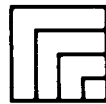


Electronic Imaging
Output Displays

Technical Report

AIIM TR19-1993



AIIM

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Technical Report for Information and Image Management

Electronic Imaging Output Displays

Association For Information and Image Management

This technical report describes current electronic display technologies that are used in the office document handling environment. It can be used as a guide when selecting appropriate display technology to match electronic image management requirements.

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Foreword

This document provides information on the types of displays used with electronic image management (EIM) systems. Particular emphasis has been given to high-resolution monochrome displays that are used for office-type documents. Color displays have been included as well as a brief review of other emerging technologies. (Note: The terms cathode ray tube, monitor and display are commonly used. For the purpose of this technical report, the term display is used.)

Throughout this report, it is important to note that primarily, two types of information are displayed on a workstation terminal. The first is text and graphics created by a software application. This information is created by the software program from stored text and graphic attribute data. Text created in this manner is optimized by the display manufacturer to have the highest resolution achievable by that display device.

The second type of information displayed is text and graphics which are represented as a digital reproduction of a document. This information is created by scanning and storing a bit-map of a document. The display quality of a scanned image is directly affected by the quality and resolution of the scanner and indirectly by the quality and resolution of the display device and any supporting software that enhances the displayed image. In considering any display device for bit-map image processing, the quality of the input must be judged. The quality and accuracy of the scanned image (a bit-mapped reproduction of a document) on any display, whether the display is high or low resolution, monochrome or color, is dependent on the condition of the original document, the quality of the scanner, and any post-scanning work done for image enhancement. Although scanning is not addressed in this document, it is important in any image system.

A second factor must be noted as it relates to resolution and displays. The definition of resolution depends on how an image is being produced and it is entirely possible

for one definition to be inappropriately used for another. Although the following do not comprise all technologies or situations, it is important to differentiate between the following terms for the purpose of this report. Fuller and more detailed explanations are provided in the appropriate sections of this technical report.

a. **Photographic resolution:** The resolution of a camera lens is typically measured by using a series of parallel lines called a test chart. The National Institute of Standards and Technology developed a chart in which the line width is equal to the space between the lines. As the line width and the space between the lines are reduced, the ability of the lens to differentiate between line and space is tested. These lines and spaces are called line pairs and are measured as line pairs per millimeter (lp/mm).

b. **Computer display resolution:** Information displayed on a computer terminal is composed of a pattern of dots that are either lighter or darker than the background light. These dots, when combined in a series, form characters or a representation of a scanned document. The resolution of the display screen is contingent on the number of dots that can be displayed as individual dots and the capability of the display to keep the dots and open space separate. These dots are typically measured as the number of dots per inch (dpi) that a display can produce.

c. **Printer output resolution:** Similar to a display, a laser printer lays down a pattern of dots that form an image of what is being printed. The resolution is dependent on the number of dots, horizontal and vertical, that can be printed in one square inch. The higher the number of dots, the smaller they are, and hence the finer the printed image can be. The human eye can then *resolve* this image. For example, the eye will typically be able to see the difference between printing at 100 dots per inch and 300 dots per inch.

A complete discussion of resolution and factors affecting resolution can be found in AIIM TR26-1993, Technical Report for Information and Image Management, Resolution as it Relates to Photographic and Electronic Imaging. We wish to acknowledge Sigma Designs and Cornerstone Technology for their valuable help with preparing this technical report. We also wish to acknowledge Dr. James Sheedy of the School of Optometry, University of California at Berkeley, for providing copies of his research for use in this technical report.

Suggestions for improvement of this technical report are welcome. They should be sent to the Chair, AIIM Standards Board, Association for Information and Image Management, 1100 Wayne Avenue, Suite 1100, Silver Spring, MD 20910.

At the time it approved this technical report, the AIIM Standards Board had the following members:

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The AIIM Electronic Imaging/Output Committee, C14, processed and approved this technical report. The committee had the following members at the time this technical report was approved:

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Technical Report for Information and Image Management — Electronic Imaging Output Displays, AIIM TR19-1993

1 Scope and purpose

1.1 Scope

This document describes basic display technology, purchasing considerations, and ergonomic considerations for buyers and sellers evaluating electronic displays, particularly within the electronic image management (EIM) environment.

1.2 Purpose

The purpose of this technical report is to provide information on various aspects of EIM display technology for users to refer to when selecting a computer display for EIM applications.

2 References

AIIM TR2-1992, Technical Report for Information and Image Management, Glossary of Imaging Technology.

AIIM TR26-1993, Technical Report for Information and Image Management, Resolution as it Relates to Photographic and Electronic Imaging.

VDTS and Vision Complaints: A Survey. James Sheedy, *Information Display*, April/May 1992, Vol. 8, No. 4 & 5, pp. 20-23.

Video Display Terminal Eye Clinic: Clinical Report. James Sheedy and Steve Parsons, *Optometry & Vision Science*, Vol. 67, No. 8, pp. 622-626.

Vision Problems at Video Display Terminals. James Sheedy, *Society for Information Display*, May 1991, pp. 471-474.

Reading Performance and Visual Comfort on a High Resolution Large Monitor Compared to a VGA Monitor. James E. Sheedy, *Journal of Electronic Imaging*, Vol. 1, No. (4), pp. 405-410.

3 Definitions

The following definitions apply to terms that appear in this technical report. Other terms are defined in AIIM TR2.

3.1 Acuity: Perceived sharpness of light emission across a pixel and the sharpness of a pixel's edge. Once the contrast ratio is high enough to easily distinguish between *on* and *off* pixels, image crispness is determined by how uniformly the on pixels emit light and how minimally that light leaks into the adjacent pixels.

3.2 Addressability: Specifies the number of discrete picture elements (pixels) in memory capable of being

addressed (e.g., 1,600 x 1,280), and often is larger than the number of visible pixels resolvable in the display window by the unaided eye, which resolves an arc-minute or 60 cycles/degree by definition of 20/20 vision. Any single pixel may be addressed and visually detected alone, but resolution is defined by the size of the smallest element of an image distinguishable from adjacent pixels.

3.3 Ambient light: General level of light in a room or an area.

3.4 Analog monitor: Device that uses an analog signal; voltage varies continuously. Capable in theory of displaying an infinite number of shades of the primary colors.

3.5 Antiglare filters: A method of coating the face of the video display tube with anti-glare material; placing an anti-glare screen in front of the face of the display tube; or etching the glass surface of the display tube to reduce glare.

3.6 Blooming: As light intensity and the spot size increase, the display will track over one scan line onto the adjacent lines. This will vary from the center of the screen to the corner.

3.7 Board: Refers to the adapter or controller board in a computer's backplane that provides the interface circuitry between the computer and display (in displays).

3.8 Brightness: Perception of the amount of light a display emits, reflects, or transmits. This can be measured as an average over an area or as pixel spot-brightness.

3.9 CGA: See color graphics adapter, 3.17.

3.10 CFF: See critical flicker frequency, 3.18.

3.11 CRT: See cathode-ray tube, 3.12.

3.12 Cathode ray tube (CRT): Signal-to-image converter tube in which a well defined and controllable beam of electrons is produced and directed onto a surface to give a visible or otherwise detectable display or effect.

3.13 Color, continuous tone: Ability of the display to produce a range of colors or varying shades of the same color. The color range is dependent on the number of bits assigned to each primary color. For example, if each primary color (red, green, blue) was capable of 256 levels of color, the display would be capable of producing 16 million colors.

3.14 Color display: Display capable of presenting colors perceived as a function of the three major subjective attributes of hue, saturation and intensity (HSI).

3.15 Color, saturated: Vivid primary colors red, green, blue (RGB) and their respective complements cyan, magenta, yellow (CMY) undiluted by white or other colors which reduce the purity as indicated by the

locus of points on the CIE and UCS chromaticity diagram. Note: cyan is equal to minus red, yellow is equal to minus blue, magenta is equal to minus green.

3.16 Contrast: Ratio of the difference between *on* pixel brightness and the surrounding background or *off* pixel brightness to the average or specified background reflection of ambient illumination. The greater the brightness, the greater the contrast difference must be to result in the same perceived contrast ratio.

3.17 Color graphics adapter (CGA): The first color video interface set of requirements established for IBM PCs. Uses analog and digital video signal. Resolution was 320 dpi x 200 dpi. Superseded by EGA.

3.18 Critical flicker frequency (CFF): Frequency at which a flicker becomes perceptible to the eye.

3.19 DPI: See dots per inch, 3.22.

3.20 Data rate: Speed of the video controller processing bits of data. Expressed in megahertz (MHz) or millions of times per second.

3.21 Display: Visual presentation.

3.22 Dots per inch: Measurement of resolution, e.g., 200 dpi or 1,600 dpi x 1,200 dpi. See also pixel, 3.47.

3.23 Dot pitch: Spacing between picture elements (pixels) in a display; dot pitch of color triads is the distance in millimeters (mm) between the phosphor triads and is a measure of the resolution capabilities of the display itself. Many EGA displays have dot-pitch measurements in the 0.31 mm range (or greater) and the trend is toward finer dot pitch of 0.28 mm or less. See triads, 3.5.9.

3.24 EGA: See enhanced graphics adapter, 3.25.

3.25 Enhanced graphics adapter (EGA): EGA is the next level of increased screen clarity and resolution beyond CGA. EGA uses digital video signal transmission. Superseded by VGA.

3.26 Flat tension mask (FTM): Tightly stretched steel that is much thinner than other masks used in displays. Fewer electrons are absorbed by the mask and result in less distortion as the mask heats up. See mask, 3.3.8.

3.27 Flicker: Change in the perceived brightness of the screen caused by a low refresh rate interaction with the integration time and persistence of the eye. See also critical flicker frequency, 3.18.

3.28 GUI: See graphical user interface, 3.29.

3.29 Graphical user interface (GUI): Software that allows users to interact with a computer on the basis of graphics rather than text and menu. GUIs are based on graphical icons to represent program functions rather than typing a command.

3.30 Grey scale: Capability to display varying levels of grey and usually represented as a number such as 16 levels of grey. The grey levels are created by varying the strength of the electron beam. The higher the level of greyscale, the smoother the transition from light to dark.

3.31 Hz (Hertz): Measure of frequency also expressed as cycles/sec, pixels/sec, lines/sec, fields/sec, etc.

3.32 Horizontal rate: Total number of raster lines per frame times the number of frames a display draws or refreshes per second. Expressed as a frequency, e.g., kilohertz (Khz). See also video graphics adaptor, 3.61.

3.33 Intensity: As intensity increases, the spot size tends to get bigger, adversely affecting resolution.

3.34 Interlace: Scanning mode in which every other line of the display is scanned on the first pass of the electron gun and remaining lines are scanned on the second pass.

3.35 LCD: See liquid crystal display, 3.36.

3.36 Liquid crystal display (LCD): Type of computerized display consisting of a matrix of twisted crystal pixels that can be addressed by a row and column scheme.

3.37 Landscape display: Display that is wider than it is high.

3.38 Mask: Device or opaque material that protects specific materials of a photosensitive area from exposure.

3.39 Misconvergence: Alignment error of the red, blue, and green electron guns. Displays with high misconvergence will display color with less purity.

3.40 Monitor: CRT, terminal or display for observing data or pictures.

3.41 Monochrome monitor: A two-tone black/white or grey scale display.

3.42 Multisync monitor: A display capable of using any video adapter cards. Some can read frequencies for both analog and digital signals or some for analog signal only.

3.43 Non-interlaced: Scanning mode in which each line on the display is scanned consecutively, typically at a 60 to 80 Hz refresh rate. See 3.50 refresh rate.

3.44 Persistence: Continued glow of the phosphors after their energizing excitation is stopped which interacts with the eye's persistence and integration time of about 0.2 seconds, therefore, the eye retains the image. Different phosphor compositions control how long the glow lasts and what colors are produced.

3.45 Phosphor: Coating inside the display which glows when excited by the electron beam. See triads, 3.5.9.