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COMPUTATIONAL ASPECTS OF DIGITAL PHOTOGRAPHY

A brief history of photographic technology

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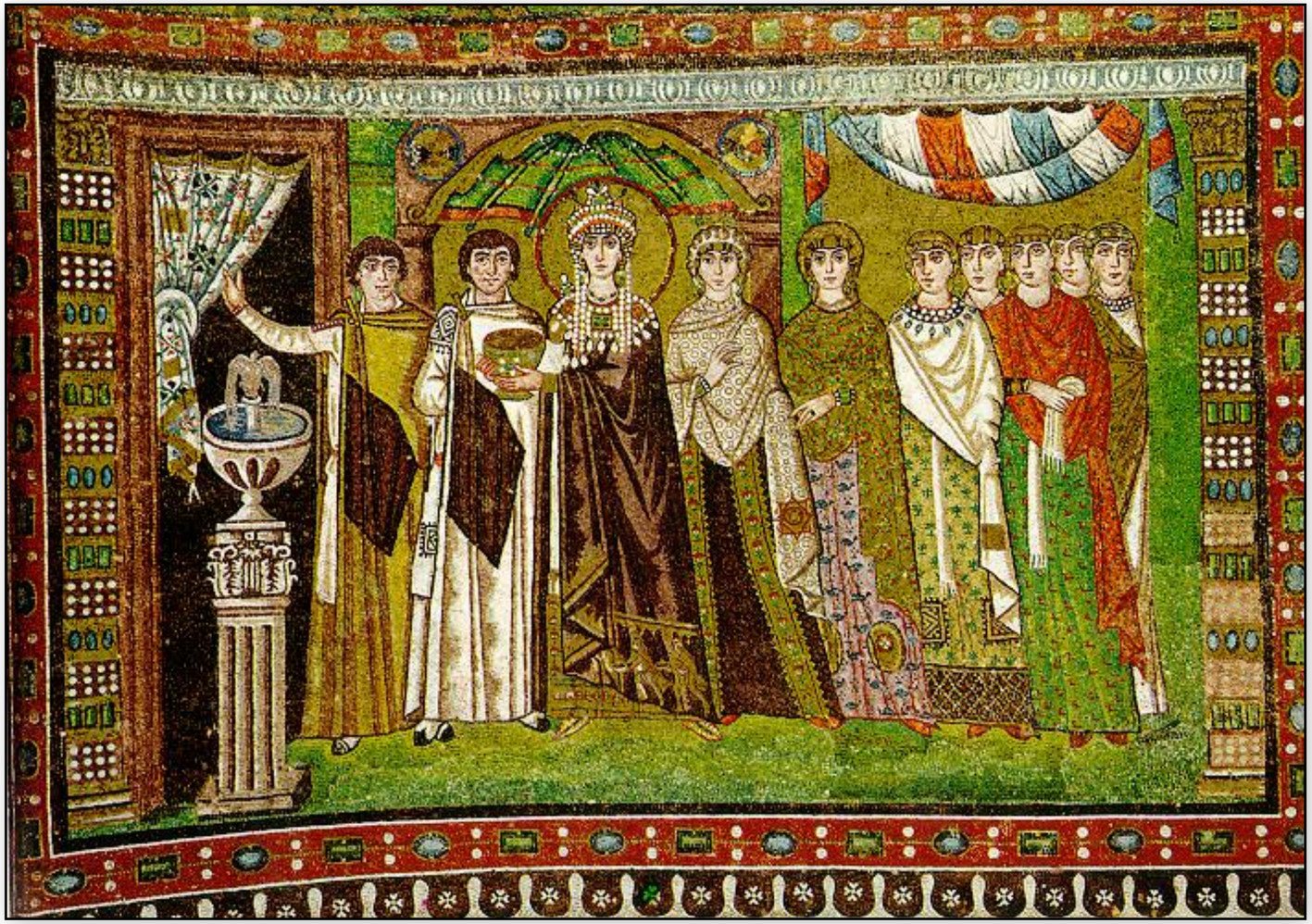
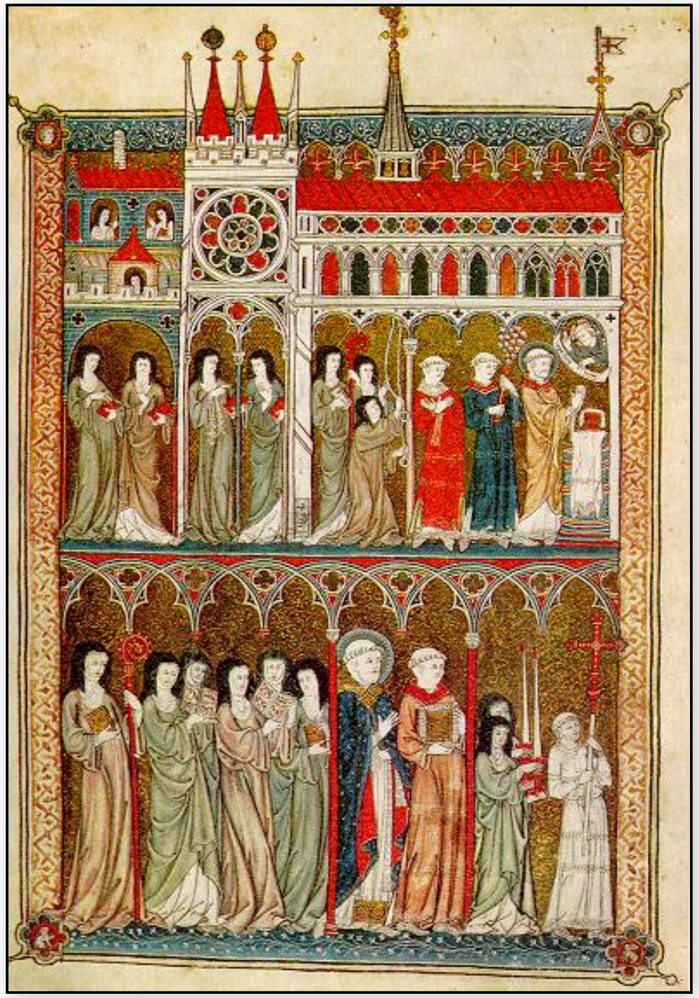
Prehistory

Prehistoric Painting, Lascaux Cave, France ca. 13,000–15,000 B.C.

Middle ages



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



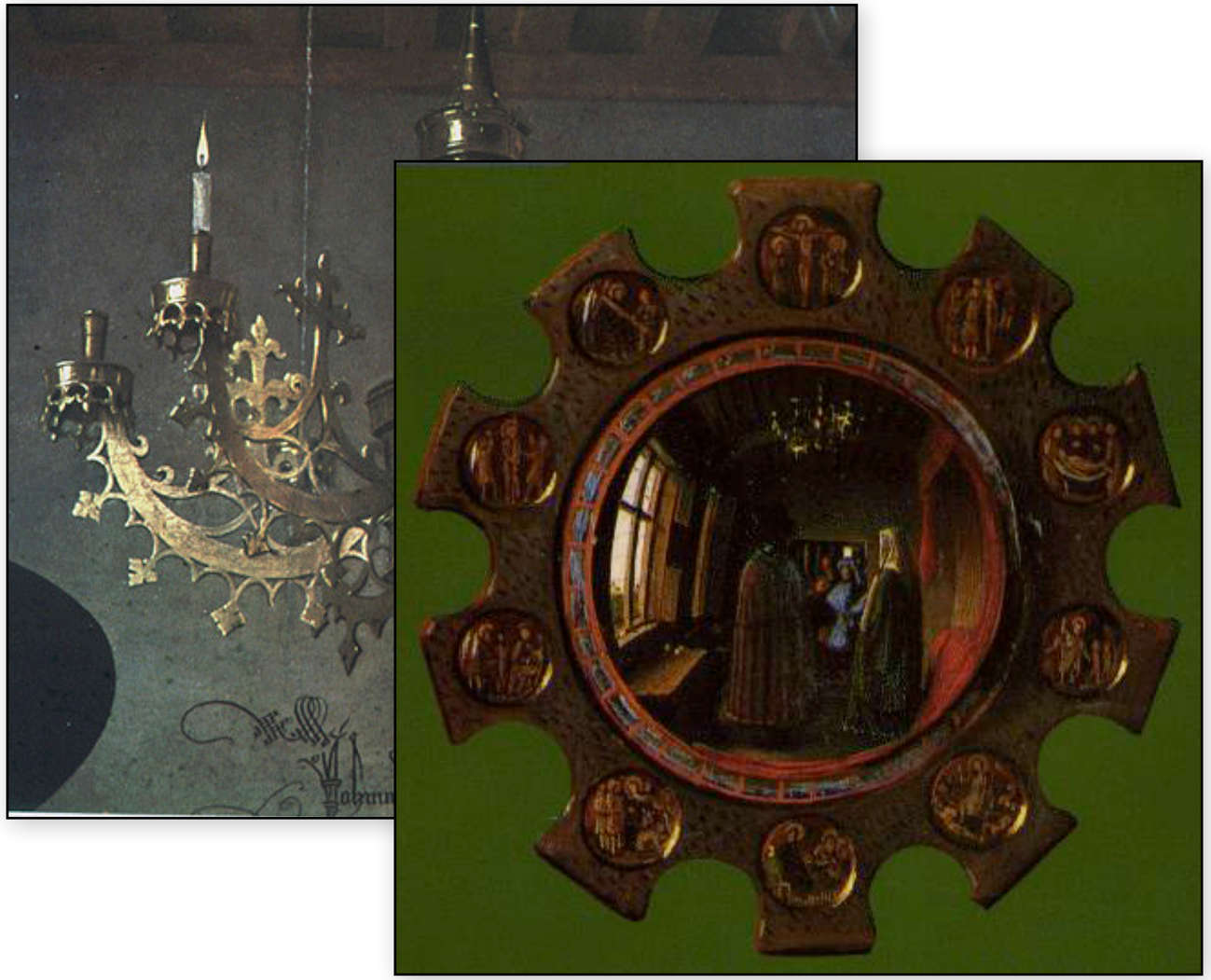
Nuns in Procession. French ms. ca. 1300.

Renaissance – perspective

The Flagellation, Piero della Francesca (c.1469)

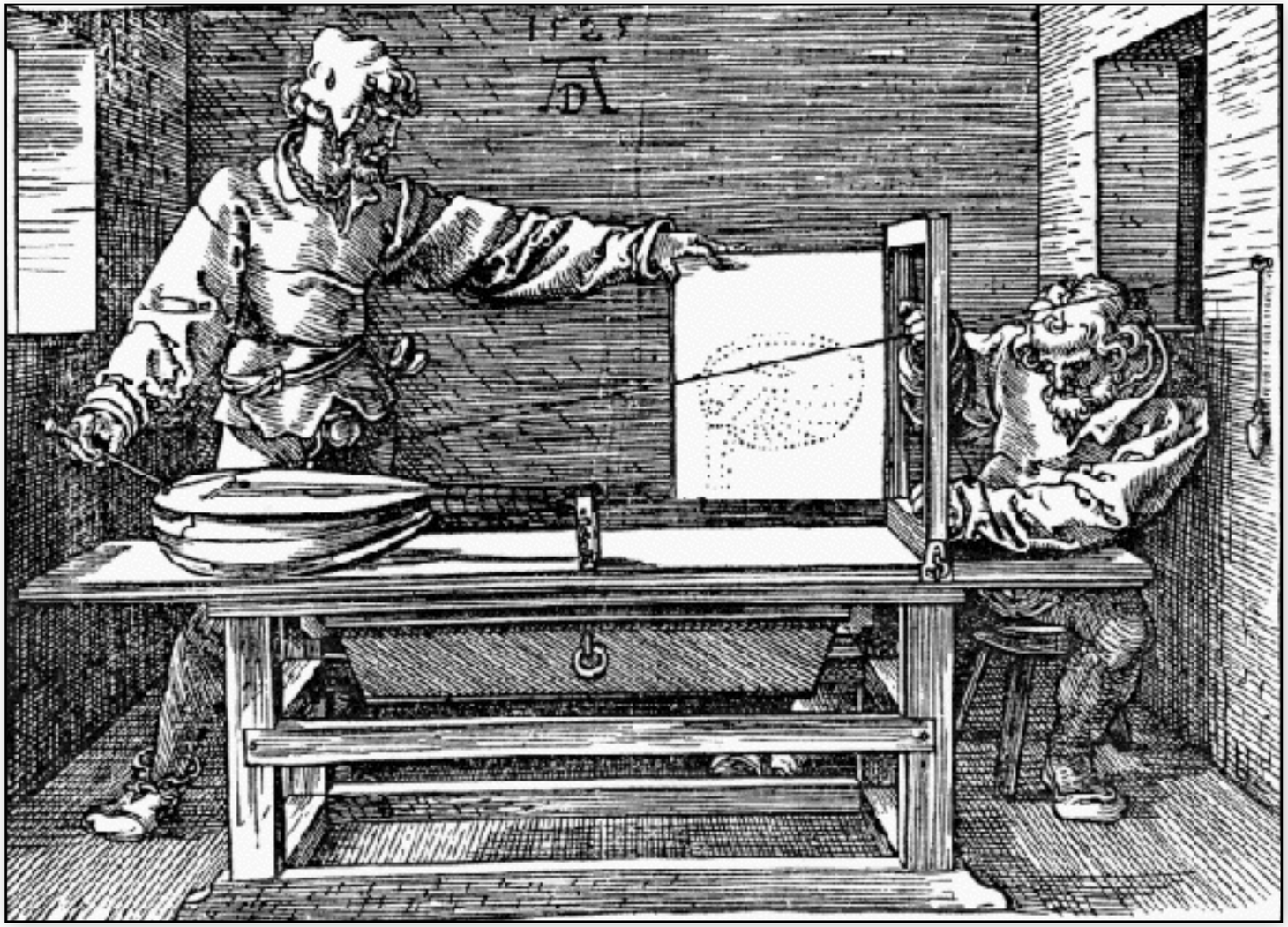
Renaissance – perspective

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



Early perspective aides

Albrecht Dürer (1525)

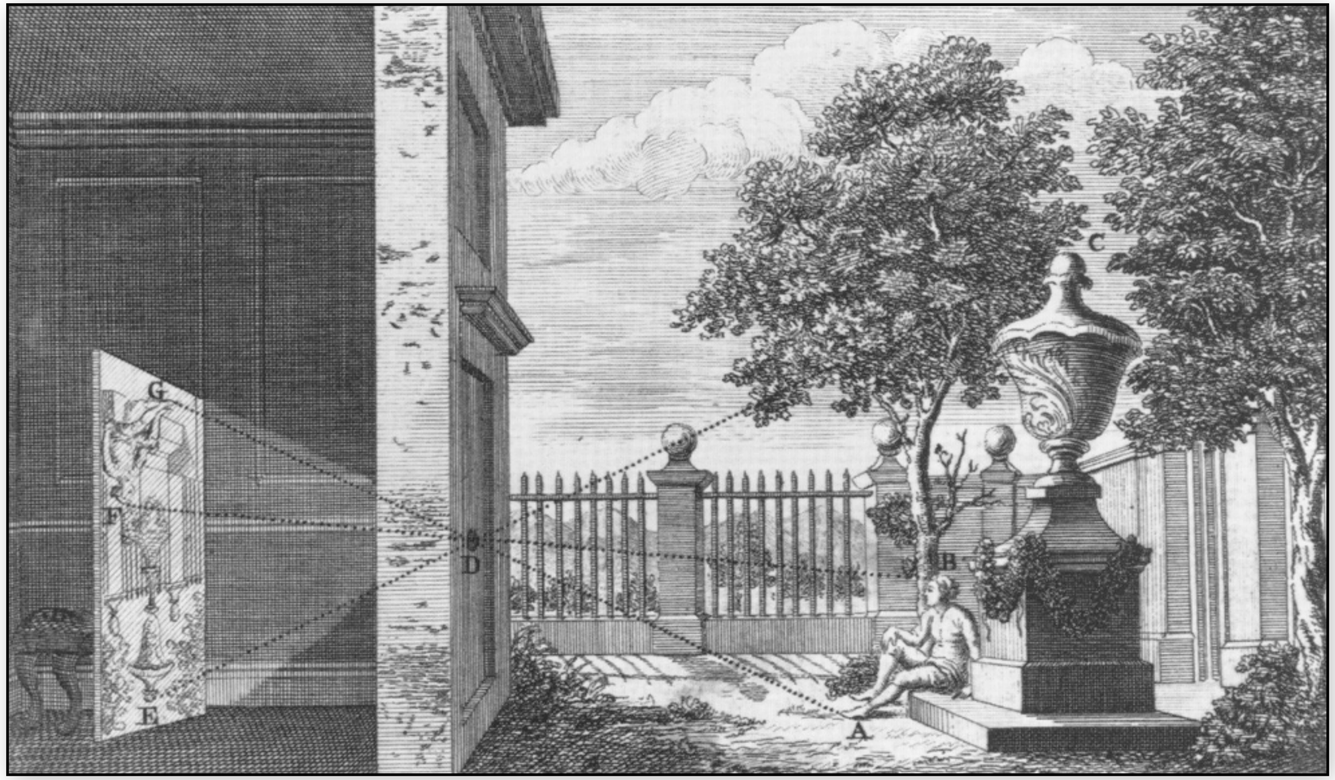


Camera obscura

A camera-like device for aiding perspective drawing

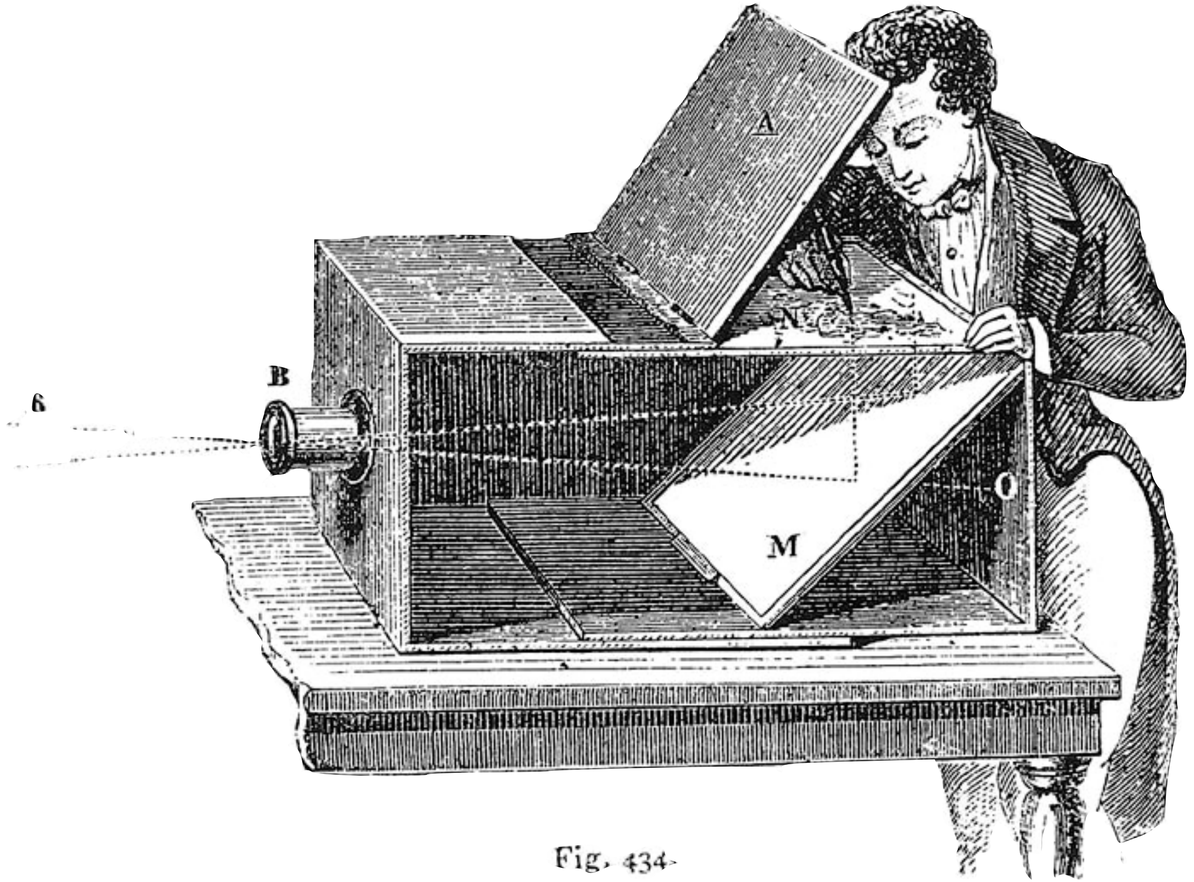
Key elements of camera already present

- Small hole projects image
- Artist traces



Forming better images

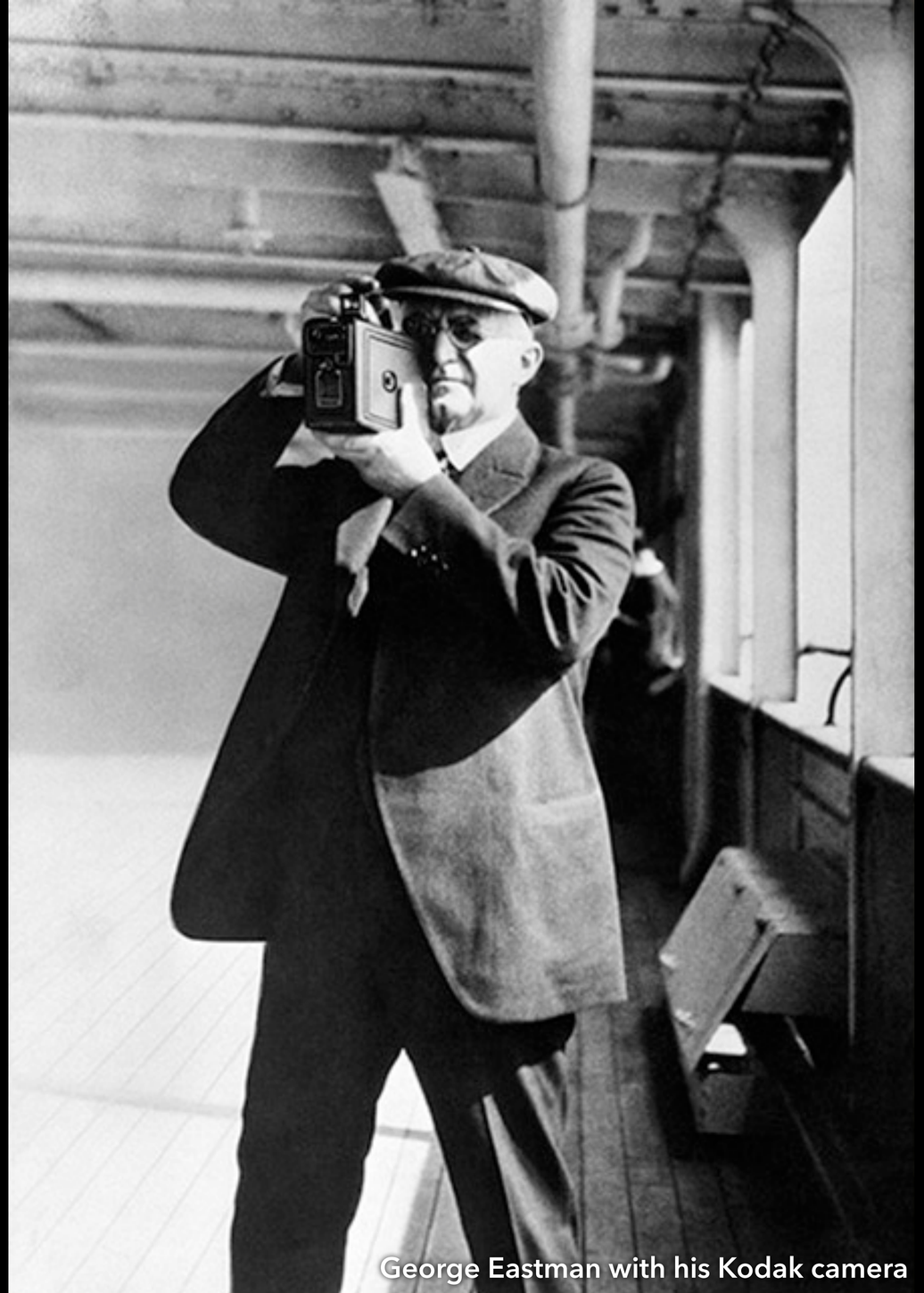
Lenses increase sharpness and brightness



Lens Based Camera Obscura, 1568

Recording images better

Still Life, Louis Jaques Mande Daguerre, 1837



George Eastman with his Kodak camera

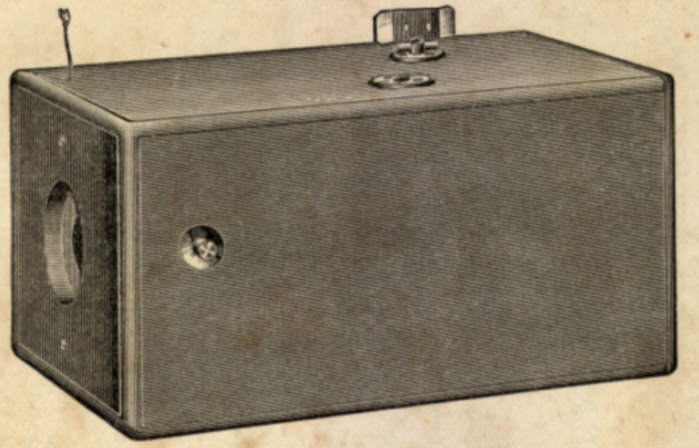
Size:
3¼ x 3¼ x 6½ inches.

Weight:
1 lb., 10 oz.

PRICE, $25.00.

Loaded for 100 pictures, including Sole Leather Carrying Case with Strap.

Size of Picture:
2½ inches diameter.



ONE-HALF LENGTH.

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.,

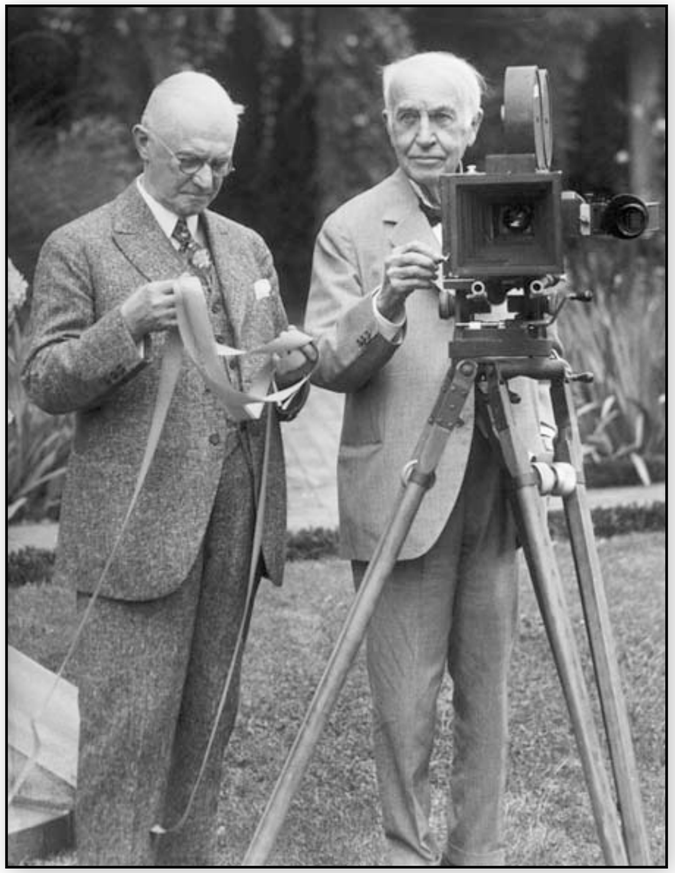
Branch: 115 Oxford St., London.

ROCHESTER, N. Y.

Motion pictures

Sensitive roll film enables sampling in time

1890s - several cameras

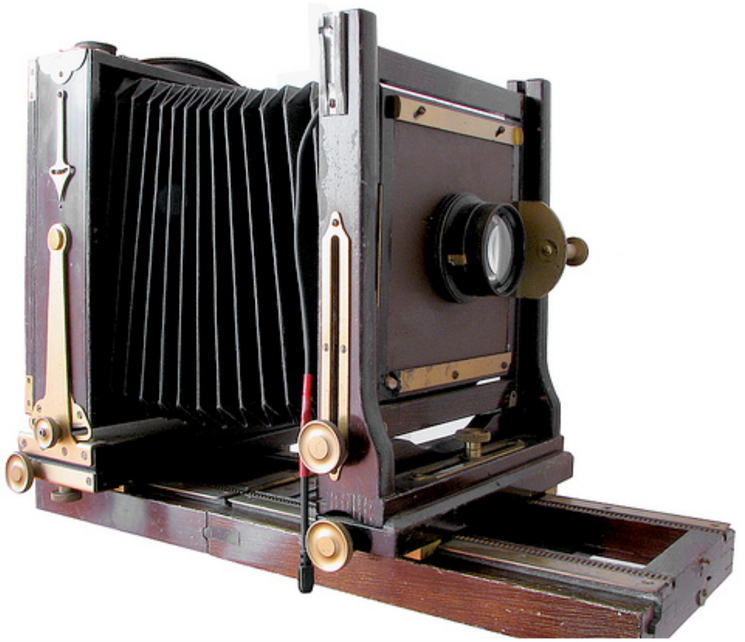


Improvements in cameras

Size and portability

Ease of use

Automation



Improvements in film

Sensitivity

- enables photographs of faster subjects

Dynamic range

- higher quality images with detail in highlights and shadows
  expanded “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

Initially seems quite different from photography

- 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

Imaging around 1950s-70s

Technology improves incrementally

- film improves; very high quality attainable in large formats
- video tech. improves; but standards keep resolution fixed
- lens designs improve, cameras become more usable

Usage is refined

- photography an established art form, widespread hobby
- cinematography develops as storytelling medium
- TV becomes dominant mass communication medium

Meanwhile…

CCD invented (1969)

- solid-state, fundamental image sensor
- quickly established in astronomy, space

Computing and computer graphics

- sufficient memory to store images (1972)

Digital signal transmission, compression & processing

George Smith and Willard Boyle in 1970

Early digital cameras

Important limitations

- low image quality (relative to film)
- slow camera perfomance
- large, heavy
- expensive image storage

Important advantages

- immediate availability of imags
- marginal cost per exposure

First adopters: photojournalists

Kodak DCS-100, 1991

Digital imaging & digital rivals film

Image editing

- 1990 - Adobe Photoshop 1.0

Image compression algorithms

Digital displaces film and video

Move from “convenience vs. quality” to “convenience & quality”

Digital slowly takes over for basically all users

- 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

Excerpt from preview of documentary Side by Side (2012)—director David Lynch interviewed by Keanu Reeves

Digital cameras today

Digital SLRs

- high-end product for professionals and enthusiasts

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- medium resolution for low-end film and high-end TV production

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Mirrorless camera systems

- smaller high-end cameras with electronic viewfinding

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- inexpensive, auto-everything for day-to-day use

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Tiny cameras in all cell phones

- The best camera is the one you have with you”

Digital photography today

Video, photography, and cinema have converged

- all use 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
- more computing steadily coming closer to the camera

Immediate TODOs

If you believe you'll use Linux servers, email me within 24 hours:

- dartmouth email address
- two desired usernames

Go on Canvas and record an intro by **Monday, Sep 21**

First programming assignment due **Tuesday, Sep 22**

Slide credits

Steve Marschner

Alyosha Efros