1. A brief history of photographic technology
Prehistoric Painting, Lascaux Cave, France ca. 13,000–15,000 B.C.
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Middle ages

The Empress Theodora with her court. Ravenna, St. Vitale, 6th century a.d.
Middle ages

Nuns in Procession. French ms. ca. 1300.
Renaissance—perspective

*The Flagellation*, Piero della Francesca (c.1469)
Renaissance—realism

Jan van Eyck, *The Arnolfini Marriage* (c.1434)
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Jan van Eyck, *The Arnolfini Marriage* (c.1434)
Camera obscura

• A camera-like device for automating perspective drawing

• Key elements of camera already present
  Image formation—small hole projects image into room
  Image recording—artists stands there and traces

• Stand in a camera obscura at the Ithaca Sciencenter!
Forming better images

- Lenses increase sharpness and brightness

Lens Based Camera Obscura, 1568
Recording images better

Still Life, Louis Jaques Mande Daguerre, 1837
Recording images automatically

- **Silver halide** (AgCl, AgBr, AgI) salts are light sensitive
  absorbed photons in halide ions cause free electrons
  electrons combine with $\text{Ag}^+$, producing metallic silver

- **Daguerre**: first practical and permanent photographic plate
  Hg vapor (yikes!) combines with Ag to produce reflective amalgam
  Daguerrotypes were widely popular

- **Indirect negative-plate processes**
  negative images on paper, glass allowed multiple copies to be printed

- **Roll film**: silver halide grains in gelatin on celluloid
  introduced by Eastman in 1880s
  portable, convenient, practical
  sensitive (“fast”) enough for moving subjects in daylight
George Eastman with his Kodak camera
THE KODAK CAMERA.

ANYBODY who can wind a watch can use the Kodak Camera. It is a magazine camera, and will make one hundred pictures without reloading. The operation of taking the picture is simply to point the camera and press a button. The picture is taken instantaneously on a strip of sensitive film, which is moved into position by turning a key.

A DIVISION OF LABOR. After the one hundred pictures have been taken, the strip of film (which is wound on a spool) may be removed, and sent by mail to the factory to have the pictures finished. Any amateur can finish his own pictures, and any number of duplicates can be made of each picture. A spool of film to reload the camera for one hundred pictures costs only two dollars.

No tripod is required, no focusing, no adjustment whatever. Rapid rectilinear lens. The Kodak will photograph anything, still or moving, indoors or out.

A PICTURESQUE DIARY of your trip to Europe, to the mountains, or the sea-shore, may be obtained without trouble with a Kodak Camera, that will be worth a hundred times its cost in after years.

A BEAUTIFUL INSTRUMENT is the Kodak, covered with dark Turkey morocco, nickel and lacquered brass trimmings, enclosed in a neat sole leather carrying case with shoulder-strap—about the size of a large field-glass.

Send for a copy of the KODAK PRIMER with Kodak photograph.

THE EASTMAN DRY PLATE AND FILM CO.,
Branch: 115 Oxford St., London.
ROCHESTER, N.Y.
Motion pictures

• Sensitive roll film enables sampling in time

• 1890s—several cameras
  Lumière brothers’ Cinematographe
  Edison’s Kinescope
George Méliès

Georges Méliès, *A Trip to the Moon*, 1902
Improvements in cameras

- Size and portability
- Ease of use
- Automation
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Improvements in film

• **Sensitivity**
  enables photographs of faster subjects—“faster” film

• **Dynamic range**
  higher quality images with detail in highlights and shadowsexpanded “latitude” to mess up the exposure

• **Resolution**
  enables smaller format cameras
Television

- Practical around 1927 (Farnsworth)
- Camera basically the same
  imaging lens plus planar image sensor
- Recording is electronic
  various early schemes
  early winner: CRT image sensors (Orthicon, Vidicon, …)
- Initially seems quite different from photography/cinematography
  ephemeral output signal—live viewing only
  low resolution, low dynamic range images
Recording video signals

- **Kinescope (1940s)**
  photograph onto motion picture film
  re-photograph the film for replay

- **Videotape (1956)**
  record signal on magnetic tape
  very high head velocities required
  —transverse or helical scanning

A Kinescope, c. 1950–55
Recording video signals

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  photograph onto motion picture film
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  record signal on magnetic tape
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![A 2-inch video tape recorder c.1970](Wikipedia)

![Helical scan](Wikipedia)
Imaging around 1950s–70s

• **Technology improves incrementally**
  - Film emulsions improve; very high quality attainable in large formats
  - Video technology improves; but standards keep resolution fixed
  - Lens designs improve, cameras become much more usable

• **Usage is refined**
  - Photography an established art form, widespread hobby
  - Cinematography develops as a storytelling medium
  - Television becomes dominant mass communication medium
Meanwhile...

- **Invention of CCD (1969)**
  - solid-state, fundamentally discrete image sensor
  - quickly established in astronomy, space
  - by mid-80s, displaces tubes in video cameras (as drop-in replacement)

- **Computing and computer graphics**
  - sufficient memory to store images becomes available
  - first framebuffers developed 1972–74

- **Digital signal transmission and processing**
  - used for audio and telephone

- **These set the stage for the next revolution**
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Digital imaging

• **Halftone printing of images**
  halftone process around for a while complex, delicate optical procedure moving images from place to place requires moving film or paper

• **Digital imaging**
  scan images from film or paper transmit images by phone do processing (e.g. halftone separation) by computing print images using laser printer or laser film recorder

• **Image editing**
  1990—Adobe Photoshop 1.0

• **Image compression algorithms**
  make image storage, transmission more practical
Digital photography

- **Digital images are established**
  people can make use of them directly

- **CCD sensors improve**
  Moore’s law makes pixels smaller
  video cameras already recording
  images electronically
  digital image capture used in scientific applications

- **Analog electronic still camera (aka. still video camera)**
  is just a video camera that takes one frame at a time
  several manufacturers made them
  but high image quality expectations for stills delays acceptance
Early digital cameras

- **Important limitations**
  - low image quality (relative to film)
  - slow camera performance
  - large, heavy, clunky
  - limited, expensive image storage

- **Important advantages**
  - immediate availability of images
  - zero (well…) marginal cost per exposure

- **First adopters: photojournalists**

- **Kodak DCS series**
  - based on film camera bodies
  - early commercial success
  - storage: PCMCIA hard disks (mid 90s)
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Digital rivals film

- **Key improvements**
  - cameras become more compact
  - resolution and dynamic range improve
  - LCD displays for immediate image review
  - costs drop

- **Meanwhile**
  - computers with high-quality color displays become pervasive

- **User experience**
  - image review is a big change for users
  - sharing of digital images suddenly becomes easier than prints
Digital video

• **Initially: improved recording medium**
  record the same old signal, but digitally
  best-quality medium for professional use

• **Improvements**
  storage and bandwidth improve by orders of magnitude
  video compression algorithms advance
  digital formats become simpler/better than analog-derived
  flexibility finally unlocks video resolution

• **Digital recording becomes standard for video**
  basic experience similar
  cost and quality greatly improved
Digital displaces film and video

- **Move from convenience vs. quality to convenience and quality**
- **Digital slowly takes over for basically all users**
  - advances in storage/transmission and compression algorithms
  - ecosystem for online sharing of photos, videos
  - declining use of printed images
- **Last bastion: cinematography**
  - delay: quality standards plus tradition
  - first took over low end because of film costs
  - now taking over high end because of superior quality/usability
Digital cinema

Excerpt from preview of documentary *Side by Side* (2012)—director David Lynch interviewed by Keanu Reeves
Digital cameras today
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  high-end product for professionals and enthusiasts
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- **Digital cinema**
  high-resolution cameras for big-budget film production
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- HD video
  medium resolution for low-end film and high-end TV production
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- **Mirrorless system cameras**
  smaller high-end cameras with electronic viewfinding
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Digital photography today

- Video, photography, and cinema have converged
  all using the same basic technology
  all modern still cameras do video too (and many vice versa)

- Cameras becoming completely pervasive
  film-equivalent quality possible in <1 cm$^3$
  mobile applications driving much sensor/lens development
  mobile cameras eating compact digicam market

- Computing power still rapidly advancing
  more and more computation being done on images
Some sources

- digicamhistory.com
- dpreview.com—lots of data on digicam models over time
- Sony history site [http://www.sony.net/SonyInfo/CorporatInfo/History/sonyhistory.html](http://www.sony.net/SonyInfo/CorporatInfo/History/sonyhistory.html)
- many Wikipedia articles