viewable so there is no image loss at the boundaries, whereas the viewable screen area of a CRT is smaller than the monitor face. Consequently a 15" LCD can give the equivalent area of a 17" CRT, and a 17" LCD the equivalent of a 19" CRT.

Do LCDs have better screen privacy than CRTs?

Yes. LCDs give better screen privacy because they cannot be clearly viewed from acute side angles. This also helps the user to maintain the alignment of the user's body with the screen. Use of an additional privacy filter further enhances this capability.

Do LCDs emit VLF/ELF electromagnetic radiation?

No. Unlike CRTs, LCDs are free from VLF/ELF electromagnetic radiation emissions associated with the scanning electron beam required for a CRT.

Do LCDs display similar colors and video?

For most office tasks the color and video quality of both LCDs and CRTs will be equivalent. For high end color graphics, CRTs can offer some advantages because LCDs can only display the colors available in the pixels, and so they can have less of a color depth than CRTs. Some LCDs (low cost, low resolution) have pixels that respond too slowly for accurate video rendering, and some tearing of the video image can occur, which usually is not an issue for CRTs.

The considerations for each display technology are summarized below:

Consideration	**LCD**	**CRT**
Visual performance	Faster than CRT	Slower than LCD
Image flicker	None	Prone to flicker
Image brightness	Bright, uniform	Variable, uneven
Image geometry	Uniform	Distorted
Image sharpness	High	Moderate to high
Screen viewing area	Full area, very space efficient	Partial area, space inefficient.
Screen size	Smaller screen for equivalent CRT viewing area	Larger screen for equivalent LCD viewing area
Specular screen glare	None	Prone to specular glare
Energy consumption	Low	High
Electromagnetic emissions	No	Yes
Heat emissions	Minimal	High
Space efficiency	High	Low
Flexible positioning	Highly	Moderate
Weight	Light	Heavy
Color range	Very Good	Excellent
Cost	Moderate	Low

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