

## Chronology

### Temporal Recording and Playback

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5000 BC - Chinese Shadow Plays employ silhouette figures cast on a screen of smoke.

2000 BC - Minoans fabricate crude lens.

1084 BC - Greeks employ beacon fires in relay stations. Some of the relay towers still survive today.

360 BC - Greek historian Polybius describes a 5 x 5 signaling grid used to transmit letter codes with torchlight.

340 BC - Camera Obscura incorporating pinhole aperture and viewing screen is described by Aristotle.

310 BC - Euclid writes about refraction and reflection, and argues that light travels in straight lines.

50 AD - Roman Seneca writes about magnifying lens.

130 - Ptolemy, at Alexandria writes the *Almagest*, which observes persistence of vision and other fundamental optical principles.

525 - In Italy Boethius tries to measure the speed of light, charged with magic, and decapitated.

750 - The Arabian alchemist Geber discovers the effect of light on silver nitrate.

1038 - Modern experimental science begins. Arab Alhazen publishes an optical thesaurus with the results of experiments with parabolic mirrors and lenses; also describes camera obscura. Reprinted in the middle ages and modern times.

268 - Roger Bacon, at Oxford, publishes three books on optics, mirrors, and lenses.

1280 - Wearing of eyeglasses, in Italy. Eyeglasses are one of the first human prosthesis.

1438 - Gutenberg develops printing from movable type.

1450 - Leonone Alberti, in Italy, advances theory of perspective and invents camera lucida, which combines a lens and a prism and aids in the tracing still life.

1475 - Vatican Library opens to scholars—making it the first public library in Europe.

1482 - First printing of *Perspectiva communis* the standard Middle Ages textbook on optics for the next 100 years. Written by John Pecham.

1515 - Leonardo Da Vinci writes *Treatise on Painting*, discussing perspective, the camera obscura, and the human eye. Da Vinci describes a portable camera obscura.

1551 - Italian Gerolamo Cardano develops a 5 bit signaling system that uses 5 torches aligned in a row.

1568 - Monsignor Daniello Barbaro of Venice put a lens into the camera obscura.

1589 - Showman and light show artist Giovanni Battista della Porta in Naples writes *Magna naturalis (Natural Magic)* in which he describes lens grinding and polishing, as well as how to make light and shadow devices for entertainment.

1600 - William Gilbert publishes a treatise on magnetism that proposes the theory of a magnetic field of Earth.

16xx - Leevenhook explores microscope.

1604 - Johanne Kepler in England writes *Dioptrice (Concerning Lenses)*, which is the foundation of modern optics.

1608 - Telescope manufacturing begins. Soon after, Galileo discovers the moons of Jupiter.

Depth of field expounded

1621 - Snell invents a graphical procedure to determine refraction and it is soon formulated into algebraic notation.

1646 - Athanasius Kircher publishes *Ars Magna Lucis et Umbrae* (The Great Art of Light and Shadow), which explains the phenomena of light, lenses, mirrors, reflection, and refraction and relates these concepts to the nature of vision and the structure of eye.

1647 - French physicist Blaise Pascal publishes papers on the problem of the vacuum.

1655 - Christian Huygens and Athanasius Kircher invent magic lantern, and Kircher, possibly with the help of Gaspar Schott develops the radial picture disc.

1665 - Isaac Newton explains the principles of optics, including light, the prism, and the visual synthesis of color using a rotating color disc. [or is this 1704?]

1667 - String telephone

1712 - Steam engine marks beginning of industrial revolution.

1727 - German scientist Johann Heinrich Schultz [Schutze? Schulze?] observes that silver salts (silver nitrate) darken when exposed to light. Contact prints of the silhouettes of objects becomes possible. Fixing of the image is not understood.

1736 - Pieter van Musschonbroek animates and projects windmill cycle using a magic lantern with multiple slides.

1759 - J. H. Lambert publishes *Die freye Perspektive* in Zurich, a treatise on perspective drawing for artists.

1760 - Theoretician S. Klingenstierna and optician John Dollond produce an achromatic lens.

1784 - Ben Franklin invents bifocals.

1791 - Frenchman Claude Chappe invents the two armed semaphore, a multipositional optical telegraph.

1795 - Englishman George Murray develops an optical telegraph that uses a matrix of 3 rows and 2 columns of lights with shutters in front controlling which lights are visible.

1796 - Megaphone.

1798 - Etienne Robertson in France originates the Phantasmagoria, a theater whereby images are projected onto screens of smoke.

1802 - Thomas Young proposes there are 3 receptors in the eye; the trichromy theory of vision.

1807 - William Wollaston invents modern *camera lucida* (a lucy), a prism and lens arrangement to facilitate tracing a virtual image. A lucy is a part of any animation studio, where drawings must be enlarged and reduced. The term ludic, meaning transparent or clear, derives from a Latin word meaning a star that is able to be seen with the naked eye. [check not 1812]

1811 - F. Arago invents the polarimeter, what ever that is.

1812 - French Army officer Charles Barbier invents a 12 dot system of "night writing" for battlefield communication that uses raised dots and is a predicesor to Braille.

1815 - A. Fresnel and F. Arago commence a series of papers advocating the wave theory and light. These works include the investigation of diffraction, the discovery of the phenomenon of interference, and the proposal that light wave are transverse, rather than longitudinal, to the direction of the propagation of the light. In 1838 Arago proposes an experiment to decide whether the wave theory or the corpuscular theory of light was correct.

1814 - First photographic experiments by Joesph Nicephore Niepce employ camera obscura images onto paper sensitized with silver chloride, and which were partically fixed.

1816 - Scottish scientist Daniel Brewster invents the kaleidoscope, an optical device with prisims and broken colored glass which forms abstract patterns when rotated.

1819 - H. C. Oersted discovers the magnetic effect of an electric current and hypothesizes the principle of magnetic recording.

1819 - Sir John Herschel discovers that hypothiosulphates will dissolve silver halide. "Fixing" becomes the second step of film processing.

1824 - Peter Mark Roget publishes *Persistence of Vision Regard to Moving Objects*.

1824 - Louis Braille evolves a 6 dot cell with raised patterns for different letters to facilitate reading by blind people; the codes are internationally standardized in 1932.

1825 - Dr. John Ayrton Paris invents the thaumatrope, a small (toy) disc with two different scenes on each side, usually related to each other, and spun rapidly on a string so as to fuse into a single image.

1825 - Michael Faraday performs vision experiments.

1826 - Niepce succeeds in fixing an image by washing out the exposed salts. The shutter is defined.

1829 - American Joseph Henry publishes laws of electromagnets, and two years later uses electromagnets to demonstrate signaling.

1832 - Belgian Joseph Plateau's phenakistiscope employs rotating radial picture media and slits to view cyclic animation. In Austria Simon Ritter von Stampfer independently invents the stroboscope, a similar device with a subtle relationship to the modern usage of the word. These devices are the first modern viewer of moving action.

1833 - Zoetrope invented by William George Horner. It is also called a "wheel of life." It is uncertain if the zoetrope is a product of the early 19th century or if it has been known since antiquity.

1833 - Germans Carl Gauss and Wilhelm Weber construct galvanometer telegraph.

1835 - Nicephone Niepce and Louis Daguerre reduce exposure time to 15 minutes using silvered copper plates coated with silver iodide. They are developed with mercury vapour and fixed with salt. They make the first photograph of a human--a man getting a shoe shine.

1835 - In England Henry Fox Talbot invents the negative/print process and produces prints on paper sensitized with silver chloride, developed, and fixed. Talbot reduces exposure times to 3 minutes.

1837 - Charles Wheatstone invents an electric telegraph.

1838 - Sir Charles Wheatstone invents stereoscopic viewer, as well as the stroboscope. [or stereoscopic reflection?]

1839 - Thomas Wedgewood fuses a camera obscura with a photosensitive paper emulsion and records real images. A London camera company sells camera photographic.

1839 - Edmond Becquerl in France discovers the photoelectric effect, that is, the electrochemical effects of light.

1840 - H.L. Child introduces "Dissolving Views" Act; projects translations.

1840 - First exhibition of photographic portraits is by Swiss painter Johann Isenring. The images are hand colored.

1840 - Railroad signaling is introduced as a means to avoid train collisions. Three basic indicators evolve: stop, proceed with caution, and all clear.

1841 - Carl Friedrich Gauss treatise on optics introduced concept of focal length.

1844 - Samuel Morse demonstrates electric telegraph in Maryland. He employs a variable length discrete code to represent letters.

1847 - Niepce de Saint Victor reduces exposure time to 3 seconds.

1847 - Englishmen Alexander Bair and then Frederick Bakewell invent the facsimile, a "copying telegraph," and perform the first image transmission.

1848 - Sir David Brewster invents stereoscopic camera.

1850 - Interlocking signals and the block system are introduced on railroads in France and England in order to facilitate safe and effective transportation of multiple trains on a single or intersecting tracks.

1850? - L.P. Seidel theory of lens aberrations (science of lens design).

1850 - Philadelphia brothers Frederick and William Langenheim produce Hyalotype positives on glass slides and market lantern slide stories.

1851 - Frederick Scott Archer invents a wet collodion process that produces glass plate negatives from which many prints can be made. Photographic exposure time is reduced to 10 seconds.

1851 - The number of photo studios in NY exceeds 50.

1851 - International Morse code is standardized.

1852 - Wheatstone perfects cinematic (kine) stereoscopic viewer.

1852 - First experiments to display poised still photographic pictures in cyclic viewers.

1852 - Fox Talbot invents the halftone screen. It is instrumental for reproducing photographs in printing and is further perfected during the 1880s. Its main advantage is that the photography and text are now both conveniently fused on the printing press.

1853 - Austrian Franz von Uchatius constructs a motion projector apparatus to project animated phase pictures onto a screen. It combines the magic lantern and a transparent Plateau disc; a second disc is used for shutters.

1856 - Stereoscopic phenaskistiscope.

1856 - Frenchman Edouard-Leon Scott de Martinville constructs first known sound recording device, the phonograph, which transcribes sound vibrations into lateral undulations on a cylindrical sheet or round disc of lampblack paper and is used as a laboratory instrument for measuring and analyzing sound waves. Unfortunately, it lacks a method to replay the sound.

1858 - J. d'Almeida describes anaglyphic color process.

1858 - First attempt to build a transatlantic cable is a commercial failure.

1859 - George Phelps perfects a printing telegraph.

1859 - Henry Robinson publishes a booklet of how to prepare double exposures.

1859 - Kelvin relates the nature of temperature and colorimetry.

1860 - Stereoscope collecting craze peaks. Among the attractions are stereoscopic "spirit" images of ghosts, created by subjects moving into and out of the frame during the exposure.

1860 - Jean Bardot invents a 5 level time division multiplexing printing teletype and a 5 bit code for alphanumeric communications.

~1862 - English physicist William Crooks discovers thallium, and element. He also experiments with a vacuum tube, and passes high voltages across two electrodes that are separated inside the vacuum.

1861 - Coleman Sellers in America patents the Kinematoscope, a paddle wheel viewer. He photographs actors in successive phases of action and simulates live action.

1861 - Sir James Clerk Maxwell demonstrates additive color theory by recording and projecting a full color image of an object.

1861 - Abbe Caselli operates first fax service, France.



1864 - Maxwell theorizes radio.

1866 - The Diorama, Panorama, Cyclorama emerge as popular amusements.

1866 - The first transatlantic telegraph is completed.

1867 - Bell jar stock ticker introduced; speed is 40 words per minute.

1868 - Englishman Linnett patents the flip book, which becomes a popular moving picture form.

1869 - Louis Ducos du Harone demonstrates subtractive color theory method of photography and reflective color photography. He also invents anaglyphs--stereoscopic photographs using two superimposed photos or drawing in two colors and viewed with two different colored glasses.

1869 - New Yorker John Hyatt invents cellulose acetate, a transparent film that will eventually replace glass as a photographic medium.

1871 - Richard Maddox's dry plate photographic process reduces exposure time below 1/100th second, forcing the shutter to become well understood and making roll film media a possibility. One implication of the dry plate is that photography evolves from contact printing and begins to incorporate optical enlargement as a part of the production process. This in turn, encourages the cropping and editing of pictures.

1873 - Englander Joseph May discovers the photoconductivity of selenium.

1875 - American George Caney proposes parallel pixel TV.

1876 - Alexander Bell perfects electric telephone.

1877 - In Paris Charles Reynard develops the Praxinoscope, a variation of the Plateau-Stampfer disc with a mirror set in the center for viewing; two years later he succeeds in projecting moving images.

1877 - Thomas Edison accidentally invents the tinfoil cylinder phonograph and records and plays back "Mary Had a Little Lamb." Within a few years wax cylinders would become a popular consumer item.

1877 - Sir W. Siemens in England invents the dynamic moving coil speaker.

1878 - William Crookes develops cathode ray tube.

1878 - First commercial telephone exchange begins operation at New Haven, Connecticut. Patch cords connect 21 initial subscribers and hand cranks ring bells.

1878 - Eadweard Muybridge couples photography to motion recording. He uses 24 cameras activated with trip wires to record serial sequences of real live motion. In 1879 he makes the first recording of humans in motion perfects a projecting phenakistiscope (a zoopraxiscope) for screening. Before Muybridge the gaits of the horse were studied by listening to them; Muybridge's cinematography proves that a running horse has all four feet in the air some of the time.

1879 - Edison perfects incandescent light. It is a vacuum tube technology with a resistant filament between two low voltage inputs that glows.

1879 - Teletypewriter superimposed atop Morse Technology.

1879 - George Eastman patents an emulsion coating machine and, the next year founds a photographic media company.

1880 - Flash power is invented.

1881 - British Shelford Bidwell builds fax machine with an X,Y translate platin containing a pinhole box camera containing a selenium cell. Scanning is obtained by moving the camera.

1881 - Michelson measures the speed of light.

1882 - Etienne Jules Marey pioneers the chronophotograph: a single camera and medium used to record multiple exposures. Later, strobes will enhance this idea.

1884 - German Paul Nipkow patents a spirally apertured rotating disc shutter that is used as a flying spot scanner in early television systems.

1884 - Eastman develops a negative emulsion on roll paper.

1885 - Emile Berliner, a German born immigrant in America, perfects a negative/positive manufacturing processing for photographic discs. Although both cylinder and disc audio recording technologies were well known, copies had to be dubbed from the original recording. In Berliner's process mechanical electroplate molds were made from the master disc, and the records were made by stamping, at first from vulcanite (a hard rubber), later from a shellac compound, and eventually from vinyl plastic. The most common early form of this is the 7 inch diameter, 78 rpm record.

1885 - Heinrich Hertz explains electromagnetic waves.

1886 - Alexander Graham Bells patents the selenium photo-electric cell.

1887 - Marey, in Paris, invents cyclic camera.

1887 - Sczcepanik and Kleinburg describe an apparatus which performs zigzag scanning.

1888 - Eastman develops a negative emulsion on clear, flexible, celluloid roll film, and markets a simple camera to use it.

1889 - William Dickson (at Edison's lab) perfects a single lens moving picture camera, the kinetograph, that uses roll film and an intermittent shutter, and shoots the first U.S. movie on celluloid. Edison also experimates with synchronious sound, where the sound is recorded on wax cylinders.

1889 - George Eastman applies for a patent on motion picture film.

1889 - German Lazare Weiller invents rotating mirror scanning system for television.

1889 - Ottomar Anschutz invents the tachyscope and electrical tachyscope, an image viewing device which uses a luminous Geissler tube to intermittently illuminate transparent pictures mounted around the circumference of a wheel. This advance eliminated the need for slits or shutters and allowed electric light to project images.

1889 - The Columbia Multiplex Graphophone Grand is introduced, a multiple track, stereo sound recording and playback machine that recorded parallel and separate tracks on a single cylinder using separate horns.

1890 - Page transmission concept added to teletypewriter.

1890 - British physicist James Dewar perfects the vacuum flask, in which a double walled glass flask contains a vacuum inside, so that heat transfer is minimized.

1891 - Edison applies for patents for the kinetoscope, a roll film viewing apparatus, and the complementary kinetograph (the camera).

1892 - Emile Reynaud presents *Pantomimes Lumineuses*—animated roll paper drawings projected onto a screen—and opens the Theatre Optique at the Paris Wax Museum. Titles include *A Good Glass of Beer* and *A Clown and His Dog*.

1892 - Edison builds the "black maria" film studio.

1892 - Frank Hall perfects a mechanical Braille writing machine.

1893 - Valdemar Poulsen experiments with magnetic recording and playback techniques.

1894 - J. J. Thompson accumulates evidence for the existence of the electron.

1894 - Edison introduces Kinetoscope peep show parlors in several cities, including the Chicago Exposition and 1155 Broadway, in New York.

1894 - Edison copyrights *Fred Ott's Sneeze*. Ott worked at the Edison studio and this 45 frame documentary is the oldest film in the Library of Congress.

1895 - Brothers Louis and August Lumiere develop an open back moving picture shuttle. This design allows the it to double as both a camera and projector; the open back allows light to be projected thru a developed motion picture film print and onto a screen. Having perfected the projector they next invent the movie theatre, charging the public admission to attend screenings. The next year an uncertain Edison introduces movie projector into USA.

1895 - Herman Castler manufactures the Mutoscope paddle wheel viewer, a crank operated peep show that fanned a thousand or so still images in front of a viewing lens.

1895 - Thomas Armet, in Washington, builds a motion picture projector that flashes each frame twice.

1895 - German scientist Wilhelm Roentgen discovers invisible "X-rays" that are able to pass through paper, wood, and even the human body. He is able to generate them with a special kind of vacuum tube.

1896 - Edison introduces movie projectors into America. The first pictures exhibited are at the Koster & Bial's Music Hall at 34th Street and Broadway, New York (May 2).

1896 - Hand coloring (tint color) used by Pont in a film about cowboys.

1896 - Michael Pupin at Columbia University takes the first diagnostic X-ray photograph in the United States and within four weeks a diagnostic X-ray is used as an aid to set a bond fracture of a young boy named Eddie McCarthy of Hanover, New Hampshire.

1896 - H. Becquerel in Paris discovers radioactivity.

1897 - K.F. Braun in Germany introduces the cathode ray tube, a vacuum tube with fluorescent screen and deflected beam, and which becomes the basic of the oscilloscope, and later, the TV.

1897 - Gaumont invents the synchronous motor.

1898 - Polarizing stereoscopic film projector is patented.

1899 - English physicist J. J. Thomson describes how a current can be made to flow between two electrodes in a vacuum tube if one of them is heated.

1901 - Marconi demonstrates transatlantic wireless telegraph transmission. His earliest successes date from 1895.

1901 - Edison 4 inch wax cylinder format is standardized. There are 100 laterally cut grooves per inch, a speed of 160 rpm, and a total playing time of 2 minutes.

1903 - D.W. Griffith's *The Great Train Robbery* marries roll media and storytelling, creating the photoplay. It is filmed near Orange, New Jersey, and is 12 minutes long.

1903 - Eugen Lauste demonstrates optical sound recording using a selenium cell.

1904 - Panchromatic B&W film is perfected.

1904 - Englishman A.J. Fleming invents DIODE vacuum tube.

1904 - German Arthur Korn solves phase and sync problems of fax machine. This firmly establishes the concept of the frame and the scan line.

1905 - Albert Einstein elaborates the theory of relativity.

1906 - Lee De Forest invents the TRIODE, a vacuum tube with three elements and with the ability to amplify electronic signals. Wireless telephony becomes possible. De Forest also combines Lauste sound on film experiments with a photoelectric cell to facilitate playback.

1906 - Charles Urban and Albert Smith introduce a two color cinematography process called Kinemacolor which uses field sequential red and cyan colored filters.

1907 - The Lumiere brothers perfect reversal color photography, the Autochrome process, which records images onto a three color screen consisting of potato starch grains and a panchromatic emulsion. A typical exposure time for bright daylight is f8 at 1 second, an ASA around .275. Autochrome will be used until Kodachrome, introduced in 1936, replaces it.

1907 - Russian Boris Rosing combines a mechanical scanning shutter along with a fluorescent face CRT television receiver in which the beam is deflected with electromagnets. Rosing also successfully synchronizes the transmitter and receiver scanning.

1907 - Phonograph playing time becomes increasingly competitive: 10 inch discs play 3 minutes, 12 inch discs play 4 minutes. Edison doubles the groove resolution of his 4 inch cylinder, from 100 to 200 grooves per inch, doubling the playing time from 2 to 4 minutes, and Columbia Records extends its 4 inch cylinder to 6 inches, holding constant at 100 grooves per inch, to increase playing time to 3 minutes. A variation, the office dictaphone, is introduced.

1908 - Scottish engineer Campbell Swinton proposes that the mechanical Nipkow shutter be replaced with luminance modulated scanning electron beams, and that the entire TV system be electronic.

1908 - In America the Motion Picture Patents Corp is formed to tighten up control of key patents and consolidate an industry. Movie houses in 3000 cities change shows daily; immigrants don't need language skills to watch silent movies.

1909 - 35mm film gauge is standardized.

1909 - Neils Bohr formulates the atomic theory.

1912 - The United States Navy builds radio station NNA in Arlington, Virginia to communicate with ships. It is the first high powered broadcasting station.

1915 - AT&T demonstrates AM radio transatlantic speech.

1915 - Audio amplification is introduced into the phone system and the first transcontinental lines are put into service in America.

1915 - Albert Einstein expounds the theory of relativity.

1919 - American Harry Nyquist (at Bell Labs) defines the term bandwidth.

1919 - Bell system installs first step by step switching in central office.

1919 - Three color traffic light is installed in Detroit to control automobile traffic.

1919 - First known electrically amplified sound recording is made at Westminster Abbey in England. In America Joseph Maxfield and Henry Harrison at Bell Labs begins research on electronically mediated sound recording.

1920 - KDKA broadcasts Cox-Harding election results, and commercial radio begins.

1920 - Edwin Armstrong patents the heterodyne circuit, creating a breakthrough in radio receiver design.

1920 - Charles Hoxie at General Electric demonstrates sound on film. Lee de Forest, 1921; Western Electric, 1922; Peterson and Poulsen patent, 1924.

1921 - Transatlantic digital picture transmission service becomes available via the Bartlane cable. Pictures are quantized into five intensity levels and reproduced using a teletype equipped with a typeface of patterns with different halftone densities. The service takes three hours and the quality is suitable for newspaper reproduction. In 1929 the service is increased to 15 levels of grey.

1921 - First fully automated telephone exchange, at Omaha.

1923 - Charles Jenkins demonstrates mechanical television of shadow graphs.



1923 - Working at Westinghouse in the United States, Russian born Vladimir Zworykin demonstrates the iconoscope, an electronic television camera pickup tube, and files for a patent. The laboratory also succeeds in combining all the television picture information and the syn on a single carrier. The following year he patents a television receiver. Although his first experiments are not impressive, in 1929 he is offered a position to direct television development at RCA, which becomes the impetus for modern TV.

1923 - The 16mm motion picture format is introduced, with equipment from Bell and Howell and stock from Kodak. The new stocks use a cellulose acetate base and reversal black and white film is perfected.

1924 - Leica in Germany, introduces the professional 35mm still camera.

1925 - Victor Talking Machine Co releases the first commercial record to be electronically recorded using the Western Electric process that had been developed at Bell Labs. The frequency response of the older acoustic process was 200 to 3000 cycles per second; the new response range is 100 to 5000 hertz. Microphones suddenly could be divorced from the recording apparatus itself.

1925 - Flash bulb is manufactured.

1926-27 - First sound pictures. Jolson's *Jazz Singer* employs a double system for picture and sound. Disney's ??

1926 - In the USA Jenkins demonstrates a mechanical television with continuous tone images and broadcasts a 15 line TV signal from a radio station in Washington.

1926 - John Baird in London experiments with a 30 line frame sequential color television system using a mechanical Nipkow disc.

1926 - E. Schrodinger equations mark the beginning of quantum mechanics.

1927 - Bell Laboratories demonstrates 50 line mechanical picture telephone between Washington and New York.

1927 - German P. Fleumer develops reel to reel magnetic tape. Its use evolves in Germany during the 1930s.

1928 - Nyquist establishes the idea of a sampling limit, and lays the foundation for digitizing theory.

1928 - Armstrong perfects FM radio broadcasting.

1928 - Eastman Kodak introduces Kodacolor 16mm film; it is a negative stock using an additive process.

1928 - Jenkins establishes first (mechanical) television station--W3XK in Washington DC. WRNY transmits pictures in New York and GE broadcasts from Schenectady. The GE station broadcasts 48 lines on channels just above the AM band at 2100 Kcycles. Waxed discs are used to record moving pictures (Phonovision). Picture frequencies are as low as 12 frames per second.

1928 - Frenchman Henri Chretien invents a widescreen motion picture process called Cinemascope that uses an anamorphic lens to squeeze the wide picture into a standard 35mm frame (in the X axes). The invention is ignored until television begins to erode the film market, and is introduced in 1953.

1929 - 70mm film introduced.

1929 - RXCA demonstrates 16mm film with optical sound.

1930 - German company Telefunken applies interlace scanning to electronic television signal. In America, interlace is independently discovered and patented by RCA in 1933.

1930 - Finlay color photography process is developed in England. It uses a fixed screen and is a faster, but grainer technology than Autochrome.

1931 - AT&T offers a teletypewriter exchange service (TWX).

1931 - CBS mechanical television station W2XAB goes on air in New York. Natalie Towers is the first actress ever engaged by a nation-wide broadcasting system exclusively for TV. W2XAB operates with a bandwidth of 100 kilocycles on a channel centered at 2800 kc (or between 2750 and 2850 kilocycles) with 500 watts

of power. W1XAV-W1XAU in Boston builds a 60 line 20 frame per second transmitter. The video operates on 2870 kc with 1000 watts and the audio is on 1604 at 500 watts and simultaneously broadcast. Broadcast bandwidth is understood to be a limiting factor; another difficulty is lack of scanning resolution standards.

1931 - Victor introduces the long play phonograph record, revolving at 33 1/3 rpm, in 10 and 12 inch sizes, and pressed in plastic.

1931 - Englishman A. D. Blumlein patents a special sound recording head which is able to record two audio tracks (stereo) in a single groove.

1932 - Technicolor introduces a three color subtractive process which uses a beam splitter and records three parallel black and white (pan separation) negatives. Color prints are then made using a color dye transfer process. The Technicolor process is used by Disney to make *Flowers and Trees*, but it is three years before it is used for live action (*Becky Sharp* in 1935).

1932 - W9XK at University of Iowa is first educational TV station.

1932 - Kodak introduces 8mm film.

1932 - Edmund ? Land introduces polarizing filters which only let light pass which has a certain orientation in space. These have wide application in science, photography, and stereoscopic projection.

1933 - Fusion of the motion pictures and the automobile: the first drive in theater opens in Camden, New Jersey.

1934 - Dry process recording paper used in fascimile.

1934 - Electronic television is synchronized to the AC power frequency, forming the basis of the 30 frames, 60 fields per second standard.

1935 - First live action Technicolor movie, *Becky Sharp*.

1935 - Eastman Kodachrome demonstrates a tripack color reversal film with faster speed and fine grain and revolutionizes color photography. The stock is initially released as 16mm movie film, but in 1936 Kodak begins selling the emulsion in the still popular 35mm size.

1935 - Associated Press initiates its Wirephoto facsimile network, initially with 39 newspaper subscribers. The service transmitted photographs, weather maps, and other graphics. Resolution is 100 lines per inch and a 880,000 pixel typical photo is transmitted in 8 minutes.

1935 - David Sarnoff, president of RCA, tell shareholders that RCA has produced 343 line pictures at 60 frames per second. He announces perfection of the iconoscope, a vacuum tube image pickup transducer.

1936 - BBC begins medium resolution television service.

1937 - Last mechanical TV station is W6XAO, Los Angeles.

1938 - American A. Rose invents Orthicon tube.

1938 - Orson Welles' radio broadcast of the War of the Worlds, simulates news broadcasts of an invasion of New Jersey by Martians causes thousands of radio listeners to panic and abandon their homes.

1939 - Reeves defines pulse code modulation and a way to sample and quantize digital signals.

1939 - AEG develops spinning magnetic recording head.

1939 - The magnetron tube is developed in Britain, making possible radar as well as microwave communications.

1939 - First stereoscopic projection using polarizing filters.

1941 - NTSC Black and White all electronic TV standard adopted.

1941 - Stereophonic sound introduced in *Fantasia*.

1942 - Kodacolor negative stock introduced (again) by Kodak.

1942 - Radar perfected.

1942 - Enrico Fermi leads an effort to build the first atomic reactor, CP-1, in Chicago. This is the first self-sustaining chain reaction and controlled release of nuclear energy

1944 - Magnetic tape recording perfected.

1945 - Americans and British explode the first atomic bomb in a remote site near Alamagordo, New Mexico.

1945 - Magnetic tape audio recorder at 30 inches per second becomes the standard audio mastering instrument.

1946 - CBS develops a field sequential color TV system that employs a spinning color wheel and successive red, green and blue fields.

1947 - Herman [or Edwin?] Land invents self developing instant black and white film. The film pack contained the chemicals that were released after exposure.

1947 - Transistor is invented at Bell Labs.

1948 - Columbia introduces the long-playing microgroove record, invented by Peter Goldmark in their research labs. It is similar to the 1931 RCA long play record and revolves at 33 1/3 rpm, but it has a finer groove and a playing time of about 30 minutes per side for a 12 inch diameter record.

1948 - RCA Victor introduces the 7 inch 45 rpm record, a microgroove record that has remained popular for popular single songs, and marked the death tolls for the 78 rpm record.

1949 - RCA perfects the vidicon, a photoconductive camera vacuum tube.

1949 - A. Rose invents shadow mask color picture tube.

1949 - US courts rule in the Paramount case that it is illegal for studios to operate their own chain of theaters.

1950 - The introduction this year of daylight balanced Eastman color negative (ASA 16) begins the eventual replacement of the Technicolor process. In 1953 Kodak replaces it with a slightly faster stock (ASA 25) balanced to 3200 degree Kelvin, a current standard for tungsten light.

1951 - PAL composite color television system defined.

1951 - Experimental high speed longitudinal video tape recorder demonstrated by Bing Crosby Enterprises. Also first experiments with rotating head recorders.

1951 - AT&T introduces direct distance dialing (DDD), a public switched telephone network to route calls based on area code, exchange, and subscription line number.

1952 - Hollywood responds to the pressures of television by introducing wider aspect ratios. The Cinerama movie format is introduced in New York. It employs multitrack sound and three synchronized cameras/projectors and a curved screen to provide a 70 or 80 degree wide angle field of view.

1952 - Image Orthicon television camera becomes the black and white standard.

1952 - Americans detonate first hydrogen bomb, in South Pacific.

1953 - Twentieth Century Fox acquires the wide screen Cinemascope process (see 1928) and introduces it in the movie *The Robe*. Magnetic strip tracks are employed for stereophonic sound. A similar process called Panavision is introduced shortly thereafter.

1953 - A color television method developed by RCA is adopted by FCC; this extends the NTSC standard by overlaying color information overtop a black and white signal.

1953 - RCA builds an experimental high speed color longitudinal VTR. The machine runs at 360 inches per second and a 17 inch diameter reel holds enough tape to record four minutes.

1953 - Bardot code and 75 word per minute Teletype (model 28) are standardized and become international communication device.

1954 - The Army/McCarthy Senate hearing on communism are televised live, capturing the American attention and capitulating the new medium.

1954 - Another wide screen format, VistaVision, is introduced. The format uses standard 35mm film, only running horizontally, with a frame that is 8 perf holes wide.

1954 - Gabor(?) invents laser.

1954 - 16mm film with magnetic stripe tracks is introduced.

1955 - Circlevision is introduced by Disney. The format is a 360 degree projection that surrounds viewer and which employs either 11 16mm cameras/projectors or 9 35mm cameras/projectors.

1955 - Todd-AO process records on anamorphic 65mm film and projects using 70mm film that includes 5 magnetic sound tracks. The format for each frame is 5 perf holes tall. Because the aspect ratio is similar to Cinerama and only one strand of film is involved Cinerama becomes obsolete.

1955 - RCA demonstrates large screen video projector with a 15 by 20 foot image.

1956 - Ampex demonstrates video tape recorder (VTR) that employs 2" wide tape (made by 3M) and quadraplex (4 head) recording using frequency modulation (FM). First video tape broadcast.

1956 - Transatlantic telephone cable completed.

1957 - Soviet Union launch first man-made satellite, Sputnik, into Earth orbit.

1958 - First stereo phonograph records appear on the market.

1958 - Miniturized Nagra field sound recorder is introduced.

1960 - Toshiba introduces a helical scan VTR.

1961 - Soviet Union perform first manned spaceflight.

1962 - Philips introduces the compact audio tape cassette.

1962 - Telstar communication satellite is launched and provides international relay of TV pictures.

1962 - SECAM color television standard is introduced in France. It has more lines of resolution than NTSC but a slower frame rate, and include a 1 horizontal line delay line (a row buffer).

1963 - Syncom II geosynchronous orbit satellite ushers in the era of satellite relay long distance telephone communications.

1963 - Polaroid releases a self-developing instant color film. It is based on a subtractive color dye transfer process.

1963 - TV is used during the Mercury 9 manned space flight.

1963 - Laser made holograms are demonstrated at the University of Michigan.

1964 - All transistor, color quadraplex 2" VTR introduced by Ampex.

1964 - Jet Propulsion Laboratory in Pasadena uses digital frequency domain image enhancement techniques to enhance television pictures from the Ranger 7 moon probe.

1964 - Techniscope format introduced, which uses standard 35mm film, only with a two perf hole high frame. Thus the format is both wide screen and non-anamorphic.

1965 - Super 8 mm film gauge is introduced.

1965 - Color television cameras adopt newer plumbicon tubes; zoom lenses replace turret mounts.

1966 - Lunar Orbiter I takes the first photos of a whole earth from space.

1966 - The 7 level American Standard Code for Information Interchange (ASCII) is adopted to meet communication needs which



require a code set bigger than the Bardot code. It is initially used in the Teletype model 37, introduced in 1968, which operated at 150 words per minute, but has continued to remain a widespread standard.

1966 - PAL television standard introduced in England, West Germany and Holland. It has a higher line rate and a slower frame rate than NTSC, as well as a delay line.

1967 - First time code videotape editing system is demonstrated by CBS. Ampex demonstrated an electronic edit on videotape. Prior to this, all editing on videotape was done by physically cutting the medium and splicing it back together again.

1967 - Ampex introduces an analog magnetic video disc recording and playback system, the HS-100, that can record 30 seconds of video and play back single frames, slow motion, or backward action. The instant replay is born and revolutionizes sports broadcasting.

1967 - PAL and SECAM color format standards are approved.

1968 - Apollo 7 makes first monochrome TV broadcast from a manned space flight.

1969 - First telephone call to the moon, between Richard Nixon and astronauts Neil Armstrong and Buzz Aldren, during the first landing of men on the moon.

1969 - SMPTE time code established as standard.

1970 - Commercial Picturephone service is announced by AT&T. It uses a 1 megahertz line and is a commercial failure.

1970 - NHK in Tokyo begins first experiments on 1125 line HDTV system.

1971 - Soviet Union launches *Salyut*, ushering in the era of semipermanent manned space stations.

1971 - Japanese companies Sony and JVC introduces U-matic 3/4 video tape recording format. It employs a helical scan color recorder and a self enclosed tape cassette. Internally the signal is

recorded in a component form called color under, but the output, once time base corrected, is broadcastable. The equipment is too expensive for consumer use but revolutionized the professional market. In 1989 Sony sells its millionth U-matic machine.

1972 - Digital time base correctors are introduced by Microtime and Consolidated Video Systems.

1972 - Denon digital audio.

1972 - The CMX 300, the first computerized editing system, is introduced for on-line editing.

1972 - Phillips and MCA demonstrate a lasor videodisc player.

1973 - First color hand held ENG minicams are introduced by Ikegami, Philips, Hitachi and RCA. The units consist of a camera, weighing about 12 pounds, and a backpack, weighing about 20. By the end of the decade 3/4" electronic new gathering will have completely replaced 16mm film, and 3/4" will become the dominant distribution medium for most educational and corporate communications.

1973 - Video Time Base Corrector introduced NAB.

1973 - First gene splicing achieved at Stanford University. Biological (re)programming begins in earnest.

1974 - Willard Boyle and George Smith at Bell Labs perfect the charge-couple device (CCD), a solid state image sensor constructed as a chip.

1975 - RCA demonstrates the Selectavision videodisc system, which employs a mechanical transducer and is a commercial failure.

1976 - The VHS and Beta home videocassette formats are introduced by Sony and Panasonic. Both are color, and involve helical scan recording on a 1/2 inch wide tape.

1976 - Colorization of black and white movies.

1976 - British biologist Richard Dawkins advances the theory of memes, constructs which are mental knowledge which is

analogous to genetic knowledge, and which is passed as learned behavior.

1976 - Ampex introduces a digital video disc still store and slow motion recorder, the ESS-1. It replaces the HS-100.

1977 - Ampex and Sony introduce 1" C helical scan video tape format. Both studio and portable field machines are delivered the next year. The format supports still-frame playback, picture-in-shuttle (picture visible during fast forward and rewind), and single frame recording.

1977 - The home satellite dish redefines the economics and politics of television broadcasting, enabling people with little or no local television origination to view TV from all over the world.

1978 - Laser videodisc is commercially introduced by Philips.

1979 - Bosch introduces a telecine that employs a charge coupled device.

1980 - First fiber optic communication links are installed.

1980 - Time code is introduced into the 1" C format.

1980 - Sony introduces the still video camera. It employs a CCD transducer and records frames on a floppy disc. The pictures may be viewed on a TV, recorded on a paper printer, or transmitted via a modem.

1981 - Sony introduces the Betacam videocassette format. It is a professional quality 1/2 inch cassette format that records component video with separate luminance and chrominance information. The smaller equipment includes a handheld camcorder that combines the camera and recorder into a single unit. The next year Panasonic introduces M, also a 1/2" format.

1982 - Kodak announces film stocks with transparent magnetic layers that can be used to record time code or digitally encoded pictures.

1982 - Polaroid introduces a self-developing color slide film.

1982 - Sony demonstrates an 1125 line HDTV system at the NAB.

1982 - CMX and Orrox introduce a disc based non linear video editing system.

1982 - CD audio discs employ laser and digital audio.

1983 - First intercity long distance digital TV transmission using fiber optics.

1984 - WNBC-TV, New York becomes the first television station to broadcast a stereo program—*The Tonight Show*.

1984 - RCA introduces a broadcast quality ENG camera with a CCD transducer.

1984 - Montage and Lucasfilm/Convergence demonstrate non linear editing systems that use cassettes and laser discs respectively and work with time code.

1984 - Epson introduced the first vest pocket, portable, color TV receiver with a color liquid crystal display. It weighs one pound, has a 2 inch screen and is powered by 5 AA batteries.

1984 - 8mm helical scan videocassette format is introduced, initially as a consumer format. Its secret is an imbedded tracking servo which permits very slow linear tape speeds, and will shrink the camcorder to a palmcorder.

1984 - Optical Disk Corp and Panasonic each introduce recordable videodisc systems.

1986 - Betacam is upgraded to Betacam SP, and M is upgraded to M2

1986 - Super VHS video format is introduced. It is a backwards compatible format with component recording that targets industrial users.

1986 - Sony unveils digital component VCR (D1 format).

1986 - Barry Rebo, in New York, founds first business in America producing high definition television (HDTV). His equipment, manufactured by Sony, includes a camera, recorder, monitor, and switcher.

1987 - Digital audiotape introduced for consumer products.

1987 - Digital composite VCR (D2 format) is introduced. The system employs a 19mm wide cartridge tape and records a digitized NTSC (or PAL) video signal. Luminance is sampled at 13.5 megahertz, chrominance at 6.75 megahertz with 8 bits per sample. Spatial resolution is 720 pixels per line. Bandwidth is 227 mbits/second.

1988 - Kodak introduces color and black and white film stocks utilizing flat tabular shaped silver halide crystals. The new stocks are very fine grain and also very fast, with ratings that can be pushed to 50,000 ASA.

1988 - Sony introduces the Walkman, the first miniature TV receiver with a built in VCR. It uses a color liquid crystal display and 8mm video cassettes.

1989 - Sony introduces a handheld video camcorder, the Handycam CCD-TR5, which uses a CCD transducer, records 2 hours on an 8mm videocassette, includes a zoom lens, variable speed shutter, auto focus, auto iris and auto white balance and weighs under 2 pounds.

1989 - Starsignal, an American company, introduces a color fax machine to the office market.

1989 - Avid introduces a non-linear videotape editing system that runs on a Macintosh II. It digitizes and stores low resolution video images on disk, and produces an edit list for conforming the original.

1991 - Unicode is introduced. It is a 16 bit standard for letters, numbers, punctuation marks, mathematical and technical symbols, geometric shapes, and dingbats ( $\pi$  case) for most languages of the world, including Latin derivatives with diacriticals, Greek, Cyrillic, Hebrew, Armenian, Arabic, Ethiopian, Chinese,

Tiawanese, Japanese, Korean, and the languages of the Indian subcontinent.

- Omnimax

- Imax

195? - Smell-O-Vision is introduced. For the thriller *Scents of Mystery*, odors are released into the theater to coincide with moments on the screen.

195? - Theater seats are wired with joy-buzzers for *The Tingle*.

Edison ?? invents the microphone.

Genghis Khan employs homing pigeons as a communication device.

Widespread use of signal flags is popularized by Navies.

Valentin Haüy (1745-1822) employs embossed paper with normal letters as a reading method for the blind.

The Greek foot messenger...

First electronic television switcher able to dissolve between two or more cameras.

The digital still store.

Step by step telephone switching introduced.

Crossbar switching introduced.

Tone dialing introduced for voice phone service.

193? - Farnsworth invents the image dissector, an early vacuum tube design for capturing an image. Farnsworth is claimed to have observed, at age 15, the rows of a corn field being plowed, and realize it was the way to scan an image. This may be folklore, given that raster scan machines had been around for decades, but it is a good metaphor.

195?? - Over-under 35mm stereoscopic cinema format is introduced.

After 1974.= before 1989. Tektronix manufactures a 2048 square CCD array that measures 2.5 inches square. It is the largest integrated circuit made to this date.

1984 ? - Doug Trumbull perfects Showscan format, arguing that 60 frames per second on 70mm film provide a more visceral experience for the movie viewer.

- Remington introduces the QWERTY typewriter keyboard.