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Intro to Computer Concepts

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# **A Guide to Digital Video**

## Introduction

Digital video has changed the world since its invention in 1977 and its rapid advancements have changed our ability to consume information forever. How does it work? How do video file formats differ? All these questions feel very daunting when first beginning to work with it. Digital video has become so integrated into the world we have become numb to it. The leap from analog video (film) to digital video has changed the way information is processed and seen throughout the world. Today there are so many different types of files it feels daunting to pick one, and once you do, there is the possibility it is not compatible with what you need. This essay will cover the ins and outs of its history, operation, and uses in an easy-to-understand way.

## Why was Digital Video Needed?

Before the invention of digital video and cameras, video was taken through analog film cameras. Film cameras capture video by using a roll of film, a material made of celluloid and coated with light-sensitive gelatin emulsion. When the shutter opens, light shoots into the lens, and makes an imprint onto the film. Several frames of film are exposed to light every second, creating the impression of motion. This technology worked well for nearly half a century; however, it had its issues. Film can be very volatile; difficult to use unless one was a trained expert. If the shot was overexposed, underexposed, out of focus, or any other of the countless reasons why a shot can go wrong, the expensive film would become unusable. There is also the issue of editing film together. Film is edited by physically slicing and splicing the shots together, this is extremely time consuming with little to no room for error. Film reels are also heavy and take up a lot of space, as well as being highly combustible. On the consumer end as well, film can be less than ideal. The noise, as in grainy blur generated during transmission to televisions does not make for a picturesque image. Clearly, the use of analog cameras and film come with a multitude of issues that make them impractical for the average consumer/low budget filmmaker, which created the need for digital cameras/video to be created.

## A Brief History

The advancement into digital video was first brought by experiments conducted by the British Broadcasting Corporation (The BBC) and at Bell Laboratories (right here in New Jersey!) This was first done by digitizing video shot on film. The digitized film made editing and correction

much easier in production, and the film would be converted back into analog for transmission. Equipment meant for this was introduced in the 1970s- early 1980s for production companies but was still not the standard. The first digital camera was invented in 1975 by Eastman Kodak engineer Steven Sasson. He used Fairchild CCD electric sensors to capture the light, replacing film. Still, digital transmission was not widely available until 1986 when Sony produced Sony D-1 format, which revolutionized the tv industry by allowing digital broadcast tape format. In 1995, the digital video (DV) was invented by a consortium of companies led by Sony, and it became the standard. This is when an assortment of different types of video files would be able to be developed. The digital video disk was invented in 1995 and released in 1996, which would allow consumers to play high quality video in their own homes. Throughout the 2000s, companies would begin to compete with their own types of video file formats, compatible for different operating systems that were becoming more and more commonly used on home computers.

### Resolution and Bitrate

Video, or any image that can be displayed on a computer screen, is composed of pixels. Resolution determines the size of the pixels on the screen, while bit rate determines the amount of information displayed on screen per unit of time. Resolution is measured in pixels on the screen. An example of this is something you have likely heard before, 1080p, otherwise known as Full HD. 1080p means 1920 pixels across and 1080 pixels down, creating a total of more than 2 million pixels. Higher resolution takes more energy to process. Bitrate is measured by units of data per second, for example: Megabytes per second; Mbp. Higher bit rates can cause a video to buffer if the connection speed is low.

### Codecs

If you have ever used a video editing software before, you are familiar with the concept of exporting. This is when you move your project with all its individual clips, audio, subtitles, effects, and whatever else your heart desires into one single playable video. A common codec is H.264. Codec is an acronym for compressor/decompressor. Computers, hard drives, or any type of digital storage device, have a finite amount of space. Imagine a cabinet from IKEA. You can see the built piece of furniture in the pictures, but it would take more time, energy, and space for IKEA to ship the product fully put together, so you assemble the pieces into the finished product.

Codecs do essentially the same thing. When a video file is not in use, the codec compresses it by reducing it in aspects such as color and picture quality. Then when you open the file, the codec will decompress the file, or in the former analogy, build the Ikea cabinet. There are two ways a codec can compress files, “lossy” or “lossless.” Lossy means that it will lose some of its metadata or merge it in the process, like how the IKEA furniture is always missing a few parts. This is why sometimes when you email a video file, it loses its quality on the other end. Lossless is the opposite, the data remains completely intact. This however can take up more space and require more computing power. These are all important to take into consideration when deciding what type of video file is right for you to export.

## Containers

The word containers may sound unfamiliar in this setting, but almost everybody has first-hand seen them on their computers. Containers are the box that the cabinet comes in. It is how all of the data is wrapped up and contained together. Some containers have the capability of holding a vast amount of metadata for things such as 4k video, subtitles, and high quality audio. Others can only hold low quality video and audio. All containers can hold audio and video, but the quality can vary. Containers can be identified by the end of the file. `NorasFifthBirthday.mp4`. Some of containers include `.mp4`, `.mov`, and `.avi` respectively. Many containers are designed to work for specific operating systems or editing software.

## MPEG-4 aka MP4

While called MPEG-4, it uses the file extension MP4. It has become the standard for both the internet and TV. This is because it has high quality while also taking up relatively less space. While there is no such thing as one size fits all, MP4 comes pretty close, hence why it is the most used file type. It is the perfect type of file for social media apps such as TikTok, where high quality fast video is essential to the platform. The downside for MP4 is that its codec, H.264, can be slower and demanding on a computer when the conditions are not well. The file must be decompressed in real time as the video plays, meaning that with an older computer and poor internet connection, a buffering video is a very real issue. It is still likely the most reliable and accessible video file format, making it the most popular video format today.

## MOV

The MOV format is likely the second most popular type of video. It has a higher quality than the MP4, at the sacrifice of storage space. One of the benefits of MOV is that it can also support text, meaning that the text is separate from the video, while still being in the same container of course. This means that the viewer can have the choice of subtitles or not, as they are not imprinted onto the video. Most platforms that support MP4 support .mov, such as TikTok, snapchat, twitter, etc. MOV was originally developed by Apple for its quick time player. It is primarily used for editing video picture, such as the practice of color grading and color correction. However, the video still needs to be compressed to be uploaded to the web, so while it is possible, it is relatively rare for one to upload a video for viewing under the MOV format.

## MKV

The MKV format is primarily used in video editing. It is an open source One of its main benefits is that it is compatible with any codec, making exporting a lot more versatile for the editors' specific needs. The format is free and open source, again, making it a good choice for editors who need to move from project to project quickly and cheaply. Perhaps the biggest issue with MKV is its low compatibility. While it is compatible with editing software such as Adobe Premiere Pro and VLC, it is not compatible with say YouTube or X (formerly known as Twitter.) It also needs high storage, creating a slower loading time.

## AVI

The AVI format, which stands for Audio Video Interleave, is known for its very high-quality video. It has strong compatibility, as it works on MacOS, Windows, and Linux, although it is originally designed for and primarily used on Windows. AVI used to be one of the most popular file formats, however it does have some glaring issues. With its high quality, lossless compression becomes impossible. A few minutes of AVI can create 1 gigabyte of data, making uploading to the internet pretty much impossible. This is why AVI is primarily used for DVD management. AVI is considered good for storage, but sub-par for streaming video. While it can be uploaded to YouTube, it is quite uncommon.

## AVCHD

The AVCHD format was developed by Sony and Panasonic for camcorders. It was created to capture high-definition video that can be played directly after it is recorded. It has lost a lot of its relevance, however, because despite its high quality, the file sizes are inconveniently large (taking up to 1000 MBs). Because of this, most newer camcorders have swapped AVCHD for MP4, despite its quality being slightly lower. AVCHD is also not compatible with most players, as it is only compatible with VLC media player and Blu-ray.

## WMV

The WMV format stands for Windows Media Video. It was developed by Microsoft for the Windows operating system. It has super high quality with small file sizes, making it decent for web use in some cases. Its biggest issue is that it is not compatible with Apple or Linux, meaning despite its quality and optimal file size, it will likely never beat out MP4 for standard format.

## Converting Video

Unsurprisingly, the lack of universal ability amongst video file types can create a problem. Some cameras only shoot a certain type of video that may be incompatible with your media player or editing software. This is where video converters come in. What these do is they transcode the video files. There are two types of video converters: Hardware and Software. A hardware video converter is an adapter for digital film equipment. It allows for a video to be captured on camera while being displayed on a monitor in real time. This is important for filmmakers as it allows them to have a more detailed view of the shot and see things that may be difficult to see on a camera screen. The difference between decent hardware video converters and poor ones is the codec they use. The quality of the codec can diminish the aspect ratio, resolution and bitrate by changing the container format. Software video converters do essentially the same thing, except they do it in one location. There is an array of video converters available for download on the internet, each ranging in quality and ability. It is important to be careful when using free video converters, however, as many of these software can contain viruses and malware. Some software work can convert more types of videos, others can convert much quicker, some are more user friendly, and some can increase the quality of the original video.

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