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Audio and Video Editing

Fundamentals of Digital Video and Video Standards

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Basic Concepts of Digital Video

- Digital video represents **moving-image recording in a digital format**, used across all areas of modern production, from the professional film and television industry, to amateur and educational projects.
- Unlike analogue recording, where each copy leads to a loss of image and sound quality, a digital record consists of binary data and can be copied indefinitely without loss. This feature makes the digital format ideal for archiving and distribution.
- Digital video covers all stages: **recording, editing, transmission, archiving and playback**. Thanks to the advancement of digital technologies, the quality of footage today can be extremely high even in home conditions, while professional cameras allow resolutions that exceed the standard definition.

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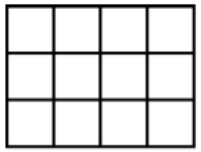
Advantages of Digital vs Analogue Recording

- With analog recording, each copy and each new generation of recording leads to a gradual deterioration in quality, image sharpness decreases, noise occurs, detail is lost, and color distortion occurs.
- The digital record eliminates this problem because it is based on precise numerical values. When the digital signal is copied, the result is complete fidelity to the original, without any degradation.
- In addition, digital formats allow easier editing, processing and distribution, because video can be directly edited on a computer, transmitted over the Internet and stored on various media, from hard drives to cloud services. This is a major advantage in today's media environment, where speed and efficient information exchange are essential.

Digital Television and the Evolution of Video Standards

- Digital television, together with Internet distribution, DVD and Blu-ray formats, has enabled the maximum potential of digital video.
  There are two basic groups of standards:
  - **SD (Standard Definition)** – resolution 720×576 (PAL) or 720×480 (NTSC), aspect ratio 4:3 or 16:9.
  - **HD (High Definition)** – Resolution 1280×720 (HD Ready) and 1920×1080 (Full HD), exclusively 16:9 ratio.



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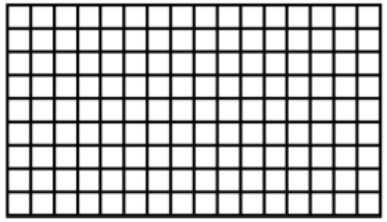

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Digital Television and the Evolution of Video Standards

- Beyond television, digital technology has been used for years in the film industry, especially in post-production. Interestingly, producers sometimes artificially add grainy structure to an image to make it more like classic film material.
- Although the film camera still gives a greater dynamic range of colors and contrasts, digital production is more economical, more accessible, and increasingly dominant in modern filmmaking.

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Linear and Nonlinear Editing

- Before the emergence of digital systems, the editing was **linear** – the material was transferred from tape to tape in order, which meant that each modification had to be done from the beginning.
- With the arrival of **non-linear editing**, complete freedom in working with the material was introduced. In non-linear systems, such as Adobe Premiere Pro, footage is imported into a digital format and can be freely moved, trimmed, replaced or rearranged without damaging the original.
- The benefits are enormous: faster editing, instant access to every frame, the ability to multi-track work (video, audio, effects), as well as fine-tuning the format.
- This transition marked a revolution in the film and television industry, as editing became faster, more creative and much more accessible.

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Frame and Field

- To create the illusion of motion, a sequence of at least **12 sequential images per second** must be displayed. This value is called the **frame rate** and is measured in frames per second (fps).
- In professional standards, the most common values are 24fps (film), 25fps (PAL) and 30fps (NTSC).
- Each image (frame) can be displayed:
  - **progressive** – the whole image is displayed at once, suitable for digital screens,
  - **Interlaced** – consists of two fields (half-frames), which was previously used due to technical limitations of the CRT screen.
- In the PAL standard, 50 fields make 25 frames per second.
- When converting film (24 fps) to TV (50 fields), telecine is used, and the film is played 4% faster to make up for the difference in display speed.

Image Resolution

- Resolution represents the number of pixels forming the image (horizontal × vertical) (e.g. 720×576).
- In digital television and computer displays, the resolution is standardized, and the most common formats are:
  - **SD PAL**: 720×576 pixels
  - **HD Ready**: 1280×720 pixels
  - **Full HD**: 1920×1080 pixels
  - **4K UHD**: 3840x2160 pixels

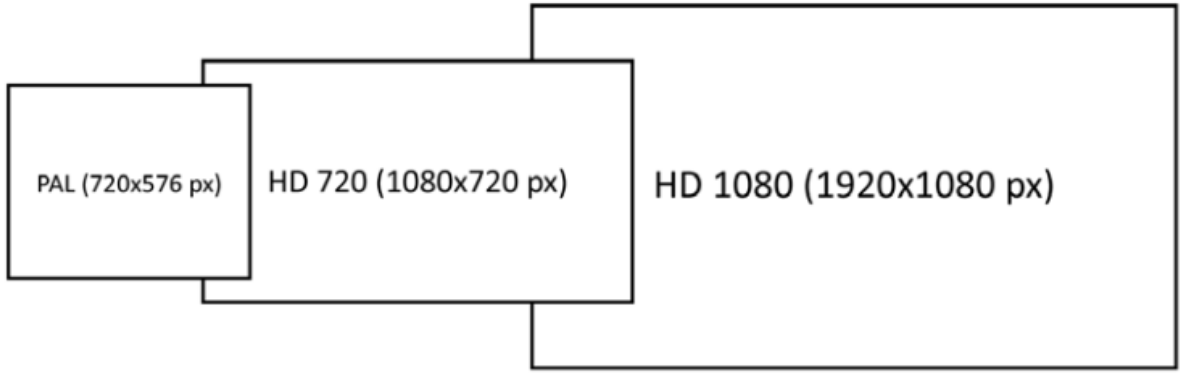
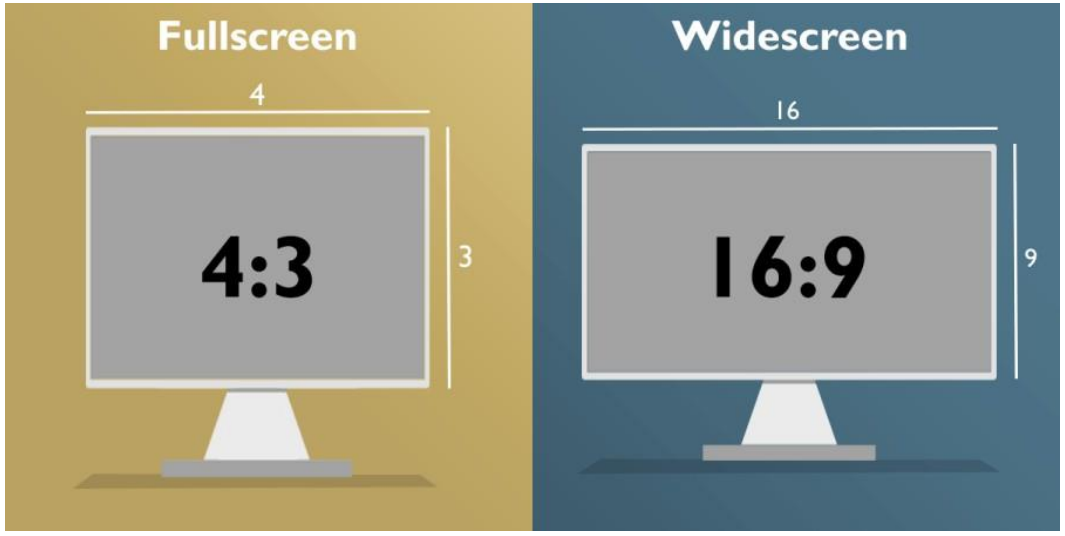


Image Resolution

- The width-to-height proportion of the image is called the **aspect ratio**. The traditional **4:3** ratio originates from 35mm film, while 16:9 has become the standard for modern televisions and monitors.
- With the advent of widescreen display, the classic 4:3 format has almost disappeared from use, as most new devices use only 16:9 display.



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Video Compression and Color Component Ratio

- Due to the large amount of data, the video is almost always compressed.
- There are three basic approaches:
  - **Uncompressed video** – retains all information, but requires a large amount of memory.
  - **Lossless compression** – mathematically alters data but with no visible loss.
  - **Lossy compression** – removes data that is difficult for the eye to notice, thus significantly reducing the file size.

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Video Compression and Color Component Ratio

- In digital formats, chroma subsampling is used:
  - **4:4:4** - full color, which makes a complete RGB palette and where the first number represents luminance, and the other two the difference of the color components of blue and red (chroma difference – Cb, Cr),
  - **4:2:2** - professional standard, in lossless compressed formats, for every 4 luminance samples, there are 2 chroma samples,
  - **4:1:1** and **4:2:0** - used in consumer and online formats.
- Higher numbers mean more detail preserved in luminance and color.

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DV Formats and Professional Codecs

- **DV25** is the most commonly used compression format in semi-professional cameras. It has 5:1 compression, 25 Mbps data rate, and one hour of material takes up about 13 GB. Audio is recorded at 16-bit, at 48 kHz.
- Professional variants of this format include:
  - **Sony DVCAM** and **Panasonic DVPRO** – higher resilience, better recording quality, lower image degradation.
  - **DV50 / DVCPRO50** – 2:1 compression, 4:2:2 color subsampling, 50 Mbps.
  - **DV100 / DVCPROHD** – used for HD recording with 100 Mbps data rate and 4:2:2 color ratio.
- The highest standards, such as **Digital Betacam** and **HDCAM**, use data rates ranging from 270 Mbps to 1.5 Gbps and professional SDI/HD-SDI connections.
- Modern formats, such as **Sony XDCAM** and **Panasonic P2**, allow tapeless recording – directly to memory cards or discs, which speeds up material transfer and makes post-production easier.

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Questions & Answers

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