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# Displays

- Colored phosphors on a **cathode ray tube (CRT)** screen glow red, green, or blue when they are energized by an electron beam.
- The intensity of the beam varies as it moves across the screen, some colors glow brighter than others.
- Finely tuned magnets around the picture tube aim the electrons onto the phosphor screen, while the intensity of the beamis varied according to the video signal. This is why you needed to keep speakers (which have strong magnets in them) away from a CRT screen.
- A strong external magnetic field can skew the electron beam to one area of the screen and sometimes caused a permanent blotch that cannot be fixed by **degaussing**—an electronic process that readjusts the magnets that guide the electrons.
- If a computer displays a still image or words onto a CRT for a long time without changing, the phosphors will permanently change, and the image or words can become visible, even when the CRT is powered down. Screen savers were invented to prevent this from happening.
- Flat screen displays are all-digital, using either **liquid crystal display (LCD)** or **plasma** technologies, and have replaced CRTs for computer use.
- Some professional video producers and studios prefer CRTs to flat screen displays, claiming colors are brighter and more accurately reproduced.
- Full integration of digital video in cameras and on computers eliminates the analog television form of video, from both the multimedia production and the delivery platform.
- If your video camera generates a digital output signal, you can record your video direct-to-disk, where it is ready for editing. If a video clip is stored as data on a hard disk, CD-ROM, DVD, r other mass-storage device, that clip can be played back on a computer's monitor without special hardware.

# Interlacing and Progressive Scan

- The process of building a single frame from two fields is called interlacing, a technique that helps to prevent flicker on CRT screens.
- Computer monitors use a different **progressive-scan** technology, and draw the lines of an entire frame in a single pass, without interlacing them and without flicker.
- In television, the electron beam actually makes two passes on the screen as it draws a single video frame, first laying down all the odd-numbered lines, then all the even-numbered lines, as they are interlaced.
- On a computer monitor, lines are painted one-pixel thick and are not interlaced. Single pixel lines displayed on a computer monitor look fine; on a television, these thin lines flicker brightly because they only appear in every other field.
- To prevent this flicker on CRTs, make sure your lines are greater than two pixels thick and that you avoid typefaces that are very thin or have elaborate serifs.
- If you are capturing images from a video signal, you can filter them through a de-interlacing filter provided by image-editing applications such as Photoshop and Fireworks.
- With typefaces, interlacing flicker can often be avoided by anti-aliasing the type to slightly blur the edges of the characters.
- The term "interlacing" has a different meaning on the Web, where it describes the progressive display of lines of pixels as image data is downloaded, giving the impression that the image is coming from blurry into focus as increasingly more data arrives.
- Most computers today provide video outputs to CRT, LCD, or plasma monitors at greater than 1024 × 768 resolution.
- Table 6-1 describes the various aspect ratios and width/heights in pixels used by computer displays since IBM's VGA standard was adopted in 1987. The VGA's once ubiquitous 640 × 480 screen resolution is again becoming common for handheld and mobile device displays.

| Acronym | Name | Aspect Ratio | Width (pixels) | Height (pixels) |
|---|---|---|---|---|
| VGA | Video Graphics Array | 4:3 | 640 | 480 |
| SVGA | Super Video Graphics Array | 4:3 | 800 | 600 |
| XGA | eXtended Graphics Array | 4:3 | 1024 | 768 |
| XGA+ | eXtended Graphics Array Plus | 4:3 | 1152 | 864 |
| WXGA | Widescreen eXtended Graphics Array | 5:3 | 1280 | 768 |
| WXGA | Widescreen eXtended Graphics Array | 8:5 (16:10) | 1280 | 800 |
| SXGA | Super eXtended Graphics Array | 4:3 | 1280 | 960 |
| SXGA | Super eXtended Graphics Array | 5:4 | 1280 | 1024 |
| HD | High Definition (Basic) | 16:9 | 1366 | 768 |
| WSXGA | Widescreen Super eXtended Graphics Array | 8:5 (16:10) | 1440 | 900 |
| HD+ | High Definiton (Plus) | 16:9 | 1600 | 900 |
| UXGA | Ultra eXtended Graphics Array | 4:3 | 1600 | 1200 |
| WSXGA+ | Widescreen Super eXtended Graphics Array Plus | 8:5 (16:10) | 1680 | 1050 |
| HD-1080 | Full High Definition | 16:9 | 1920 | 1080 |
| WUXGA | Widescreen Ultra eXtended Graphics Array | 8:5 (16:10) | 1920 | 1200 |

**Table 6-1** Screen Resolutions for Computer Monitors

- Table 6-2 shows the most common screen resolutions.
- Note that the highest resolution, 1080p, does not include a 60-per-second frame refresh rate.
- When the ATSC standard was written in the early 1990s, that was simply too fast for the broadcast digital signal to keep up. Not shown is the 720 × 576 resolution used in PAL systems.

| Scan Lines from Top to Bottom | Pixels from Left to Right | Aspect Ratio | Display Rate in Frames per Second |
|---|---|---|---|
| 1080p (progressive) | 1920 | 16:9 | 30, 24 |
| 1080i (interlaced) | 1920 | 16:9 | 30 |
| 720p (progressive) | 1280 | 16:9 | 60, 30, 24 |
| 480p (progressive) | 704 or 640 | 16:9 or 4:3 | 60, 30, 24 |
| 480i (interlaced) | 704 or 640 | 16:9 or 4:3 | 30 |

**Table 6-2** Common Digital Television Resolutions

## Overscan and the Safe Title Area

- It is common practice in the television industry to broadcast an image larger than will fit on a standard TV screen so that the "edge" of the image seen by a viewer is always bounded by the TV's physical frame, or bezel. This is called **overscan**.

- In contrast, computer monitors display a smaller image on the monitor's picture tube (**underscan**), leaving a black border inside the bezel.
- When a digitized video image is displayed on a CRT, there is a border around the image; and, when a computer screen is converted to video, the outer edges of the image will not fit on a TV screen. Only about 360 of the 480 lines of the computer screen will be visible. Video editing software often will show you the safe areas while you are editing.
- Avoid using the outer 15 percent of the screen when producing computer generated graphics and titles for use in television video. The **safe title area** is where your image will not be affected by over scanning, even in the worst conditions.

## Digital Video Containers

- A digital video architecture is made up of an algorithm for compressing and encoding video and audio, a container in which to put the compressed data, and a player that can recognize and play back those files.
- Common containers for video are Ogg (.ogg, Theora for video, Vorbis for audio), Flash Video (.flv), MPEG (.mp4), QuickTime (.mov), Windows Media Format (.wmv), WebM (.webm), and RealMedia (.rm).
- Containers may include data compressed by a choice of codecs, and media players may recognize and play back more than one video file container format.
- Container formats may also include metadata—important information about the tracks contained in them—and even additional media besides audio and video.
- The QuickTime container, for example, allows inclusion of text tracks, chapter markers, transitions, and even interactive sprites.
- Totally Hip's LiveStage Pro (www.totallyhip.com) is an authoring tool that can produce interactive multimedia self-contained within a single QuickTime .mov container.

## **Codecs**

- To digitize and store a 10-second clip of full-motion video in your computer requires the transfer of an enormous amount of data in a very short amount of time.
- Reproducing just one frame of digital video component video at 24 bits requires almost 1MB of computer data; 30 seconds of full-screen, uncompressed video will fill a gigabyte hard disk. Full-size, full-motion uncompressed video requires that the computer deliver data at about 30MB per second. This overwhelming technological bottleneck is overcome using digital video compression schemes or codecs (*co*ders/*dec*oders).
- A **codec** is the algorithm used to compress a video for delivery and then decode it in real time for fast playback.
- Different codecs are optimized for different methods of delivery (for example, from a hard drive, from a DVD, or overthe Web).
- Codecs such as **Theora** and H.264 compress digital video information at rates that range from 50:1 to 200:1.
- Some codecs store only the image data that changes from frame to frame instead of the data that makes up each and every individual frame. Other codecs use computation intensive methods to predict what pixels will change from frame to frame and store the predictions to be deconstructed during playback.
- These are all lossy codecs where image quality is (somewhat) sacrificed to significantly reduce file size.

## MPEG

- The MPEG standards were developed by the **Moving Picture Experts Group** (**MPEG**, www.mpeg.org), a working group convened by the International Organization for Standardization (ISO) and the International Electro-technical Commission (IEC), which created standards for the digital representation of moving pictures as well as associated audio and other data.
- Using **MPEG-1** (specifications released in 1992), you could deliver 1.2 Mbps (megabits per second) of video and 250 Kbps (kilobits per second) of two-channel stereo audio using CD-ROM technology.
- **MPEG-2** (specifications released in 1994), a completely different system from MPEG-1, required higher data rates (3 to 15 Mbps) but also delivered higher image resolution, improved picture quality, interlaced video formats, multiresolution scalability, and multichannel audio features.
- MPEG-2 became the video compression standard required for digital television (DTV) and for making DVDs.

- The MPEG specifications since MPEG-2 include elements beyond just the encoding of video.
- As a container, **MPEG-4** (specifications released in 1998 and 1999) provides a content-based method for assimilating multimedia elements.
- It offers indexing, hyperlinking, querying, browsing, uploading, downloading, and deleting functions, as well as "hybrid natural and synthetic data coding," which will enable harmonious integration of natural and synthetic audio visual objects.
- With MPEG-4, multiple views, layers, and multiple sound tracks of a scene, as well as stereoscopic and 3-D views, are available, making virtual reality workable.
- MPEG-4 can adjust to varied download speeds, making it an attractive option for delivery of video on the Web.
- The MPEG-4 AVC standard (Advanced Video Coding, Part 10) requires the H.264 codec for Blu-ray discs.
- Because the software behind MPEG-4 is patented by more than two dozen companies, developers who build video editors and players that read and write MPEG-4 files must purchase licenses and make royalty payment.

For any doubt contact 9873961596