White Paper

LCD Transition Gains Traction

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Overview

Market research firm DisplaySearch (Austin, Texas) predicts that TFT-LCD monitors will enjoy a 104 percent unit growth this year alone (from 6.9 million units to 14 million units) and will grow to more than 46 million units worldwide by 2005.

The venerable CRT is finally beginning to show its age. Invented in the early 1900s, the CRT has been the heart of most displays including consumer (TV sets), industrial (oscilloscopes), commercial (air traffic control monitors, ATMs) and computer monitors for nearly 50 years. Even huge public displays such as scoreboards found at sport stadiums are comprised of thousands of single color CRTs. Only applications requiring operation under high shock and vibration or high magnetic fields or in other "unfriendly" environments were candidates for other display technologies. This is now changing rapidly and the technology leading to this change is the LCD (liquid crystal display).

Background

The LCD is a relative newcomer in the display continuum, having its origins in military displays in the early 1960s and commercially available in watches and calculators in the early 1970s. Early LCD computer displays suffered from limited gray scale graduations, poorly saturated colors, narrow viewing angles, and slow response. The current state-of-the-art LCD panels are evolving rapidly and approach or exceed CRTs in each of these categories, and they continue to improve each year.

Advantages

Screen Performance

The typical ViewSonic LCD monitor has a brightness of 200 to 250 nits compared with a typical CRT brightness of 100 nits. Thus the LCD can be used in very bright environments that would wash out a CRT monitor. Since an LCD acts like a shutter, it can be made brighter by increasing the brightness of the backlight. When the beam current of a CRT is increased to increase brightness, the beam spot size increases also (an effect called blooming), which lowers effective resolution and yields a soft or fuzzy image.

By design, a CRT must be continuously refreshed or rewritten. If this process is not fast enough (> 75Hz), a subtle flicker results that can cause headache and eyestrain. The LCD monitor does not flicker by design and its perfect focus and geometry further reduce fatigue that results from long periods working at the display. This fatigue has come to be known as Computer Vision Syndrome (CVS).

A computer creates an image to be displayed by rendering it in local video memory called a frame buffer. To drive a CRT monitor, the frame buffer must be converted to an analog signal and sent down the video cable to the monitor. Since LCD monitors are the "newcomers," they have been designed to emulate CRT monitors although they are inherently digital products. To do this, the LCD must perform an analog to digital conversion on the incoming video. It is possible to eliminate the two conversions, to and from the analog domain, and drive the LCD monitor in a digital-to-digital mode utilizing a new industry standard interface called Digital Visual Interface or DVI. By eliminating two conversions and the inherent artifacts generated, a clearer, more stable image is generated by the monitor. In addition, the digital mode eliminates the need for size, positioning, and pixel clock adjustments, thereby further simplifying installation. ViewSonic has developed OptiSync™ technology that combines an analog input for legacy systems with a DVI input for future systems. Now LCD monitors can truly be "plug & play."
ADVANTAGE: LCD

Focus

The CRT electron beam, as described above, must be directed from the top left of the screen, as viewed from the front, scanning from left to right, then down one line, until it arrives at the bottom right. This is repeated as many times per second as defined by the refresh rate (i.e. 75Hz equals the "full scan" from top left to bottom right, 75

times per second). As with a flashlight projecting a beam of light against a flat wall, the beam shape is circular when aimed directly in front but becomes distorted when aimed up, down, left, or right. In a CRT, this will cause image clarity or focus is sues at the screen edge. An LCD has millions of picture elements, each one effectively independent from it's neighbor and does not rely upon a scanning electron beam; therefore distortion problems are negligible. The image is always perfectly "focused" over the entire screen.
ADVANTAGE: LCD

Longevity

Display aging is as inevitable as the wear of brake pads and tires on your car. The display industry measures the lifetime of a product as the time it takes for the display to reach a point where the brightness is one half that of the original. A CRT ages in two ways—an oxide layer forms on the cathode of the electron gun and it generates less beam current; and the phosphor ages and becomes less efficient at converting electron energy to light. The CRT half-brightness point occurs between 10,000 and 20,000 hours depending upon electron gun design.

The only item that ages on an LCD monitor is the backlight which is comprised of one or more tiny fluorescent tubes. The typical life of these tubes is 50,000 hours to the half brightness point.
ADVANTAGE: LCD

Power Consumption

The power required to run an LCD monitor is about 25% of that required for a CRT with the same screen area. In this era of high energy prices and rolling blackouts, this is a significant advantage. Furthermore, the amount of heat generated by an LCD monitor is considerably less than a CRT monitor, resulting in a lower load on air conditioning. If the monitor is used with a system supported by an uninterruptible power supply (UPS), the lower power required by the LCD provides precious extra minutes to store critical data and shut down gracefully in the event of a power failure.
ADVANTAGE: LCD

Emissions

A CRT monitor can generate electric, magnetic and even X-ray emissions due to the high voltage power supply necessary to drive the CRT. Extra circuitry is required to control these emissions to acceptable levels as defined by the Swedish Confederation of Professional Employees (TCO), a global sanctioning organization. The LCD monitor does not require a high voltage supply like the CRT and is essentially emission-free. The smaller size of the LCD monitor permits any shielding required to prevent RFI to be incorporated in the design much less expensively than shielding a CRT monitor.

In addition to emitting less radiation, the LCD is less perturbed by external radiation than a CRT monitor. A magnetic field such as might be generated by a nearby speaker or an electric fan will cause severe purity problems with a CRT monitor, while an LCD monitor will be unaffected.
ADVANTAGE: LCD

Recyclability

A CRT monitor can be a liability at the end of life due to the amount of lead and mercury in the tube. Special measures must be taken when recycling to prevent hazardous materials from fouling our environment. The LCD uses much less of these materials uses less energy to recycle; thus, it is much more environmentally friendly.
ADVANTAGE: LCD

Ergonomics (pivot)

The space saving of an LCD monitor means that it can fit into locations that would be impossible for a CRT monitor. The size and weight of the LCD also permit the unit to be wall or arm mounted easily for essentially zero-footprint installation.

The LCD size permits mounting in landscape (normal) and portrait (90-degree rotation) modes to enhance certain applications like word processing and web design. Full pages can be displayed without scrolling resulting in improved usability and throughput. The CRT monitor does not lend itself to rotation by its considerable size and weight. Furthermore, a CRT monitor may develop cooling problems when rotated unless the chassis and cabinet are designed taking rotation into consideration. Finally, effects from the earth's magnetic field will permanently

magnetize the CRT shadowmask each time the monitor rotates, mandating a degauss cycle. Until the LCD monitor became generally available, fixed portrait-mode CRT monitors were niche products found primarily on dedicated word processors and on some medical instrumentation.
ADVANTAGE: LCD

Price

One factor that caused a significant impediment to the transition to LCD was price. As recently as a year ago, an LCD monitor was typically 5 to 6 times more expensive than the comparably sized CRT monitor. Improvements in manufacturing processes resulting in greatly enhanced yields as well as new factory capacity commencing LCD production has caused a major price erosion across all sizes of LCD monitors. This price decrease has fueled demand and caused a regenerative process that has resulted in still lower prices. When the cost of purchase, the cost of operation, and the residual value (total cost of ownership) is considered, the LCD is now less expensive than a similar size CRT monitor.
ADVANTAGE: LCD

Conclusion

The advantages of the LCD monitor have been detailed above. Although there are still areas in which a CRT monitor has an advantage, such as viewing angle and response speed, the gap has closed to the point where the LCD advantages far outweigh the disadvantages. The final barrier, LCD monitor cost, has been crossed.

Will prices decrease further? Ultimately yes, but market demand and total manufacturing capacity are not in sync which could result in near term price hikes. There has never been a better time to purchase an LCD monitor

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