

Digital Video Primer

An Introduction to Desktop Digital Video

Like the advent of desktop publishing in the 1980s, desktop digital video systems enable personal computer users to perform video production tasks previously handled only by large studios and production firms. As the necessary hardware and software for video production and post-production becomes more affordable, Macintosh ® and Windows ® users can turn their computers into complete video production workstations where they can create video productions in full broadcast quality. With digital video, users can completely repurpose taped video footage; from the same original digital files, they can render productions for use on film, videotape, DVD, CD-ROM, or the Internet.

Video projects are created in two main phases: production and post-production. The production phase involves capturing footage on videotape. Once the footage has been shot, the post-production process— editing, creating effects, and adding titles—begins. Analog video editing and post-production is done linearly, proceeding from the first image or transition to the fade to black after the last screen credit. If an error occurs when the user is editing or laying down visual effects, they must return to that mistake and then redo all work from that point.

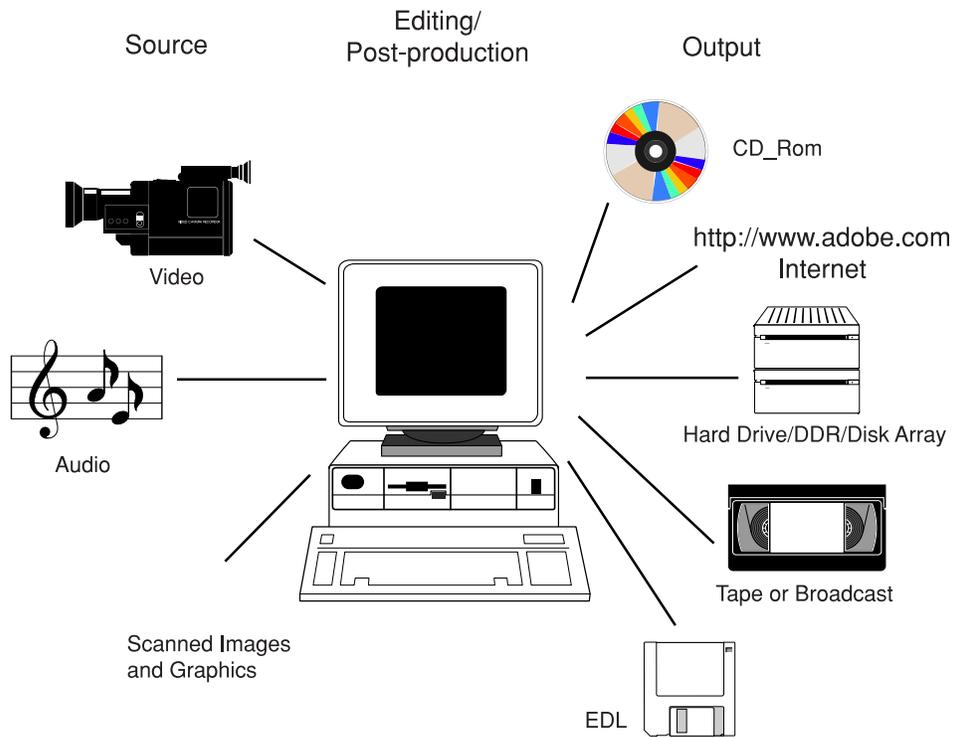
Digital video editing involves converting videotaped footage into data that can be stored on, and accessed from, a computer hard drive (or any other digital storage medium). Digital video editing is nonlinear, permitting any video clip, sound, edit, or effect to be removed, replaced, moved, or modified at any time, without overwriting or changing the original clip. Post-production becomes a fluid, flexible process in which the imagination is the only limitation.

The digital video revolution began with the introduction of highly specialized, dedicated video hardware on which users could create digital video effects (DVE), such as spinning or rotating an image on the screen, or compositing one video image onto another. Then came turnkey, or closed-architecture, digital editing systems. Although nonlinear, these systems were very expensive (in the \$30,000 to \$200,000 range) and used proprietary hardware and software that preclude cross-system compatibility and forced users to rely on one vendor to supply creative tools and technical support. Today, open-architecture digital video systems are prevalent; they use off-the-shelf software and hardware compatible with readily available personal computers.

Open-architecture solutions allow for the integration of many different kinds of digital media, such as sound, still images, 2D and 3D animations, and video clips. In addition, source files can be easily repurposed for videotape, CD-ROM, on-screen, or Internet distribution. The advantages of open-architecture systems are the control they offer the user over every aspect of the creative process and the freedom to choose the best technologies and components. Because they use commonly available technologies, open architecture digital editing systems are very cost-effective. Open systems run natively on the Mac™ and Windows Operating Systems, enabling users to expand their video-processing capabilities as they upgrade their computers. What's more, users don't have to rely on a single vendor to provide hardware, software, accessories, or upgrades; they can choose the editing software, effects software, and image-processing software best suited for a specific application, whether they're creating QuickTime ® or Video for Windows movies for a CD-ROM, broadcast-quality video for television, or even film-resolution work for motion pictures.

Digital Video—The Process

A nonlinear, open architecture digital video system is based on a multistep process that includes logging and digitizing (i.e. capturing) source video; editing and post-production; and transferring final output to videotape, CD-ROM, DVD, or a hard drive.



Logging is the first step of video-intensive projects. Logging involves looking through source video footage or media and determining exactly what takes, images, or clips to use. Users can roughly log their video by mark-ing down the beginning and ending of a clip, using the time indicator on a home VCR. Or they can designate frame-accurate in-and-out points using timecode on a professional video deck.

Capturing, or **digitizing**, video entails converting the analog signal from a videotape to digital data, stored on a hard drive. This is done using **video capture**—built-in or plug-in hardware boards installed in the computer. Users hook up their VCR or camcorder to the video capture port. Like a VCR, the board captures the video played into it, converts it into digital data, and records it to a hard drive. Most of these boards also compress the video as they digitize, using compressor/decompressor (codec) chips. Codecs compress the video to decrease the storage requirements of the video footage and to reduce the bandwidth of the video data to one that the computer can handle smoothly. Codecs are critical to determining how to make digital video look best for the delivery methods used.

Once the footage is digitized, imagination and creativity can take over. Using editing programs such as Adobe Premiere ® and compositing and effects applications such as Adobe After Effects ™, users can begin **post-production**. An essential part of post-production is **editing**, and precision tools such as Adobe Premiere software can keep editing exact and video well-paced. Users can combine video clips to produce a coherent sequence of images and sound to communicate messages, emotions, or themes. **Audio** is another essential— and often overlooked—aspect of video editing. Audio effects, voice-overs, and musical soundtracks can be added during the post-production phase.

Visual effects, usually generated in post-production, comprise several broad categories:

- **Compositing** involves blending images from one scene into another to create the illusion that they were never separate. Compositing is the secret of how Superman flies and is what animates the moving weather maps and graphics that television meteorologists use. **Keys, mattes**, and specialized techniques such as **bluescreen** are some of the many techniques used to composite multiple video and/or still visual elements.

- **Animation** is the art of using many still images to create the illusion of motion, called **persistence of vision**, which can range from the traditional, hand-painted cell animation of cartoons, to computer-generated 3D, animation of graphics, or the extended animations seen in films such as *Toy Story* and *Jurassic Park*).
- **Titles**, or text that appears over video images, are often an overlooked aspect of video. They are used primarily for project credits, in commercials (to impart information) and in art and music videos (to enhance or juxtapose meaning).
- **Motion control** corrects an effect or makes it correspond with camera moves. Motion control is especially important if the motion of a special effect must follow the motion of the camera in the original clip (the dinosaurs of *Jurassic Park* are a great example of composited images that had to match some rather athletic camera moves). Adobe After Effects and Adobe Premiere software have some of the most robust motion control tools found on Macintosh or PC systems. After Effects offers many advanced techniques, such as motion tracking and even stabilization of a wiggling or shaking camera shot.
- **Transitions** are a means for cutting between scenes and images. Cuts are simply edits where one shot ends and another begins; wipes, fades, and dissolves are more complex transitions used to enhance a scene or to visually separate a unique episode, such as a flashback or a dream sequence.
- **Image processing** involves color correction, special effects filters, and other techniques to affect the appearance of a video clip. Image processing can enhance poorly shot footage, correcting imbalanced color or sharpening blurred images, or it can be used to create special effects, from color tinting to warping. With programs such as Adobe After Effects and Adobe Premiere, parameters of special effects can change (or interpolate) over time, generating astounding dynamic visual effects.

Digital Video Applications

Digital video has a variety of applications, ranging from broadcast television, corporate videos, multimedia presentations, CD-ROM, or movies on the World Wide Web. Digital video to be shown on videotape is produced through either off-line or on-line editing.

On-line editing refers to the final edit of a video using original master tapes to produce the finished piece. Digital Video can be used as an on-line editing tool because, with the appropriate hardware, the quality of the output is sufficient for many purposes from CD-ROM and Internet movies to video tape.

With off-line editing, copies of the original master tapes and relatively low cost hardware are used to make editing decisions. These decisions are recorded in an EDL (edit decision list). The EDL is simply a compiled list of edits and transitions that most on-line video editing systems can perform. An on-line editor uses this list to automate a video switcher to make the final edits.

Under the Hood: Technology Overview

Video Architectures

Apple developed QuickTime, a software-only video technology, for MacOS, Windows 3.1, Windows 95, and Windows NT as its underlying desktop video technology. Microsoft developed Video for Windows, ActiveMovie and Direct X as PC-based software-only video technologies that run under Windows 3.1 (Video for Windows only), Windows 95, and Windows NT™. These technologies form the foundation of open-architecture systems, which define standard file formats and allow the use of any compatible hardware or software.

Both of these technologies use digital data compression and decompression schemes—codecs—to play and store video and audio. QuickTime and Video for Windows or Direct X, however, are not themselves codecs; they are architectures into which codecs are “plugged.” Within this architecture several codecs from different manufacturers may be available. Also included within the architecture are the mechanisms or drivers for playing back compressed video and audio.

Compression

Codecs analyze digitized footage and describe the images in a more efficient way, reducing digital video file sizes and enabling them to play more smoothly. Codecs can be either software or hardware based.

Codecs employ two types of compression—spatial and temporal. Spatial compression reduces the data contained in a single video frame by identifying areas of similar color and eliminating redundancy. (This is why highly compressed digital video often appears blurred or “chunky.”) With spatial compression, areas of fine detail, such as a sequined dress, will not compress efficiently—or at all. The less detail and contrast a video clip has, the better it compresses, and the more a user ultimately can fit on a hard drive or a CD-ROM.

Temporal compression reduces the differences between individual video frames. In a process known as frame differencing, a codec can compare any given video frame to the next frame and establish differences in color and brightness values. By establishing which pixels remain exactly the same color, the codec doesn't have to redraw every pixel of each frame, making the video clip's playback rate faster. If there's extensive motion or many changing colors or tones—such as those generated by a fast camera move—frame differencing won't work as efficiently as it could, resulting in larger file sizes and slower playback.

There are many different codecs available, which makes choosing the correct codec confusing. Typically, the codec is determined by the playback requirements for the final movie. A few examples: if you'll be playing your movie out to video tape, you'll use the hardware codec for your capture card; if you'll be playing back your movie from CD-Rom, you'll typically use either Cinepak, Intel Indeo or Sorenson MPEG; if you'll be playing your movie from an internet site, you'll use a codec that supports streaming like RealVideo or Vivo. For a detailed discussion of specific codecs, see the document, “Using Video Compression with Premiere General Information” available from the Support Database on Adobe's web site (<http://www.adobe.com/supportservice/custsupport/database.html>).

Setting Up A Digital Video Studio

The computer, whether it runs MacOS, Windows 95, Windows 98, or Windows NT, is the heart of any open-architecture video system. Everything else, from hardware to software, can be mixed and matched to fit exact creative and budgetary needs. The more one can spend, the better the equipment and the better the video will look; however, even a modest budget enables participation in the world of desktop digital video.

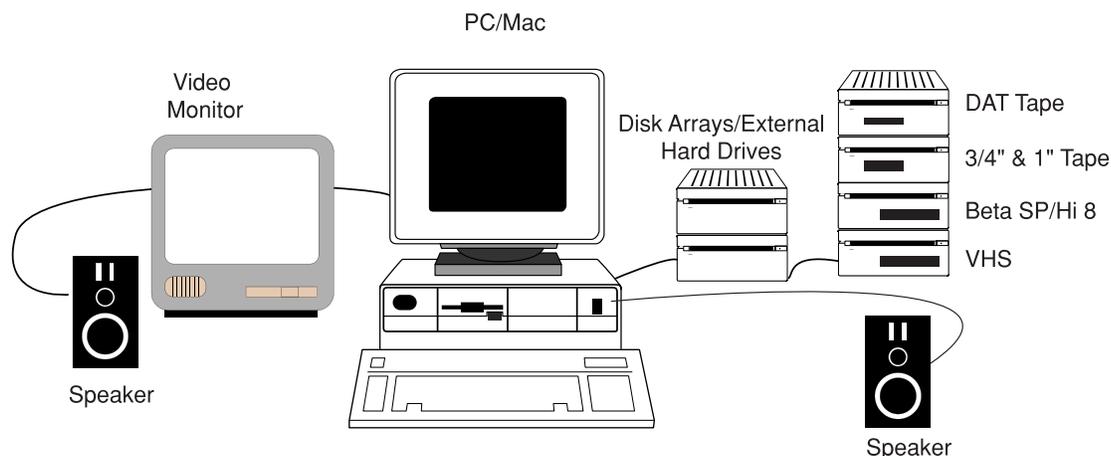
Choose the fastest computer, the largest and fastest hard drives, as much RAM as your budget allows, and suitable display devices to match production needs.

• **The Computer.** Power Macintosh® and Pentium class computers are the most powerful personal computers available and therefore the most popular for digital video production. But other considerations exist. Because video quality is directly related, to some extent, to data rates (i.e., the higher the movie's data rate, the better the quality), it's important to maximize the sustained data rate of the bus, capture card, and hard drive. Video capture cards and other add-on boards plug into the hardware bus inside the computer; older Macintosh computers use a system called NuBus ® for plug-in peripheral boards, while older PCs use ISA or EISA bus architectures. Macintosh and PC computers have converted to a cross-platform hardware bus system called PCI (peripheral component interconnect). The PCI architecture is much faster than NuBus, ISA, or EISA, so a PCI video capture board and a PCI-bus computer is recommended for the best capture and playback performance.

Macintosh A/V (audio/visual) computers have built-in video and audio capture ports. Currently, the built-in capabilities are great for multimedia and internet video production but not fast enough for full resolution, full speed broadcast quality video production.

There's also a new input/output interface standard named FireWire, which is an implementation of the IEEE 1394 specification. FireWire offers a high data transfer rate, supports “hot-swapping,” (allowing peripherals to be connected and disconnected without shutting down the host computer), and requires no dip switches, ID selectors, or terminators. FireWire connections are currently used with new digital

(DV) camcorders. Several PCI-based computer boards will support FireWire connectors for video input, and Apple and Microsoft plan to offer support for FireWire as a standard computer connection in the future. FireWire may eventually replace the SCSI interface to external devices.



- **Hard Drives.** Hard drives built for fast, sustained data transfer, such as “AV drives,” Ultra SCSI drives, and disk arrays are the best drives for digital video. Disk arrays are multiple hard disks formatted to act as a single hard-drive volume, greatly accelerating reading and writing operations. Ultra SCSI drives, which connect to a computer's PCI slot via an adapter, can maintain data rate transfers of up to 40 MB/second. Some companies have also made array and SCSI hardware accelerators, improving read/write speeds and helping data move faster through the SCSI bus. Users who plan to process multimedia-class digital video should consider a hard drive from 2 to 4 GB as a minimum size, preferably an array. For broadcast-quality video, users may want to purchase specialized hard-drive arrays larger than 4 GB. For more information on storage space requirements, see the document, “How to Calculate File Sizes and Disk Space for Digital Video” available from Adobe’s On-line Support Database.

- **RAM.** RAM is money in the bank: you can never have enough. Most digital video professionals start with 64 MB of RAM, but even 32 MB permits some multimedia-level video work. The more RAM you have, the shorter your processing times will be. Modern personal computers can usually accept a maximum of between 256 MB and 1,024 MB of RAM.

- **Displays and Monitors.** Macintosh system users might want a secondary monitor for additional screen real estate. Digital video editing software often has a lot of floating palettes and tool boxes, so having one monitor to preview images and video and another to view software controls is quite useful. The video preview monitor can be a video display (NTSC or PAL), helpful for both previewing video as well as for viewing output or source footage from a video deck.

- **Analog or Digital video equipment,** to shoot and store original footage, will most likely be required. For those who simply want to experiment with desktop digital video for personal use or as a hobby, core equipment can be a consumer-level camcorder (Hi-8 or VHS) and a VCR (VHS or S-VHS). With this, a general user can digitize composite video output and audio from either a camcorder or a VCR. For those who are serious about financial investment and video quality, it’s a good idea to purchase a camcorder with more than one charged couple device (CCD—an electronic sensor for image capture; three-chip cameras have a separate CCD for each individual RGB channel) and a VCR that has S-video (or even component outputs) and timecode support. SMPTE timecode and device control are features on professional VTRs and are necessary for creating EDLs. Hi-8 and SVHS video formats are high quality formats. Those doing more advanced video production might consider investing in professional-level VTRs, three-CCD cameras, and DV or Betacam-based equipment. Starting with high-quality analog source video is critical to producing high-quality digital video.

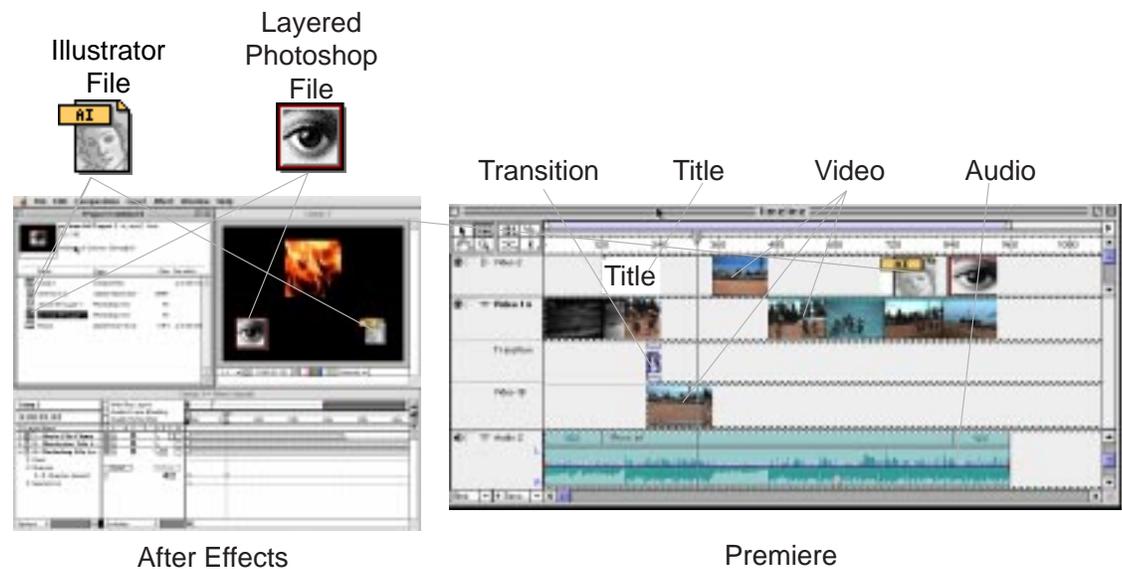
- **Video capture hardware** is the next requirement. For multimedia digital video production, many low-cost (under \$1,000) video capture boards are available. They usually can create digital video files

from 320-x-240 to 640-x-480 pixels in size, capture from 15 to 30 frames per second, and accept composite input and output. For output to video or broadcast, a combination of professional features such as full-screen capture, 60 field capture and component in/out.

- **Audio capture hardware** requirements depend on individual needs and the computer platform being used. Many video capture cards have built-in audio capture. Typically, cards that capture both video and audio provide better audio and video synchronization. Also recommended is a pair of speakers, properly shielded. (Speakers contain huge magnetic coils and can damage magnetic storage media such as tapes, floppy disks, and hard drives.)

The Adobe Media Production Suite

Software provides the tools that let creativity soar. Adobe Premiere, Adobe After Effects, Adobe Photoshop®, and Adobe Illustrator® are the four most popular and powerful applications for Dynamic Media creation, but there are many other programs on the market to choose from, depending on budget, creative needs, and computer platform. One reason why open-architecture digital video is so compelling is that it permits the integration of media and creative tools into a video project. For example, Adobe Photoshop files can appear in video, their individual layers animated with After Effects, or a logo created in Adobe Illustrator can be used as an on-screen graphic or even extruded in 3D to spin over the Hi-8 Grand Canyon video footage captured using Adobe Premiere.



This high level of data sharing and integration among Adobe Photoshop, Adobe Illustrator, Adobe Premiere, and Adobe After Effects software provides a full solution for digital image creation and animation, with maximum workflow efficiency at every step of the post-production process.

The world of desktop digital video lets users integrate most forms of media—from video and animation to sound and the spoken word—into one of the most compelling and captivating forms of communication of this century. Through multimedia, video, television, and film, digital video grants users the power to communicate and share their vision with the world.

For a comprehensive listing of available resources (e.g., training materials, hardware and software manufacturers, on-line mailing lists, etc.) see the document, “Digital Video Resources General Information” available from Adobe’s On-line Support Database. You may also search the Database for information on other video-related topics!