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Display Directions

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Based on a presentation by Rick Knox, CEO, D2Audio Corporation

When Johannes Gutenberg thought up the printing press in 1450, there was no way that he could have foreseen the advances in displaying text on paper and screens that we have seen. Rick Knox, CEO of D2Audio Corporation, discussed the current landscape of the display marketplace, arguing that we are beginning to see a revolution in display technologies that will result in new and exciting technologies being available in the near to mid term.

Introduction and Overview

The world of display technology is rapidly changing. While IT seeks to put data and information into the hands of the knowledge workers, one critical question is the choice of display technology used to reproduce the colors in the real-world. While three main technologies dominate the business world (LCD, CRT, and Plasma), more players are entering the marketplace, thus creating chaos. In September 2002, the ISRC welcomed Rick Knox to discuss the structure of the display market and the future technologies that will emerge. He first discussed how displays are created (in general), before focusing upon specific technologies. Next, he presented a structural view of the marketplace, highlighting important trends. Finally, six emerging display technologies were shown, each with the potential to change how we think about computers and the role that they will play in the business and consumer world of tomorrow. Before seeing the future, however, it is important to understand the background of how colors are created.

Background Information

To understand display technologies, it is first important to understand how colors are made. Without considering computing, there are three fundamental colors in the world: red, green, and blue. Every other color comes as a combination of these three colors. Display technologies are thus trying to replicate these combinations in a manner that maximizes the color spectrum and comes close to replicating real life.

Display technologies show color in the form of pixels (or a “picture element”). The objective for manufacturers is to display more the pixels on a screen, thus resulting in a sharper image. Within each pixel are all of 3 fundamental colors (R, G, and B). All display technologies work by manipulating the intersection between these three elements to create a combination of R, G, and B.

The Current Display Marketplace

The current display marketplace is full of different technologies that are being used to combine the R, G, and B elements into a color representation of the real world. In the table below, the three most common technologies are introduced, including a discussion of how they work and the advantages of each approach.

Display Type	Short for…	How it works…	Advantages…
CRT	Cathode Ray Tube	An electron beam strikes a phosphorescent surface with R, G, and B molecules within a vacuum tube	• **Cheap** • **Commonly accepted protocol for displays**
LCD	Liquid Crystal Display	An electric field is applied to a liquid crystal substance, with a backlight blocking the appropriate molecules to create color	• **Thinner than a CRT** • **Consume less power than LED, since the objective is to block molecules rather than combine them**
Plasma	**Neon/Xenon Gas Plasma**	**Cavities within the screen contain phosphorus that are activated when gas is moved through the screen**	• **No latency time-the material is instantly activated** • **Displays are straight and thin, not curved**

In addition to these three common display types, many other technologies are being used, including: OLED/OLEP (Organic Light Emitting Diode/Polymer); EL (Electro Luminescent); Laser (Scanned Beam or Flood); LED (Gas as Light Emitting Diode), MEM (Micro-Electromechanical-Machine); LCOS (Liquid Crystal on Silicon); VF (Vacuum Fluorescent); and Cholesteric (Bi-Stable Cholesteric).

Mainstream Applications of the Display Technology

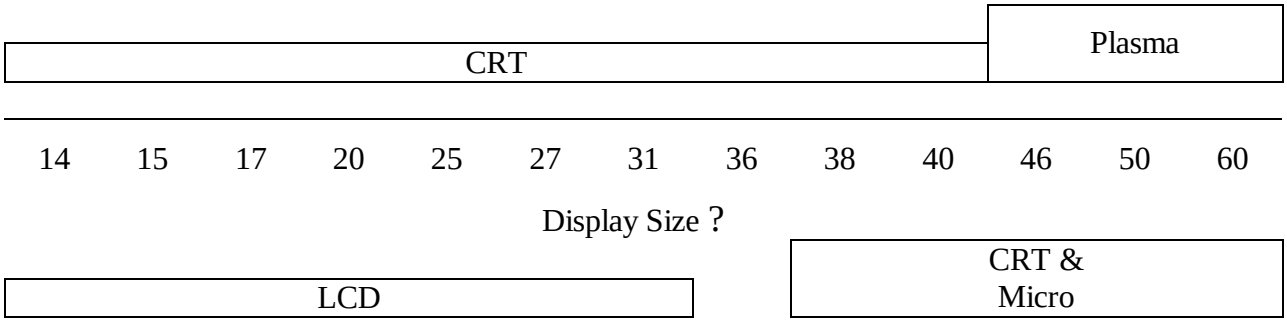
Looking at how these technologies are applied, there have been two separate markets that have been defined: the business side and the audio-visual (or consumer oriented) side.

On the business side, the approach was to make displays square. Thus, the formats for display technologies derive from this approach. Some of the formats include: QVCA, GA, SVGA, XGA, SXGA, and UXGA, with the format designating the number of pixels on the screen.

On the consumer side, the approach was to make displays rectangular. Thus, the formats were attempting to create a screen that was rectangular, for example: High Definition Television ranges from 1280 by 768 to 1920 by 1080.

Seeking a merger between these two applications, many companies are seeking convergence, creating screens that are 1920 pixels (the highest from the consumer side) by 1200 pixels (the highest from the business side).

If the marketplace is divided by the display size, certain technologies tend to dominate. This relationship is depicted in the figure below.



Marketplace Trends

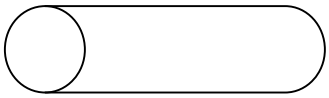
To consider where the marketplace is headed, we must first consider trends that are appearing in the marketplace now. Consider the following:

- With every release of operating systems, Microsoft has pushed manufacturers to create more powerful computers that allows for more horsepower to drive displays. The result: crisper, clearer screens
- The market for LCD cellular-phone displays will grow steadily between now and 2007, with more capable graphics displays increasing their penetration into the market
- Global demand for plasma screens is expected to grow nearly ten-fold between 2000 and 2003, with much of that demand coming from the consumer side
- The use of display technologies has grown from computers to include PDA's, digital cameras, viewfinders, mobile telephones, and more
- By the year 2006, the expected revenue for display technologies will nearly double from their 2000 levels
- The move toward audio-video devices is pushing display technologies to allow for a clearer, sharper resolution picture
- The displays that we have now show only a fraction of the number of colors present in nature

As a result of these trends, several new technologies are arriving that will change the way that we view display devices.

The Direction of Display Devices

Rick Knox highlighted six future possible display devices that are emerging. These are summarized below.



Display Direction #1: The Flexible Tube. A screen is embedded in the tube. When the user pulls the screen out of the tube, information is displayed. When the user returns the screen back, the information is refreshed.

Display Direction #2: e-ink. The liquid material has black and white particles that are manipulated with electrical charges. If a positive charge is applied, black particles rise to the surface, while a negative charge pulls up white.

Display Direction #3: eyewear/wearable displays. A small screen is embedded in the eyeglasses (top picture). This display shows the user information sent to it by tiny computers that the user is wearing. However, one variation of this is that the display may not go to the eyewear directly. Instead, it may be shown somewhere on the body of the individual, perhaps on a t-shirt or a small flat screen attached to their body.

Display Direction #5: Flexible displays/flexi-glass. If polymers can be manipulated (using OLEP technology), then anything can become a display source. This will lead to displays that are flexible and new display technologies can be developed. One example of this is flexible glass.

Display Direction #6: Smart cards. If smart cards become used as an identifier, they can easily become a display technology, showing information on them using LED technology.

Conclusions

The display technology marketplace is becoming increasingly more complex and cluttered. Fundamentally, however, each of these technologies are attempting to recreate the colors found in the real-world so that we can see them before our eyes. It is this ambitious endeavor that would have made Johannes Gutenberg proud 500 years ago.

For More Information/References

The pictures used in this summary are linked to articles with further information. We refer the reader to:

- Eyewear from: www.businessweek.com/2000/ 00_10/design4.htm
- E-ink from: http://www.lib.rochester.edu/main/ebooks/newsletter1-1/vol1-e-ink.htm
- Wearable from: www.usatoday.com/life/cyber/ ccarch/2002/04/03/baig.htm
- Flexible from: www.futureprint.kent.edu/ articles/west01.htm
- Smart card from: www.scia.org/knowledgebase/ resources/Amazon.htm

Other resources for more information on display technologies are:

- Display Search: FPD Market Research and Consulting: www.displaysearch.com
- Stanford Resources: Electronic Display Industry Specialists: www.stanfordresources.com
- The Society for Information Display: www.sid.org
- U. S. Display Consortium: www.usdc.org
- McLaughlin Consulting Group: Custom Technology Services: www.mcgweb.com
- International Society for Optical Engineering: www.spie.org
- Micro Display Report: www.insightmedia.info/home.html